Estimating the Causal Relationship among the Short-Term Interest Rate, the Inflation Rate, and the Budget Deficit Based on Three-Variable VAR Models with MWALD Test for Causality in the Case of Canada

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Abstract:

This study examines the possible existing causal relationship among the short-term interest rate, inflation rate and budget deficit in their level logarithmic form. First, it summarizes a body of theoretical and empirical views about these relationships. Second, it investigates the causal relationships among the short-term interest rate, inflation rate and budget deficit by using the VAR models with the MWALD test for causality associated with two lag variables in each proposition. The data in this study is yearly observations for a 33-year period (1981 to 2014) from the Organization for Economic Cooperation and Development (OECD) on Canada.

The main findings of the paper is that: (1) it was observed that the variables were found to be nonstationary; (2) it was revealed that there are no directional causality relationships in its level form among the short-term interest rate, inflation rate and budget deficit in the Canadian economy over that period. These imply that a budget deficit is a symptom of other economic variables; rather, than a cause of the short-term interest rate and inflation rate. Thus, if the goal of policymakers is to reduce the inflation rate and increase output, we should look to more direct problems than focusing on controlling the budget deficit.

Keywords: Relationship, causality, interest rate, inflation rate, budget deficit, Canada, MWALD test

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Section 1. Introduction: Should Policymakers be Concerned over the Budget Deficit?

Policy proposals view the budget deficit as a "bad potato" since the 1980s, because of the presumed negative consequences that a larger budget deficit could have in raising the inflation rate and interest rates. These assumptions have had the support of policymakers and have fostered debate in macroeconomic theory. However, macroeconomic theory fails to provide a clear causal connection between budget deficits and economic variables such as the inflation rate and interest rate. Over the years there has been an ongoing debate among economists and policymakers on the relationships among the interest rates, inflation rate and budget deficit that has included Canada in this debate. The debate had focused on whether the increasing budget deficit has the potential to cause higher inflation rates and higher interest rates. The importance of these relationships has been well recognized in the field of macroeconomics; however, we could not observe these relationships empirically. Thus, policy makers concerned with deficit spending may be attacking the symptoms rather than the causes when the growth rate slows down.

To illustrate whether there is an existing causal relationship between the short-term interest rate, the inflation rate and the budget deficit; this paper will: (1) examine the body of existing research (both theoretical and empirical) on the nature of these relationships between these three variables; and (2) investigate the causal relationships between the three variables using the VAR models with the MWALD test. The **aim** of this study is to examine whether a budget deficit is a symptom of the short-term interest rate and inflation rate; or whether it is a symptom of other economic variables.

Thus, there are two objectives in this paper, which are:

Objective One: This study will test whether the forms of observations we used is stationary or nonstationary. The Augmented Dickey-Fuller (ADF) test method applied here is based on two hypotheses: The null hypothesis is that the variable has a unit root and is a nonstationary series and the alternative hypothesis is that the variable has no unit root and is a stationary series.

Objective Two: This study will examine MWALD causality among the observations within the well-known VAR framework in its level form. Hence, we are able to test for causality, as well as identify which variables cause others.

To detect the statistically significant causal relationships among the short-term interest rate, inflation rate, and budget deficit, the study uses the three-variable VAR models associated with the MWALD causality test by considering yearly data for a 33-year period (1981 to 2014) from the Organization for Economic Cooperation and Development (OECD) in the case of Canada. The MWALD test has two major advantages over the existing empirical research on this issue. Firstly, it allows researchers to use Vector Autoregressive (VAR) models instead of the Vector Error Correction (VEC) models with possible cointegration problems. Secondly, it allows researchers to use nonstationary variables in its level form instead of its first difference form.

In this study, following standard practice in empirical studies, we use our indicators for the short-term interest rate in logarithmic form, inflation rate in the logarithmic form, and budget deficit in its original level. The logarithmic form of variables enables us to transform non-linear functions like the Cobb-Douglas functions to linear functions. However, the budget balance is not always positive, and, for this reason, we use the budget balance in its original level. At the same time, it is more reasonable for me to believe that there are some causality relationships

among variables in their level form instead of their first difference, because no economic view is based on the first difference.

This paper is structured as follows. Section 2 gives a brief literature review of the theoretical and empirical evidence on the relationships among the interest rate, inflation rate, and budget deficit. Section 3 describes the econometric model to address the causal relationships among the short-term interest rate, inflation rate, and budget deficit as non-stationary variables, associated with possible co-integration in the case of Canada. Section 4 describes the data. Section 5 presents the results and Section 6 offers the conclusions.

