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Revisiting the Stability of Money Multiplier on Determination of Money Supply: Evidence from Canada

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Abstract

This study revisits the stability of the money multiplier on the determination of the money supply process for Canada under the assumption of potential nonlinear relation between the money supply (M1 and M2) and monetary base. To this aim, we apply the recently developed nonlinear autoregressive distributed lag (ARDL) model by Shin et al. (2014) between 2000M1-2018M09. This model decomposes the monetary base series into increases and decreases separately. The main empirical findings of this study indicate that the nonlinear model successfully detects potentially concealed proportional nonlinear (asymmetric) relations between monetary base and money supply (M1). Additionally, increases in monetary base have strong proportional relation with M1. This implies an almost stable money multiplier and exogenous money supply determination process for the Bank of Canada (BoC). This can be interpreted that the BoC determines money supply exogenously only its expansionary monetary policy in the long-run. This finding may allow the BoC to apply more proactive and manageable monetary policy.

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1. Introduction

Understanding the mechanism of the money supply determination process is necessary in order to conduct a successful monetary policy. A successful monetary policy may require a controllable money supply through a controllable monetary base and a stable money multiplier. If the money multiplier is unstable and unpredictable, changes in monetary base by the central banks can cause undesirable results in all macroeconomic variables. This means that money supply is determined by the central banks endogenously. On the other hand, a stable and predictable money multiple provides the central banks a means to determine and control money supply exogenously. Accordingly, knowing whether the money multiplier is stable or unstable plays a key role for the central banks in achieving their monetary policy goals.

There is no consensus about the stability of the money multiplier and controllable monetary base among monetary economists. The historical and theoretical discussions in the schools of economics thought about this are outside the scope of this empirical study. However, there are two main approaches on this issue. In the orthodox (monetarist) approach, it is assumed that money supply is determined by the central banks exogenously. This means that a given change in monetary base leads to proportional changes in money supply through a stable and predictable money multiplier. The other approach, the Post Keynesian approach, assumes that money supply is determined endogenously because portfolio choices of economic agents and market forces may change the magnitude of money multiplier and make it unstable (changeable).

This study revisits the stability of the money multiplier for Canada for M1 and M2. There are some empirical studies examining the money supply determination process with different methodologies for this country. For instance, Howells and Hussein (1998) used cointegration and causality tests for the G7 countries and found an unstable money multiplier (endogenous money supply) for all countries including Canada. Similarly, Panagopoulos and Spiliotis (2008) applied the Error Correction Vector Autoregressive (VAR) causality for the same group of countries and found an unstable money multiplier for all. Badarudin et al. (2013) applied the Vector Error Correction (VECM) and Trivariate vector autoregression model (VAR) for the G7 countries and found that the money supply is unstable for all countries including Canada. Similarly, Nayan et al. (2013) used the Generalized Method of Moments (GMM) for 177 countries including Canada and found an unstable money multiplier for all.

All these empirical studies, however, assume that there is a linear (symmetric) long-run proportional relation between money supply and monetary base. This relation though may potentially exhibit nonlinear (asymmetric) characteristic. This means that increases and decreases in the monetary base may separately lead to different size and sign proportional impacts on the money supply. Another possibility is that while increases in the monetary base may have impacts on the money supply, decreases may not or vice versa. The rising uncertainties in financial markets and the changing portfolio choices of economic agents can easily cause this nonlinear (asymmetric) characteristic on the money supply determination process. Accordingly, this study differs from aforementioned empirical studies and is constructed on this potential nonlinear (asymmetric) relation. To this aim, the newly developed nonlinear autoregressive distributed lag (ARDL) model by Shin et al. (2014) is applied.

2. Empirical Model and Methodology

The empirical model of this study is based on the interpretation of the *money multiplier model* by Brunner (1961) and Brunner and Meltzer (1964). This model is constructed in the following proportional form:

$$M = mm * MB \qquad (1)$$

where M is the money supply, mm is the money multiplier and MB is the monetary base. The money multiplier (mm) links the monetary base (MB) to the money supply (M). The model in Eqn. (1) can be written in the following logarithmic form:

$$LogM = Logmm + logMB \qquad (2)$$

Eqn. (2). can be rewritten in the following regression form:

