Multivariate Causality between Stock price index and Macro variables: evidence from Canadian stock market

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Abstract

Currently, the investor considers monetary indicators a vital factor when making any investment in equity prices. This research aim to find the long-run relationship between stock returns (DLSP) of Canada and monetary indicators as the exchange rate (LEXC), the interest rate (LINT), and inflation rate (INF). We consider T=232 observations for each variable from January 1999 to April 2018. From the **Johansen cointegration** approaches, there is **no** long-run association between stock prices and monetary indicators. Results of **the Granger causality** tests have demonstrated the **unidirectional** causation from the stock return to Inflation rate and to Exchange rate growth. While Results of **Toda and Yamamoto Wald** tests have demonstrated a **bidirectional** causal relation between stock price and consumer price index and a **unidirectional** causation from stock price to the interest rate and to the exchange rate growth. Based on IRFs, **Inflation** rate is shown to be **inversely** related to stock returns. Thus, it is concluded that the predictability of Canadian stock return relies only on the variations of **inflation** rate.

Key words: Canadian stock price index; macroeconomic variables; Granger non causality; Johansen cointegration; Toda and Yamamoto non causality wald test, Impulse–response functions (IRFs).

Jel classification: C32; E44; G14

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I. Introduction

The financial market of any country is to be considered as a benchmark of its economic strength. According to the literature there are several factors, including social, economic, and political factors, that can influence the working performance of an equity market.

For academics and practitioners of financial economics, the role of macroeconomic **monetary** variables in interaction with the share prices of stocks has been a crucial and interesting topic.

Monetary indicators, as the fundamental macroeconomic indicators which normally explicate the movements of stock returns, include inflation rate, interest rates, and the exchange rate.

The literature shows an association between equity prices and **inflation rate** ((Chang & Pinegar, 1990); (DeFina, 1991); (Gjerde & Sættem, 1999); (Nelson, 1976)). Using the arbitrage postulate, (Chen, Roll, & Ross, 1986) and (Ross, 1976) ascertained the effect of the **inflation rate** on equity markets in the **United States**. They concluded that both **expected and unexpected inflation** rates are **inversely** related to stock returns.

The first who investigated the cause-and-effect phenomenon for different macroeconomic **monetary** indicators and stock returns was (Fama & Schwert, 1977). According to (Ahmed, Vveinhardt, & Meenai, 2015), equity returns have relied heavily on economic variables as foreign direct investment (FDI), the inflation rate, consumption, the exchange rate, manufacturing production, money supply, and interest rate, etc.

Hence, given these postulates, we are persuated, as researcher to examine the linkage between monetary variables (inflation, interest rate, and exchange rate) and equity prices. This research aims then to find the long-run relationship between stock **returns** of Canada and monetary indicators.

The study investigates the nature of the causal static and dynamic relationships between UK stock price and the key macro-economic variables in UK economy for the period January, 1999 to April, 2018 using monthly data.

To reach the objective of the study various econometrics tests for different specifications will be carried out, namely unit root tests (ADF and PP), Vector Auto Regression (VAR) to select the optimal lag length, VEC Model and (Johansen, 1988)' test for cointegration, Granger non causality test and (Toda &

Yamamoto, 1995) Wald non causality test, and VAR model and IRFs. All are done by Eviews 10.

Therefore this paper has been organized as follows. Section II analyses the required mentioned data and their sources. Section III outlines the methodology used in subsection 1. Subsection 2 provides the empirical results and analysis. And finally, concluding remarks are given in section **IV**.

II. Data analysis

We begin by the descriptive analysis. **Table 1** shows the details of the macroeconomic indicators, sources, frequency of the data series, and notation. We transformed monthly data into a natural log except inflation rate. We consider T = 232 observations for each variable from January 1999 to April 2018.

Table 1. Data collection sources.

Variable	Frequency	Source	Notation
Canadian stock price	Monthly	OCDE	LSP
Interest rate	Monthly	IMF	LINT
Consumer Price Index	Monthly	IMF	LCPI
Exchange rate	Monthly	IMF	LEXC

L ≡ log transformation. OCDE ≡ Organasation de Cooperation et de Developpement Economique.