Section 2. Literature Review: Relevant Theoretical and Empirical Analysis Results - an Overview:

The purpose of this literature review is to examine the existing theories and studies on the potential causal connections from budget deficit to inflation rate, budget deficit to interest rate, and interest rate to budget deficit. There is a general presumption within economic theory that there is a causal connection. There is a presumption that a budget deficit raises the inflation rate; whilst a balanced budget reduces/stabilises the inflation rate (Taylor et al., 2012). It is important to understand the impact of the budget on the inflation rate, because public perception links these two factors to the health of the economy (Taylor et al., 2012). The public criticizes central banks and federal governments for budget deficits, because there is the presumption that there is a direct effect on the inflation rate. This means that budget deficits are viewed by the public as a "bad potato" (i.e. a bad/broken economy) (Baum & Koester, 2011). The implication is that a good economy is characterized by budgetary balance (Baum & Koester, 2011). This research is examining whether the presumed causal relationship between budget deficits and the inflation rate is factually present (especially when the post-Global Financial Crisis illustrates that austerity

and attempts to balance budgets have not necessarily stimulated growth or had a positive effect on the inflation rate). In fact, a second question arises, which is whether balancing the budget automatically has a positive impact on the economy. Thus, this review will examine different theories on the causal relationships between: (1) budget deficits and the interest rates; and (2) whether balancing the budget has a positive impact on the economy (i.e., there is a good potato as opposed to a bad one) (Baum & Koester, 2011).

Causal Connection between Budget Deficits and Inflation:

The causal relation usually described is that a higher budget deficit has a strong positive impact on the inflation rate because the economy is always gravitating around its potential output. For instance, the AS-AD model assumes that the aggregate supply becomes a vertical line (Mankiw, 2011). The AS-AD model suggests that a higher budget deficit usually has a strongly positive impact on aggregate demand; this means that a higher aggregate demand raises prices (Mankiw, 2011). The assumption of the AS-AD model is that when the output is at its maximum potential level, consumption is crowded out by the budget deficit. This is because of the resulting high inflation rate or even hyperinflation (Mankiw, 2011).

Budget balances and inflation rates are of special concern to economists and non-economists alike, because they are deemed to be an indicator on whether the economy is in good shape (Baum & Koester, 2011). The number of studies on the causal relation between budget deficits and the interest rate illustrates how important this issue is, but the bad potato analogy may be overly simplified (Baum & Koester, 2011). The reality is that the causal relationship between budget deficits and inflation rates is much more complex (Sawyer, 2012). Austerity measures have been developed on this premise (i.e. (1) reducing the deficit will have a positive impact on

inflation rates; and (2) lower inflation rates will stimulate growth in the economy (Sawyer, 2012)).

The failure of austerity illustrates that there may not be a framework that is wholly based upon balancing budgets, because an economy is much more complex than a pocket book (Sawyer, 2012). However, even stimulus-based economics (i.e., the Keynesian model) supports the causal relationship (Mankiw, 2011). The principle that a budget deficit will be inflationary is identified in both New Keynesian economic analysis and classical economics (Mankiw, 2011). Traditional or classical monetarists claim that government seigniorage and the amount of currency are directly linked to economic health and liquidity. Their belief may be based on a false premise that budget deficits result in negative consequences for the economy, because classical and Keynesian economics cannot always explain the relationship between budget deficits and inflation (i.e., the right mix of economic factors that grow the budget deficit may not have the expected inflationary effect) (Popov, 2012). In fact, Keynesian economics is based on stimulus programs, which can increase the deficit (but it promotes growth) (Popov, 2012). This raises the question of whether balancing the budget will always have the presumed benefit effect on the economy (i.e., be an indicator of a healthy economy). The argument of traditional economists (Classical and Keynesian) that the budget should be balanced in order to create a healthy economy is based upon a dual premise (Begg et al., 2006). This dual premise is that: (1) the crowding out effect of budget deficit on consumption is negative and undermines growth; and (2) deficits lead to a crowding out effect in investment, which means that the economy becomes unattractive to domestic and foreign investors (Begg et al., 2006). The question that has to be asked is whether this relationship is valid. Thus, the first step is to examine: (1) the crowing out effect on consumption; and (2) the crowding out effect on investment. Then we will move to

examine other topical issues that arise out of the causal effect between the budget deficit and inflation.

The Crowding-Out Effect of Budget Deficits on Consumption

The crowding-out effect of consumption has been briefly identified due to: (1) deficits increasing inflation, and (2) the increased prices crowd out consumption (Mankiw, 2011). This section will examine some of the studies on this crowing-out effect.

Metin (1998) explored the connection between the inflation rate and the budget deficit through a single equation model in Turkey over the 1950-1987 period. Through system cointegration tests, the results suggested that there are three stationary relationships. Meanwhile, the results in a Vector Error Correction (VEC) model revealed a positive relationship between the inflation rate and budget deficits during that long period in Turkey. A larger budget deficit immediately led to an increase in the inflation rate. The result of this study is that the three-pronged crowding-out effect on consumption is plausible, but this link may be appropriate in an era where deficits and consumptions are a lot less complex than the modern financial framework.