$$LogM_t = \alpha_0 + \alpha_1 LogMB_t + e_t \qquad (3)$$

where α_0 is the logarithm of mm and e_t is the error term. Exogenous money supply determination process requires mm to be stable (stationary). Furthermore, M and MB must be stationary or cointegrated if they are not stationary at the same order of integration (Thenuwara and Morgan (2017); Bhatti and Khawaja (2018)). Hence, for a stable money multiplier ($mm = M_t/MB_t = 1$), α_0 must be zero (logarithm of mm which equals to 1) and α_1 must be 1 which implies *one-to-one* cointegrated proportional relation between money supply and monetary base in the long-run. The monthly data of M1, M2 and monetary base (MB) were obtained from the Bank of Canada (BoC). The contents of M1, M2 and MB are presented in appendix 1.

The empirical methodology of this study is based on the nonlinear ARDL model by Shin et al. (2014). This model decomposes the changes in the monetary base series (MB) as increases and decreases. Hence, it allows us to examine the impacts of increases and decreases on the money supply separately in case of the existence of potential nonlinear (asymmetric) relations. This model is the extended version of the linear ARDL model by Pesaran et al. (2001) and accounts for the nonlinearities (asymmetries) between the changes in variables. In this study, we also apply the linear ARDL model to compare the empirical results of both models.

Therefore, the model in Eqn. (3) first transforms to the following linear ARDL model by Pesaran et al. (2001). In this model, we apply bounds testing to the cointegration and error correction model (*ECM*) for the short-run and long-run impacts of the changes in the monetary base (MB) on the money supply (M):

$$\Delta LogM_t = \alpha_0 + \sum_{j=1}^{p} \alpha_{1j} \Delta LogM_{t-j} + \sum_{j=0}^{q} \alpha_{2j} \Delta LogMB_{t-j} + \alpha_3 LogM_{t-1} + \alpha_4 LogMB_{t-1} + e_t \qquad (4)$$

where Δ denotes first difference. In this linear form ARDL model, while short-run impacts of the changes in monetary base (MB) on money supply (M) are determined by the size and significance of α_{2j} the long-run impacts are determined by α_4.

In the next step, we apply the nonlinear ARDL model by Shin et al., (2014) for estimating potential nonlinear (asymmetric) impacts of the changes in monetary base (MB) on money supply (M). This model decomposes the changes in monetary base (MB) series as $MB^+$and MB^- for increases and decreases respectively with the concept of the partial sum process in the following form.

$$MB_t^+ = \sum_{j=1}^{t} \Delta MB_j^+ = \sum_{j=1}^{t} \max(\Delta MB_j, 0) \quad (5)$$

$$MB_t^- = \sum_{j=1}^{t} \Delta MB_j^- = \sum_{j=1}^{t} \min(\Delta MB_j, 0) \quad (6)$$

After this decomposition process the model in Eqn. (4). transforms into the following nonlinear form ARDL model in Eqn. (7).

$$\Delta LogM_t = \alpha_0 + \sum_{j=1}^{p} \alpha_{1j} \Delta LogM_{t-j} + \sum_{j=0}^{q} \alpha_{2j} \Delta LogMB_{t-j}^+ + \sum_{j=0}^{r} \alpha_{3j} \Delta LogMB_{t-j}^- + \alpha_4 LogM_{t-j} + \alpha_5 LogMB_{t-j}^+ + \alpha_6 LogMB_{t-j}^- + e_t \quad (7)$$

In Eqn. (7), the long-run impacts of the increases (MB^+) and decreases (MB^-) in monetary base on money supply (M) are determined by the sizes-signs and significances of α_5 and α_6 respectively. Similarly, short-run impacts of $MB^+$and MB^- are determined by α_{2j} and α_{3j} . Hence, the nonlinear ARDL model allows us to understand whether the changes in $MB^+$and MB^- have symmetric or asymmetric impacts on M. At first glance, symmetry will be confirmed if the sizes-signs of coefficients of $MB^+$and MB^- on M are significantly the same. However, for the formal decision, we apply the Wald test for both the short-run (W_{SR}) and long-run (W_{LR}).

3. Empirical Results

Before processing the ARDL models we first must ensure that the variables are stationary. To this aim, Augmented Dickey Fuller (1981, ADF) and Phillips-Perron (1988, PP) Unit Root tests are applied. The results of these tests are reported in the following Table 1.