The inflation rate can be calculated by applying the difference of the natural log. The mathematical representation of the inflation rate return is given by

$$INF_t = LCPI_t - LCPI_{t-1}$$

$$LCPI_t = \log(CPI_t)$$

where CPI_t and CPI_{t-1} are the Consumer Price Index at time t the current month and previous month t-1.

The natural log difference transformation is used to compute the **stock returns**;

$$DLSP_t = LSP_t - LSP_{t-1},$$

$$LSP_t = \log(SP_t),$$

where SP_t and SP_{t-1} are the current and previous month stock prices for the current month t and previous month t − 1.

Table 2 shows the monthly returns of Canadian stock price (DLSP), which shows that average return is 0.3578% with a volatility of 0.037974; and maximum and minimum returns of 11.1872% and −24.9987% recorded in a 1999M01 and

2008M10 respectively. The average interest rate (LINT) is recorded to be around 63.5%; while, the maximum interest rate is documented as being up to 1.77. The average inflation rate (INF) is 0.06% and the maximum went up to around 5.4%. The average reduction in Canadian money is around 20% per month. Results of the kurtosis showed that all considered time series data do not follow the normality patterns because the Kurtosis values are greater than 3 and all the series are negatively skewed except for exchange rate (LEXC).

Table 2. Descriptive statistics.

	ΔLSP(Return)	INF	LINT	LEXC
Mean	0.003578	0.000604	0.635016	0.200077
Median	0.010503	-0.000126	0.743616	0.205094
Maximum	0.111872	0.053552	1.777876	0.469458
Minimum	-0.249987	-0.086021	-0.978726	-0.045197
Std. Dev.	0.037974	0.016252	0.739797	0.153935
Skewness	-1.499048	-0.357624	-0.176842	0.153147
Kurtosis	11.05822	6.041953	1.969974	1.742338
Jarque-Bera	711.5136	93.98870	11.46511	16.19678
Probability	0.000000	0.000000	0.003239	0.000304
Observations	231	231	232	232

The plots on the following graph indicate that all the series are trending and potential I(1) processes. **Figure 1** reports the graphical evolution non-stationary data series; the stock price and consumer price index for the considered time horizon from January 1999 to April 2018. The graph shows that the series do appear to move together. **Figure 2** reports also the graphical evolution of non-stationary data series: exchange rate and interest rate respectively for the same period.

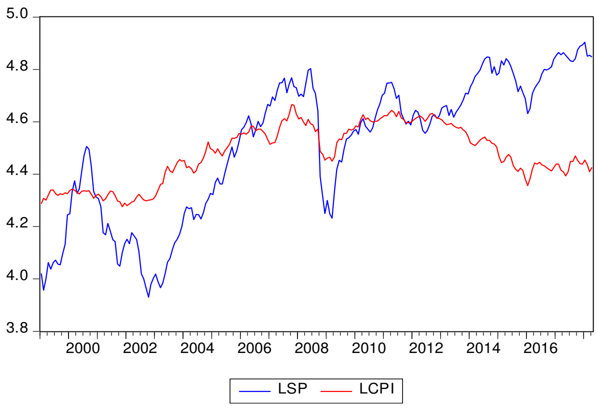

Figure 1. Stock price and consumer price index evolution in log from January 1999 to April 2018.

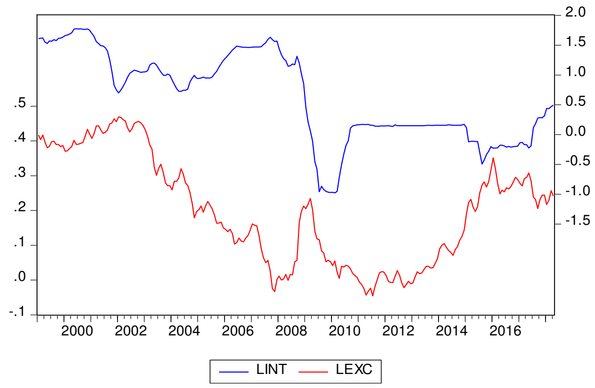

Figure 2. Exchange rate and interest rate evolution in log from January 1999 to April 2018.