Wolde-Rufael (2008) investigated the causal relationships among the inflation rate, money, and budget deficit in Ethiopia for the period 1964 to 2003. He used the autoregressive distributive lag (ARDL) approach, which estimated three unrestricted error correction (UREC) regressions considering each variable as a dependent variable and a modified Granger causality test. Compared with the results in the ARDL approach, they found that there was a causal relationship between inflation and the budget deficit with the budget deficit showing a statistically significant impact on inflation in the case of Ethiopia in the long run. In contrast, in the short term, they found that the budget deficit is not a statistically significant determinant of inflation. Through modified Granger causality test results, they found that the results rejected the hypothesis that

budget deficits do not raise inflation. The results supported the hypothesis that there is a positive and statistically significant relationship between a budget deficit and inflation in the case of Ethiopia. Once again, this study pre-dates the Global Financial Crisis and the more complex economies that arose out of globalization's open markets stemming from the 1980s to date.

The level of development and the interaction with global markets may impact the causal effect. For example, the studies of Alavirad & Athawale (2005), Luis (2008), Kheir-El-Din (2009) and Khumalo (2013) applied the crowding-out theory and methods to the Islamic Republic of Iran, Colombia, Egypt and South Africa, but these countries were not at the industrial stage of complex Western economies of the 21st Century. Nonetheless, there is an argument that there is a direct link between the budget deficit and inflation rates. Nonetheless, the simplistic crowding-out theory may not fully explain the relationships that have arisen during the post-Global Financial Crisis era where there is a great deal of complexity (Crotty, 2012; Callinicos, 2012; Boyer, 2012). Prior to engaging with this issues, the crowding-out effect of budget deficit on investment will be examined.

The Crowding-Out Effect of Budget Deficits on Investment:

There are two views on the impact of the budget deficit on interest rates. One view is that the interest rate effect of budget deficits is a "bad potato"; and the other is that there has to be stimulation of the economy to stimulate growth. The crowding-out effect is linked to the "bad potato" view of the economy (Baum & Koester, 2011), which will be the focus of this section. The second approach on the positive potential of increasing the budget deficit will be discussed later in the literature review.

The IS-LM model provides for the interest rate effects of a budget deficit in a closed economy in Neo-Keynesian economics (Blanchard & Johnson, 2012). This model divides the budget deficit

into short-term, medium-term, and long-term effects. In the short term, without any change in taxes, a larger budget deficit resulting from greater public spending will shift the IS curve to the right. It leads to an increase in output and may cause an increase in investment (Blanchard & Johnson, 2012). The interest rates are controlled by central banks, which results in the LM curve being a horizontal line (Blanchard & Johnson, 2012). In the medium term, the central bank shifts the LM upward and interest rates are higher, in order to adjust output so that it can return to its natural level (Blanchard & Johnson, 2012). Larger interest rate leads to a decrease in investment, which is a direct result of the budget deficit (Blanchard & Johnson, 2012). Through manipulation (and eventually balancing the budget) there will be a lowering of interest rates, in order to increase investment (Blanchard & Johnson, 2012). The reason why there is manipulation to lower the interest rates is to result in higher investment (Blanchard & Johnson, 2012). Lower investment leads to a lower capital stock, which leads to lower output in the future (Blanchard & Johnson, 2012). The result is a higher unemployment rate in the future. Finally, in the long term, a larger budget deficit leads to a higher unemployment rate and higher interest rate (Blanchard & Johnson, 2012). On the initial assumption of output at its potential level, the investment instead of the consumption is crowded out by the budget deficit, which would lead to a higher unemployment rate because of the higher interest rate (Blanchard & Johnson, 2012). Therefore, policymakers should avoid budget deficits, because it can result in the crowding out of investment.

There are many empirical studies that support the crowding-out-of-investment premise. Barro (1987) was one of these studies. He considered the United Kingdom to be a closed economy during the war. The study used data in the United Kingdom during 1701-1918. For long-term interest rates, he used the yield on consols. The theory implied that an increase in government

spending would have a positive effect on interest rates. The money supply was measured by the number of bank notes issued by the Bank of England. The theory implied that an increase in government spending would raise the price level in a non-gold standard period but not in a gold standard period. In this paper, the results revealed that interest rates rose along with government spending. The results also showed that the effect of military spending on the long-term interest rate is significantly positive for the non-gold standard period and the gold standard period. The effect was larger for the non-gold standard than the gold standard period. Therefore, this study shows that there is crowding out of investment. However, this study may be over-simplistic, due to the simplicity of the economy because it is isolated (i.e., it is not reflective of the modern economy that is engaged in a complex global interconnectedness (Carrick-Hagenbarth & Epstein, 2012).