Table 1: ADF and PP Unit Root Test Results

	ADF		PP	
	Level	First Difference	Level	First Difference
	Prob.	Prob.	Prob.	Prob.
$LogM1$	0.56	0.00***	0.80	0.00***
$LogM2$	0.51	0.00***	0.86	0.00***
$LogMB$	0.91	0.00***	0.64	0.00***
$LogMB^+$	0.69	0.00***	0.59	0.00***
$LogMB^-$	0.64	0.00***	0.64	000***

Note: *** denote statistical significances at 1% level respectively. The optimal lags were automatically selected by using the Akaike Information Criterion.

The test results in Table 1 indicate that variables are integrated of order one *I(1)*. Hence, we apply bounds testing of Pesaran et al. (2001) for the confirmation of cointegration relation between the variables. The results of bounds testing for both linear and nonlinear models are reported in Table 2.

Table 2: Test Results of Bounds Testing

	Dependent Variable	*k*	*F stat.*	Critical Values					
				I0 Bound			I1 Bound		
				10%	*5%*	*1%*	*10%*	*5%*	*1%*
Linear	M1	1	1.94	3.02	3.62	4.94	3.51	4.16	5.58
	M2	1	18.19***	3.02	3.62	4.94	3.51	4.16	5.58

Non-Linear	M1	2	26.97***	2.63	3.1	4.13	3.35	3.87	5
	M2	2	11.38***	2.63	3.1	4.13	3.35	3.87	5

Note: *k* is number of regressors. ***; denotes cointegration at the 1% significance level.

The test results in Table 2 indicate that all variables (except M1 in the linear model) have cointegrated relations since the calculated F-statistics exceed the critical values tabulated by Pesaran et al. (2001). Consequently, M1 will not be estimated in the following analyses in the linear model. The estimates and diagnostic tests of the linear model for short-run and long-run are reported in Table 3.

Table 3: Linear ARDL Model Estimation Results for M2

Variable	***Coef.***	***Prob.***
	Short Run	
$\Delta LogM2_{t-1}$	0.37***	0.00
$\Delta LogMB_t$	0.07	0.05
ECT_{t-1}	-0.001***	0.00
	Long Run	
$LogMB_t$	1.21	0.33
$Constant$	4.34	0.77
	Diagnostic Tests	
	Test Stat.	***Prob.***
R^2	0.99	-
$Adj. R^2$	0.99	-
DW	2.08	-
χ^2_{SC}	3.31***	0.19
χ^2_{FF}	8.81	0.00
χ^2_{NOR}	4.07***	0.13
χ^2_{HET}	12.32***	0.26
F	4.35***	0.35

Note: *** and * denote statistical significances at 1% and 10% levels respectively. CUSUM and CUSUM of Squares test graphs are reported in Chart in Appendix 2.

The test results in Table 3 indicate that there is no proportional relation between MB and M2 in the long-run since its coefficient is insignificant. It is same for the short-run. Furthermore, the significantly negative but very low size coefficient value of Error Correction Term (ECT) confirms that short-run variations between the variables converge to the long-run very slowly. The estimates of the nonlinear model both short-run and long-run with the diagnostic tests are reported in Table 4.

Table 4: Nonlinear ARDL Model Estimation Results

Dependent Variable (M1)			***Dependent Variable (M2)***		
Variable	***Coef.***	***t-st.***	***Variable***	***Coef.***	***t-st.***
$LogM1_{t-1}$	-0.022581	-1.13	$LogM2_{t-1}$	-0.007214	-1.94
$LogMB^+_{t-1}$	0.021437	0.79	$LogMB^+_{t-1}$	0.003457***	2.60
$LogMB^-_{t-1}$	-0.099277**	-2.24	$LogMB^-_{t-1}$	0.003798	0.16
$\Delta LogM1_{t-4}$	0.13**	2.40	$\Delta LogM2_{t-3}$	0.044664	1.15
$\Delta LogM1_{t-5}$	-0.18***	-2.92	$\Delta LogM2_{t-4}$	-0.046662	-1.23
$\Delta LogM1_{t-9}$	0.15***	2.76	$\Delta LogM2_{t-5}$	0.133 667***	3.52
$\Delta LogM1_{t-10}$	0.09	1.74	$\Delta LogM2_{t-6}$	-0.055557	-1.46
$\Delta LogM1_{t-12}$	-0.20***	-3.41	$\Delta LogMB^+_t$	0.021279**	2.39
$\Delta LogMB^+_t$	0.36***	400.95	$\Delta LogMB^+_{t-2}$	0.028404**	2.37
$\Delta LogMB^+_{t-5}$	0.19**	2.17	$\Delta LogMB^+_{t-3}$	-0.013998	-1.19
$\Delta LogMB^+_{t-10}$	0.12	1.56	$\Delta LogMB^+_{t-7}$	-0.015856	-1.67
$\Delta LogMB^+_{t-12}$	0.14	1.68	$\Delta LogMB^+_{t-7}$	-0.020910**	-2.12
$\Delta LogMB^-_{t-2}$	0.17	1.79	$\Delta LogMB^+_{t-12}$	-0.021958**	-2.46
$\Delta LogMB^-_{t-7}$	0.16	1.56	$\Delta LogMB^-_{t-6}$	0.025333	1.05