The results of the augmented Dickey and Fuller test is presented in **Table 3.** The results showed that all considered variables (Canadian stock price, rate of exchange, Consumer price index and interest rate) possessed a unit root at level. Therefore, the data series were transformed and checked on first difference where these data series have become stationary; consequently, the series are integrated of order one, I(1).

Table 3. Results of stationarity augmented Dickey–Fuller test.

	Augmented Dickey–Fuller test statistics at level and first difference			
Variables	**At Level**		**At First Difference**	
	t-Statistic	Prob.	t-Statistic	Prob.
LEXC	-1.6375	0.4618	-10.7858	0.0000
LCPI	-1.7787	0.3905	-12.0238	0.0000
LINT	-2.2180	0.2005	-5.5833	0.0000
LSP	-2.0376	0.2707	-10.9521	0.0000

Source: Authors' calculations. Results is based on model with constant. The same result is get with the other cases.

III. Econometric Models and Estimation

1) Methods

A. The Johansen multivariate cointegration procedure

We use the Johansen (1988, 1991) cointegration approach. The **k- dimensional VAR** process with p lags:

$$\mathbf{Y_t} = \boldsymbol{\mu}_t + \Phi_1 \mathbf{Y_{t-1}} + \ldots + \Phi p \mathbf{Y_{t-p}} + \lambda \text{ D2008} + \boldsymbol{\varepsilon}_t$$

can be rewritten in **VEC** Model form:

$$\Delta \mathbf{Y_t} = \mu_t + \Pi\, \mathbf{Y_{t-1}} + \Gamma_1 \Delta \mathbf{Y_{t-1}} + \dots + \Gamma_{p-1} \Delta \mathbf{Y_{t-p+1}} + \lambda\, D2008 + \boldsymbol{\varepsilon_t}$$

where, $\mathbf{Y_t}$ is the vector of k = 4 considered endogenous variables

$$\mathbf{Y_t} = (LSP_t, LCPI_t, LINT_t, LEXC_t)',$$

$$\boldsymbol{\mu_t} = \boldsymbol{\mu} \text{ /or } \boldsymbol{\mu_t} = \boldsymbol{\mu} + \boldsymbol{\delta}\, \mathbf{t} \text{ /or } \boldsymbol{\mu_t} = \boldsymbol{\mu} + \boldsymbol{\delta}\, \mathbf{t} + \boldsymbol{\gamma}\, \mathbf{t^2},$$

$\boldsymbol{\mu}$ is a $k \times 1$ vector of real parameters, δ (γ) is a $k \times 1$ vector of trend coefficients, t is a linear time trend, $\mathbf{t^2}$ is a quadratic time trend, D2008 is a binary variable to indicate the effect of global financial crisis (GFC)

D2008 =1 if year is 2008 and zero if not,

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

is the **long-run matrix,** and $\Gamma_1, \dots, \Gamma_{p-1}$ are $k \times k$ matrices of parameters

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

If all variables in $\mathbf{Y_t}$ are I(1), the matrix **Π has rank** $0 \le r < k$, where **r** is the **number of linearly independent cointegrating vectors**. If the variables are cointegrated (r > 0) the **VAR in first differences** is **misspecified** as it excludes the **error correction term**.[2]

In the VEC model above, when **the rank** of Π is **r > 0**, it may be expressed as

$$\Pi = \alpha\, \beta',$$

where α and β are $(k \times r)$ matrices of parameters of rank r.

The Johansen's approach is aimed to test the number **r** of cointegrating relationships. The test for cointegration between the Ys is calculated by looking at the rank of the $\Pi = \alpha\, \beta'$ matrix via its eigenvalues.[3]

There are two test statistics for cointegration under the **Johansen approach**. The **trace statistic** takes the form

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

where λ_i are the ordered eigenvalues, and

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

---

[2] If the **rank of Π = 0**, there is **no cointegration** among the nonstationary variables, and a **VAR in their first differences** is consistent. If the **rank of Π = k**, all of the variables in $\mathbf{Y_t}$ are I(0) and a **VAR in their levels** is consistent.

[3] The rank of a matrix is equal to the number of its characteristic roots (eigenvalues) that are different from zero.

where **r** is the number of cointegrating vectors under the **null hypothesis** and $\widehat{\lambda}_i$ is the estimated value for the ith ordered eigenvalue from the Π matrix.

Johansen and Juselius (1990) provide critical values for the two statistics. The distribution of the test statistics is **non-standard**.

If the **test statistic is greater than the critical value** from Johansen's tables, **reject the null hypothesis** that there are **r** cointegrating vectors in favour of the alternative that **there are r + 1** (for λ_{trace}) or **more than r** (for λ_{max}).

Sequential Johansen's testing procedure **starts** with the test for **r = zero** cointegrating equations (a maximum rank of zero) and then accepts the first null hypothesis that is not rejected.

B. Toda and Yamamoto Wald causality test

Besides the Granger causality, an important procedure was developed by Toda and Yamamoto (1995) to investigate significant direction of causality. This approach could be used regardless of the cointegration and whether the indicators are simply integrated of order zero I(0) and order one I(1).

In order to investigate Granger causality (1961), Toda and Yamamoto (1995) developed a method based on the estimation of augmented VAR model (p+dmax) where p is the optimal time lag on the first VAR model and dmax is the maximum integrated order.

The Toda and Yamamoto approach follows the following steps:

- First, we find the integration order for each series (**d**). If the integration order is different we get the maximum (**dmax**).
- Second, we create a VAR model on series **levels** regardless of integration order that we found.
- Then, we define the order of VAR model (**p**) from lag length taken from LR, final prediction error (FPE), AIC, SC, HQ criteria.

Toda and Yamamoto modified Wald test is then based on the **pairwise** equations:

$$Y_t = a + \left(\sum_{j=1}^{p} C_{j1} Y_{t-j} + \sum_{j=p+1}^{dmax} C_{j2} Y_{t-j} \right) + \left(\sum_{j=1}^{p} D_{j1} X_{t-j} + \sum_{j=p+1}^{dmax} D_{j2} X_{t-j} \right) + \varepsilon_{t1}$$

$$X_t = b_j + \left(\sum_{j=1}^{p} F_{j1} X_{t-j} + \sum_{j=p+1}^{dmax} F_{j2} X_{t-j} \right) + \left(\sum_{j=1}^{p} E_{j1} Y_{t-j} + \sum_{j=p+1}^{dmax} E_{j2} Y_{t-} \right) + \varepsilon_{t2}$$

where ε_{t1} and ε_{t2} are the **white-noise errors**.

If series have the same integration order then we continue on cointegration test using Johansen methodology.[4]

- Forth, we apply Granger causality test for non-causality using pairwise equations and modified Wald test (MWald) for the significance of parameters on examined equations on number time lags (p).

The modified Wald test (MWald) follows asymptotically Chi-square ($\chi 2$) distribution with the degrees of freedom are equal to the number of time lags (p).

- Finally, rejection of null hypothesis entails the rejection of Granger causality.

See https://www.youtube.com/watch?v=YyiLBpf-xk8

C. IRF for stationary VAR

Impulse–response functions (IRFs) from a stationary VAR die out over time. Because each variable in a stationary VAR has a time-invariant mean and finite, time-invariant variance, the effect of a shock to any one of these variables must die out so that the variable can revert to its mean.

2) Empirical results

There are several monetary variables that affect the equity markets, but the exchange rate, interest rate, and inflation rates are regarded as the extremely important elements, which exert a cogent effect upon stock returns. Therefore, we will investigate the influence of these monetary variables on stock price index from the **Canadian** stock market.

This research aim to find the long-run relationship between stock price (LSP) of **Canada** and monetary indicators, the exchange rate (LEXC), interest rate (LINT), and Consumer price index (LCPI). We use Canadian data from **January 1999 to April 2018** in logarithms. ADF Unit-root test on these series in level fail to reject the null hypothesis that contains a unit root. All are I(1) processes.