$\Delta LogMB^-_{t-10}$	0.11	1.22	$\Delta LogMB^-_{t-7}$	0.029728	1.25
$Constant$	0.125454	1.16	$Constant$	0.067100**	2.07
ECT_{t-1}	-0.81***	-278.89	ECT_{t-1}	-0.31***	-8.66
Normalized Long-Run Coefficients					
$LogMB_t^+$	0.94**	2.52	$LogMB_t^+$	0.47***	2.80
$LogMB_t^-$	-4.39	-1.74	$LogMB_t^-$	0.52	0.91
Short Run-Coefficients					
$\sum_{j=0}^{q}\alpha_{2j}\Delta LogMB_t^+$	0.83***	5.78	$\sum_{j=0}^{q}\alpha_{2j}\Delta LogMB_t^+$	-0.023	-1.21
$\sum_{j=0}^{r}\alpha_{3j}\Delta LogMB_t^-$	0.44***	2.62	$\sum_{j=0}^{r}\alpha_{3j}\Delta LogMB_t^-$	0.055	1.53
Diagnostic Tests					
	Test Stat.	***Prob.***		***Test Stat.***	***Prob.***
R^2	0.99	-	R^2	0.25	-
$Adj.R^2$	0.99	-	$Adj.R^2$	0.20	-
DW	1.53	-	DW	1.69	-
χ^2_{SC}	0.00***	1.00	χ^2_{SC}	5.30***	0.15
χ^2_{FF}	0.10***	0.74	χ^2_{FF}	3.85	0.01
χ^2_{NOR}	25.42	0.00	χ^2_{NOR}	182.59	0.00
χ^2_{HET}	23.71**	0.07	χ^2_{HET}	13.87***	0.53
F	12751.55***	0.00	F	4.54***	0.00
W_{LR}	-2.48**	-2.48$^{\#}$	W_{LR}	0.047	0.11
W_{SR}	0.39	1.78	W_{SR}	-0.078**	-2.03$^{\#}$
EG_{MAX}	-11.73***	0.00	EG_{MAX}	-5.41***	0.00

Note: *** and ** denote statistical significances at 1% and 5% levels respectively. W_{LR} and W_{SR} are long and short-run Wald tests. Normalized long-run coefficients are obtained with $LogMB_t^+ = -\alpha_5/\alpha_4$, $LogMB_t^- = -\alpha_6/\alpha_4$. Critical *t*-table values are 2.57 and 1.96 for 1% and 5%. # denotes *t*-statistic. CUSUM and CUSUM of Squares test graphs are reported in Appendix 2.

The normalized estimates in Table 4 indicate that increases (MB^+) in the monetary base have cointegrated proportional relations with M1 and M2 in the long-run since their coefficients are significant at 5% and 1% significance levels respectively. However, only the coefficient of MB^+ is close to 1 (*one-to-one relation*) implying that the money multiplier is almost stable for M1. This can be interpreted that the BoC may determine money supply (M1) exogenously only in its expansionary monetary policy (MB^+). However, the lower degree (0.47) proportional relation implies an unstable money multiplier and thereby endogenous money supply determination process by the BoC for M2. Furthermore, the short-run estimates indicate that while increases (MB^+) in the monetary base lead to increases in M1, decreases (MB^-) lead to decreases in it. Conversely, the estimates in the same table reveal that there are no proportional relations between MB^+ and MB^- with M2 in the short-run since their coefficients are insignificant. The significantly negative long-run ECT confirms that the short-run variations converge to the long-run values. Furthermore, the Wald test confirms that increases (MB^+) and decreases (MB^-) in monetary base have asymmetric impacts on M1 in long-run and symmetric effect in the short-run since $(-\alpha_5/\alpha_4) \neq (-\alpha_6/\alpha_4)$ and since $\sum_{j=0}^{q}\alpha_{2j} \cong \sum_{j=0}^{r}\alpha_{3j}$ respectively. However, same changes in monetary base have symmetric impacts on M2 in the long-run since $(-\alpha_5/\alpha_4) \cong (-\alpha_6/\alpha_4)$ and have no impacts on M2 in the short-run since their coefficients are insignificant.