[4] Otherwise, we employ (Pesaran, Shin, & Smith, 2001) approach. No matter what the result will be on cointegration, we continue with causality test.

In **first stage,** we employed (Granger, 1969) non causality and (Toda & Yamamoto, 1995) Wald test; econometrics techniques to examine the causation and causality direction between a pair of considered economic indicators. The stock price, the consumer price index, the exchange rate and the interest rate are stationary at the first difference.

To test for cointegration and before employing causation analysis, we must specify how many lags to include in the VECM and the VAR models. Therefore, in order to find out the lag length, we followed a lag length selection criterion, the SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion which suggests 2 lags for the time series data as the least value of SC (HQ), i.e -**19.16419** (**-19.49526**) corresponds to 2 lags in the selected sample period as displayed in **Table 4.**

Table 4. Optimum lag length.[5]

Lag	LogL	LR	FPE	AIC	SC	HQ
0	541.9795	NA	8.83e-08	-4.890723	-4.829021	-4.865806
1	2133.795	3111.276	5.30e-14	-19.21632	-18.90781	-19.09173
2	**2205.146**	**136.8644**	**3.21e-14**	**-19.71951**	**-19.16419***	**-19.49526***
3	2228.422	43.80071	3.00e-14	-19.78565	-18.98352	-19.46173
4	2240.352	22.01664	3.12e-14	-19.74866	-18.69972	-19.32507
5	2248.743	15.18014	3.35e-14	-19.67948	-18.38374	-19.15623
6	2272.033	41.28678	3.14e-14	-19.74576	-18.20320	-19.12283

Note: *Denotes lag order selection criterion; test statistics of LR (tested at 5% level of significance). Source: Authors' calculations

For the identification of the direction of causal association among considered variables, and to find out directional causality, we used the pairwise Granger (1969) non causality test on stationary series (in first difference).

Table 5 shows significant one-way unidirectional causal relation from **stock return** to **inflation rate** and from **stock return** to **Exchange rate growth** at 5% significance level ($p < 0.05$) at 1 lags. The other pairs of variables do not have any causation in either direction as demonstrated at **Table 5**.

[5] * indicates lag order selected by the criterion, LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.

Table 5. Results of pairwise Granger non causality at 1 lags (p=2).

Null Hypothesis:	F-Statistic	Prob.
Inflation rate ↛ ΔLSP	0.35615	0.5512
ΔLSP ↛ Inflation rate	**7.89284**	**0.0054**
Interest rate growth ↛ ΔLSP	0.94205	0.3328
ΔLSP ↛ Interest rate growth	1.59282	0.2082
Exchange rate growth ↛ ΔLSP	0.00404	0.9494
ΔLSP ↛ Exchange rate growth	**7.68260**	**0.0060**
Interest rate growth ↛ Inflation rate	2.42281	0.1210
Inflation rate ↛ Interest rate growth	2.73955	0.0993
Exchange rate growth ↛ Inflation rate	3.77398	0.0533
Inflation rate ↛ Exchange rate growth	2.31708	0.1294
Exchange rate growth ↛ Interest rate growth	1.57150	0.2113
Interest rate growth ↛ Exchange rate growth	1.89675	0.1698

Note: The rejection of null hypotheses at 5% ($p < 0.05$). All variables are in **first difference**. ↛ ≡ does not Granger Cause. **P-1=1**. Source: Authors' calculations

We hope now to validate the results of causality from more robust method, which was developed by (Toda & Yamamoto, 1995). This test is applied on non stationary series (in level).

Table *6* shows a significant one-way **unidirectional** causal relation from **stock price** to **Interest rate** and from **stock price** to exchange rate at the 5% level ($p < 0.05$). A unique significant **bidirectional** causal relation is depicted between stock price and consumer price index at the 10% level ($p < 0.1$).

From **Table** *6***,** the results of TY test indicates a **unidirectional** causal association between the exchange rate and consumer price index and between the consumer price index and interest rate at the 10% level ($p < 0.1$), and the direction of causality was confirmed respectively from the exchange rate to consumer price index and from consumer price index to interest rate. The results of the Toda and Yamamoto Wald test further demonstrate that interest rate does not have any causation to the exchange rate.

Table 6. Toda and Yamamoto (TY) Modified Wald non causality test analysis.[6]

Dependent variable	Test results	LSP	LCPI	LINT	LEXC	Conclusion
LSP	χ2	_	5.214407	0.480692	3.886288	LCPI →LSP
	P-value		0.0737	0.7864	0.1433	
LCPI	χ2	5.364993	_	3.569531	5.055652	LSP & LEXC→LCPI
	P-value	0.0684		0.1678	0.0798	
LINT	χ2	9.071495	5.452075	_	2.712829	LSP & LCPI→LINT
	P-value	0.0107	0.0655		0.2576	
LEXC	χ2	8.199344	4.286745	1.538163	_	LSP→LEXC
	P-value	0.0166	0.1173	0.4634		

Note: The rejection of null hypothesis at 5% ($p < 0.05$) or at 10% ($p < 0.1$). All variables are **in level**. VAR(2) with trend and D2008=1 if year=2008 zero if not, P+dmax=3. Source: Authors' calculations. c @trend @year=2008 lsp(-3) lexc(-3) linf(-3) lint(-3) ??

In second stage, we employed the (Johansen, 1988) cointegration approach for establishing a long-run relation between the considered macroeconomic indicators.

Since the augmented Dickey and Fuller test demonstrated that LSP and monetary variables are I(1), we can thus employ the Johansen multivariate cointegration tests.

From the results shown in **Table 7**, it is clear that there is none cointegrating vector; therefore, no long-run association can be established between LSP and the exchange rate, consumer price, and interest rate. In addition, the trace (maximum eigenvalues; see **Table 8**) test do not reject the null hypothesis of none cointegrating relation because the trace (maximum eigenvalues statistic) value is not greater than the critical value, and the corresponding probability is more than 0.05 ($p > 0.05$).

Using all four series and a model with 1 lag, we find that there are no cointegrating relationships.

[6] The graph of the eigenvalues (Figure A1 given in Annex) shows that none of the eigenvalues appears close to the unit circle. The stability check does not indicate that our model is misspecified. The results clearly indicate no serial correlation in the residuals (see Table A3 given in Annex). The results indicate also that we can strongly reject the null hypothesis of normally distributed errors (see Table A2 given at Annex) for LSP and LINT.

Table 7. Johansen test results (trace test) – unrestricted cointegration rank test (trace values).[7]

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 C V	Prob.**
None	0.071297	38.74146	54.07904	0.5344
At most 1	0.059494	21.72911	35.19275	0.6137
At most 2	0.021393	7.621584	20.26184	0.8540
At most 3	0.011446	2.647824	9.164546	0.6483

Existence of one cointegrating vector at 5% significance level (trace value).
Source: Authors' calculations

Table 8. Johansen maximum eigenvalue test – unrestricted cointegration rank test (maximum eigenvalues).

Hypothesized No. of CE(s)	Eigenvalue	Max-EigenStatistic	0.05 C V	Prob.**
None	0.071297	17.01236	28.58808	0.6598
At most 1	0.059494	14.10752	22.29962	0.4522
At most 2	0.021393	4.973761	15.89210	0.8906
At most 3	0.011446	2.647824	9.164546	0.6483

Existence of no cointegrating vector at 5% significance level (maximum eigenvalue).
Source: Authors' calculations.

Finally, we employed the **impulse response function** to carry out further analysis. Figure 3 demonstrates the impulse response function analysis to investigate occurrence of transmission from one variable to another.

Figure 3 illustrates dynamic effect of the shocks of the exchange rate, inflation rate, and interest rate over stock returns. The impulse response graphs show that the stock return behaves like an exogenous variable and the maximum part of the effect of shocks is because of its own innovations. Observing the impact of other monetary indicators, they have exerted a small effect on stock return.