In the comparison of both models, we can conclude that the nonlinear model discovers potentially concealed proportional nonlinear (asymmetric) relations between money supply and monetary base for both M1 and M2. This means that money supply determination process in Canada exhibits a nonlinear (asymmetric) mechanism.

Conclusion

The Bank of Canada has been adopting inflation targeting policy since 1991. Therefore, a controllable money supply is crucially important for this country. In this study, we revisit the stability of the money multiplier on the determination of the money supply process for Canada. This revisiting is based on the existence of potential nonlinear relation between money supply (M1 and M2) and monetary base in this country. To this aim, we apply the recently developed nonlinear ARDL model alongside the linear version of this model. The nonlinear ARDL model successfully detects potentially concealed proportional relations between money supply (M1 and M2) and monetary base. Additionally, this implies that the money supply determination process in Canada exhibit nonlinear characteristics for M1. However, the decomposed variables of the nonlinear model reveal that only increases in monetary base (denoting the expansionary monetary policy of the BoC) have strongly proportional relation with M1. This signifies an almost stable money multiplier and exogenous money supply determination process for the BoC. This finding may allow the BoC to apply more proactive monetary policy for its goals. In conclusion, it is believed that all empirical findings of this study may help the monetary policy authorities in Canada to obtain a controllable and manageable money supply determination process and thereby desirable and predictable macroeconomic variables. This study shows the need for future empirical studies using different nonlinear analysis techniques on this issue.

References

Badarudin Z.E, M. Ariff and A.M Khalid (2013) “Post-Keynesian money endogeneity: Evidence in G-7 economies” *Journal of International Money and Finance* **3**,146–162.

Bhatti, R.H. and M.J. Khawaja (2018) “The existence of a stable money multiplier in the small open economy of Kazakhstan” *Journal of Economic Studies* **45(6)**, 1211-1223.

Bank of Canada (2018). Banking and Financial Statistics, https://www.bankofcanada.ca/rates/banking-and-financial-statistics/?mtf_search=M1, Accessed 05 January 2019.

Brunner, K. (1961) “A Schema for the Supply Theory of Money” *International Economic Review* **2(1)**, 79-109.

Brunner, K. and A. H. Metzler (1964) “Some further investigations of demand and supply of money” *Journal of Finance* **19**, 240-283.

Dickey, D.A. and W.A. Fuller (1981) “Distribution of the estimators for autoregressive time series with a unit root” *Econometrica* **49**, 1057-72.

Howells P.G.A.and K. Hussein (1998) “The endogeneity of money: evidence from the G7” *Scottish Journal of Political Economy* **45(3)**, 329–340.

Nayan, S., Kadir, N., M. S. Abdullah and M. Ahmad (2013) “Post Keynesian endogeneity of money supply: Panel evidence” *Procedia Economics and Finance* **7**, 48-54.

Panagopoulos Y. and A. Spiliotis (2008) “Alternative theories of money” *Journal of Post Keynesian Economics* **30(4)**, 601–622.

Pesaran, M., Y. Shin and R. J. Smith (2001) “Bounds testing approaches to the analysis of level relationships” *Journal of Applied Econometrics* **16(3)**, 289-326.

Phillips, P.C.B. and P. Perron (1988) “Testing for a unit root in time series regression” *Biometrika* **75**, 335- 346.

Shin, Y, Yu, B. and Greenwood-Nimmo, M. (2014) "Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework, Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications, Eds. by R. Sickels and W. Horrace: Springer, 281-314.

Thenuwara, W. and B. Morgan (2017) “Monetary targeting in Sri Lanka: How much control does the central bank have over the money supply” *Journal of Economics of Finance* **41(2)**, 276–296.