From Figure 3 the impulse response between stock returns and the **inflation rate** shows that the rise in inflation rate may decreases stock returns. As inflation increases, cost of living increases and consequently this shifts funds to consumption. This will decrease the trading on the stocks. The decline in the demand of the stock market will push down the value of the stocks. Hence, the **short run** negative relationship between **inflation** and the Canadian stock market.

[7] Trend assumption: No deterministic trend (restricted constant). The same conclusion is get with other assumption (see Table A 4 given at Annex).

Finally, we can conclude that the exchange rate and the interest rate have an inverse relation to stock return, but this negative impact is not significant after 6 months.

As the value of the local currency decreases compared to the US Dollar (rise in exchange rate), people tend to invest less in the stock market as they have less money or their current income can buy less goods and services. This explains the short run negative impact on the stock market index in Canada in the case of exchange rate.

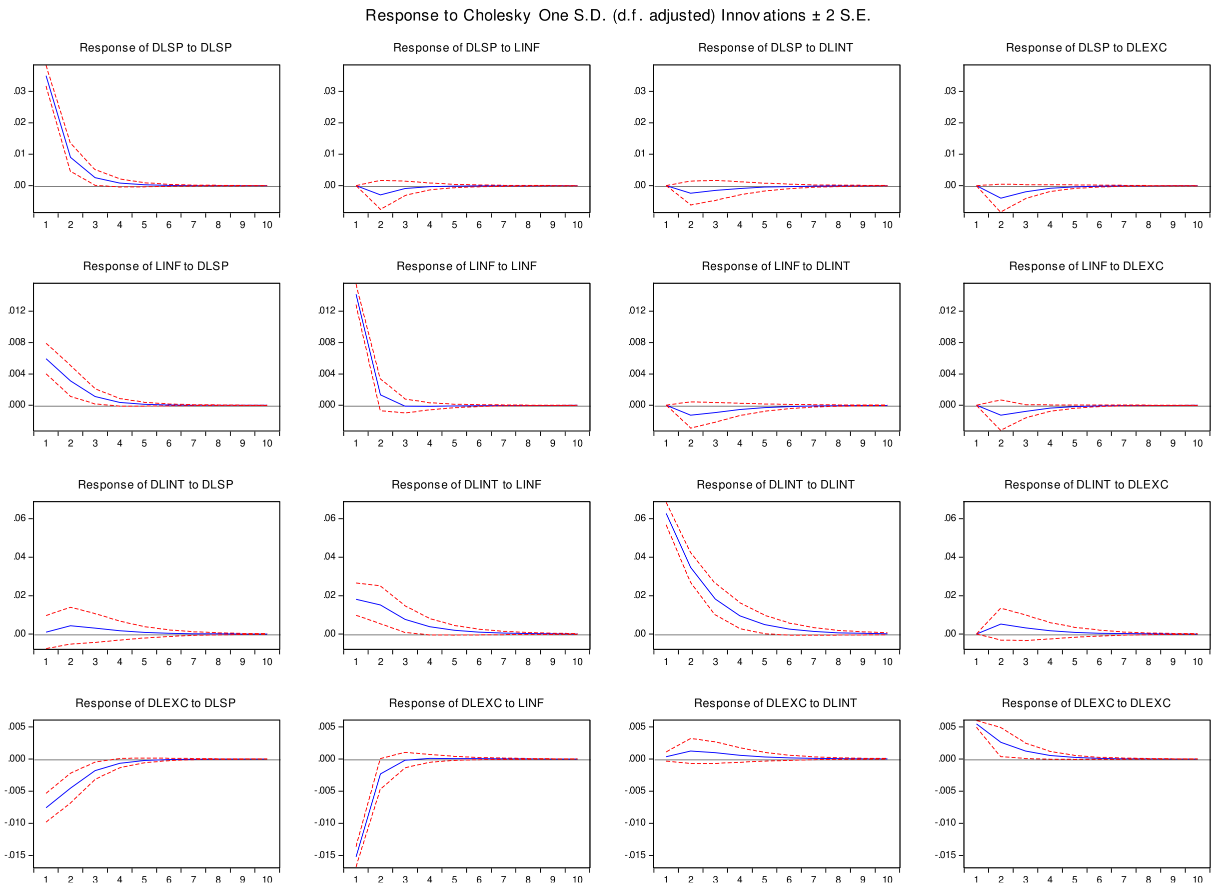

Figure 3. Impulse response analysis. Source: Authors' calculations.

Note: X-axis represents the period of 12 months, Y-axis represents the fluctuations of the variables in percent (%).

IV. Conclusions

This research aims to find the long-run relationship between stock returns (DLSP) of Canada and monetary indicators, the exchange rate (LEXC), interest rate (LINT), and inflation rate (INF). We consider T = 232 observations for each variable from January 1999 to April 2018.

The outcomes of the **Johansen** tests suggested none cointegrating vector; therefore, a long-term association has been denied between stock price of Canadian stock market and monetary indicators including the exchange rate, consumer price index, and interest rate.

For the identification of a causal association and the direction of causation, we used Granger causality and Toda and Yamamoto techniques.

Results of **the Granger causality** tests have demonstrated a **unidirectional** causation from the stock return to **Inflation rate** and to **Exchange rate** growth.

Results of **Toda and Yamamoto** Wald tests have demonstrated the **bidirectional** causal relation between stock price and consumer price index and the unidirectional causation from stock price to the **interest rate** and to the **exchange rate** growth.

The outcome of **impulse response** function demonstrated that most of the changes in the Canadian stock return are because of its own shocks. In addition, **Inflation** rate is shown to be **inversely** related to stock returns.

Thus, we can conclude that the predictability of Canadian stock return relies only on the variations of inflation rate.

Disclosure statement

No potential conflict of interest was reported by the authors.

Annex

Table: A 1: Stability condition

Root	Modulus
0.986161 - 0.016243i	0.986294
0.986161 + 0.016243i	0.986294
0.847843	0.847843
0.593055	0.593055
0.347859	0.347859
0.102746 - 0.217885i	0.240895
0.102746 + 0.217885i	0.240895
0.147612	0.147612

No root lies outside the unit circle.
VAR satisfies the stability condition.

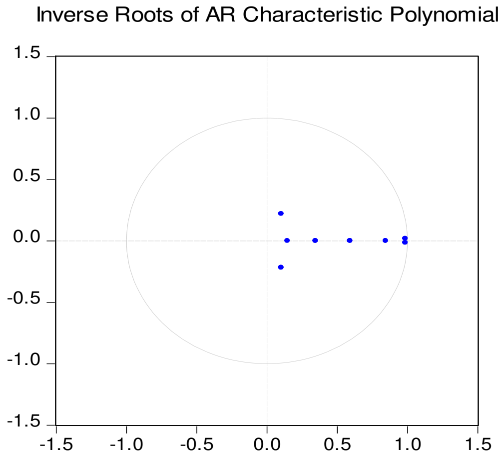

Figure B 1: Stability condition

Table A 2: Diagnostic

Component	**Jarque-Bera**	df	Prob.
LSP	142.9513	2	0.0000
LCPI	0.153661	2	**0.9260**
LINT	641.3034	2	0.0000
LEXC	0.018673	2	**0.9907**
Joint	784.4271	8	0.0000

Table A 3: VAR Residual Portmanteau Tests for Autocorrelations.

Null Hypothesis: **No residual autocorrelations up to lag h**

Lags	Q-Stat	Prob.*	Adj Q-Stat	Prob.*	df
1	2.033061	---	2.042017	---	---
2	6.556283	---	6.605268	---	---
3	18.92509	0.2726	19.13899	0.2615	16
4	35.22750	0.3180	35.73252	0.2973	32

*Test is valid only for lags larger than the VAR lag order. *df and Prob. may not be valid for models with exogenous variables. df is degrees of freedom for (approximate) chi-square distribution

Table A 4: Sum up for Johansen cointegration test results:

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

Critical values based on MacKinnon-Haug-Michelis (1999). Selected (0.05 level) Number of Cointegrating Relations by Model

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