Appendix 1:

M1, M2 and MB are defined in the following forms by the BoC.

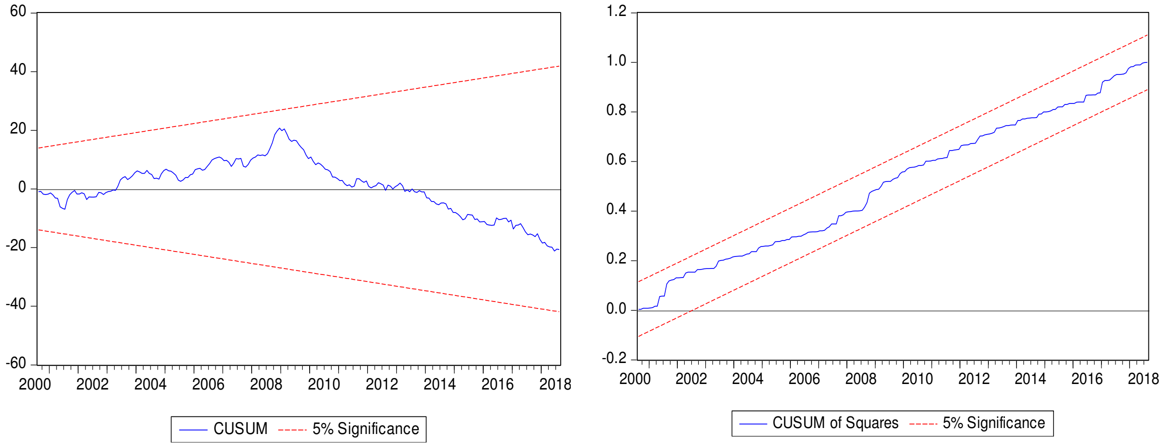
M1: Is the sum of currency outside banks plus chartered bank chequable deposits (less inter-bank chequable deposits)

M2: Currency outside banks, chartered bank demand and notice deposits, chartered bank personal term deposits, adjustments to M2 (gross) (continuity adjustments and inter-bank demand and notice deposits)

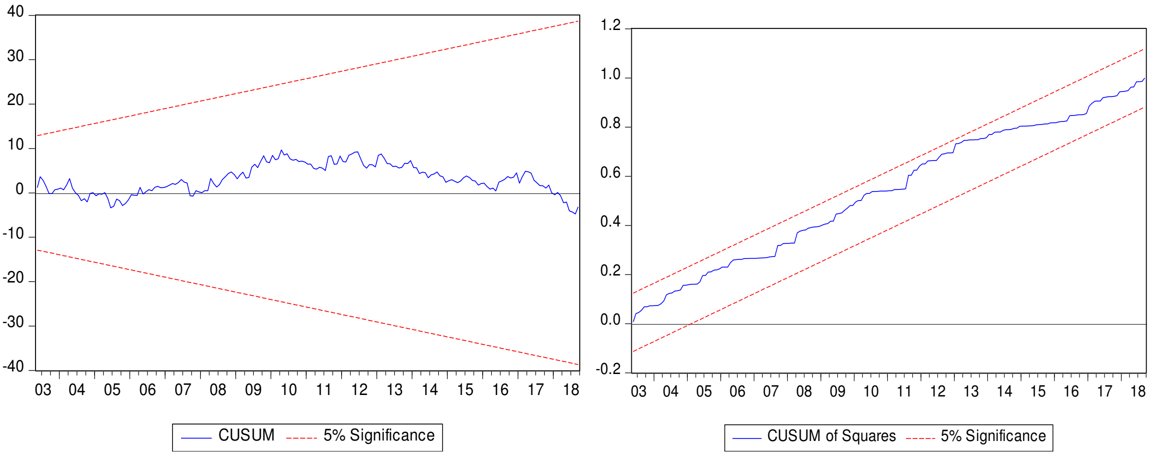
Monetary Base (MB): Notes and coin in circulation, chartered bank and other payments Canada members' deposits with the Bank of Canada

Appendix 2: Cusum end CusumQ Figures of Linear and Nonlinear ARDL Models

Linear ARDL - Dependent Variable is



Non-Linear ARDL - Dependent Variable is M1



Non-Linear ARDL - Dependent Variable is M2