Al-Saji (1993) carried out a case study of the developed economy of the United Kingdom to examine the relationship between budget balance and the long-term real interest rate during 1960:1-1990:2. The IS-LM model was applied in an open and closed economy. This is an important distinction, because modern economies are not closed; rather, they are open and interconnected in a globalised world (Mankiw, 2011). Based on the analysis, Al-Saji (1993) found that the increase in the budget deficit raised the long-term real interest rate. The proportion of the long-term real interest rate increased by 9.7 or 7.7 percent depending on whether the economy of the UK was an open or a closed economy. The implication of this study is that the causal link between budget deficits and interest rates is valid, even in an open economy. Nonetheless, the level of interconnectedness of the 21st Century has not been replicated in the study.

Aisen and Hauner (2008) investigated the relationship between budget deficits and interest rates in 60 advanced and emerging economies. They used data from the 1970 to 2006 panels. One exception is that the data does not include the US. Their results suggested that the interest rate will increase by 26 basis points when the budget deficits increase by one percent. In fact, if the government increases the budget deficit, it must accept higher real interest rates. Thus, this study does show that there is a causal link between budget deficits and interest rates in an economy of the level of interconnectedness of the 21st Century, but it does not include the US economy so the results may be questioned.

Bonga-Bonga, (2012) used the generalised impulse response functions obtained from the cointegrating vector autoregressive (VAR), in order to assess the effect of the surprise change in budget deficit on the long-term interest rate. This paper also showed a positive relationship between budget deficits and long-term interest rate under different assumptions of price expectations by economic agents during the period 1970Q3 to 2008Q3 in South Africa. Once again, there are questions whether the presumption of the crowding effect is present in all economies, because this is an emerging economy. Nonetheless, there is a general implication that there is a trend between budget deficit and interest rates; a larger budget deficit will result in crowding out of investment due to the impact on interest rates.

The last two sections have illustrated that budget deficits are bad potatoes, which will crowd out consumption and investment. However, there are problems with some of the studies. Thus, the following section will examine the accounting consequences of a recession economy on budget deficit, because this is when the concerns over interest rates lie (Begg et al., 2006).

Accounting Consequences of Recession on the Budget Deficit:

A larger budget deficit is an accounting consequence of a recession in an economy instead of an economic problem now (Begg et al., 2006). Unlike some economists who only focus on the inflation rate or interest rate effects of the increase in the budget deficit, Begg et al. (2006) included the interest rate payment into budget deficit to understand the causal effect in a recession economy.. Understanding the interest rate payment is important, because in a recession economy the government must pay for financing past deficits. Thus, Begg, et al. (2006) present the following equation of the budget balance:

$$BB = tY - G - iPD$$

In this model, tY means the tax revenue of the government in each year as the percentage of actual GDP. G is actual public spending for the government. The tY-G is the government primary budget deficit excluding these interest payments. It is the deficit between current net revenue and current public spending on goods and services. This means that a higher previous inflation rate has no impact on current budget deficit (Begg et al., 2006). The iPD is the current interest payments in the public debt. It is the cost of financing previous budget deficits by issuing bonds. This means that a larger previous short-term interest rate may lead to a larger current interest rate payment because some bonds are tied to the short-term market interest rate (Begg et al., 2006). Thus, the causal relationship between interest rates and budget deficits in the earlier studies are arguably too simplified, in order to understand the framework better.

Cheng (1998) applied a model that included interest rates. In his study, he investigated the causality between budget deficit and interest rates in Japan applying two Granger causality tests using Vector Autoregressive (VAR) models. There are two regroupings of the period. One is the period 1966-93. Another is the period 1955-93. By using the Engle-Granger two-step procedure,

the study found that a larger budget deficit has no impact on the price level and short-term interest rates. Moreover, by using Hsiao's vision of the Granger causality test associated with the aid of cointegration, the study also found no causal relationship between budget deficits and long-term interest rate, but revealed a causal relationship between budget deficits and short-term interest rates in Japan. This is an interesting outcome, because it highlights that when the more complex features of a modern economy are part of the study the presumption of the budget deficit as a "bad potato" that increases interest rates is fundamentally flawed.

Another view is that, during the recession, the economy is far away from its high-employment level and it is necessary to use packages of policy mixes that include larger budget deficits, which may or may not be associated with larger interest rates, to push the economy to return its original output level (Baumol et al., 2010). It means that a larger budget deficit is a good thing that ought to be implemented during the recession. Baumol et al. (2010) described this effect as a crowding-in effect. An increase in the budget deficit raises wages and will lead to an increase in individuals' consumption and investment. It shifts the IS curve to the right and induces higher investment and higher output regardless of the interest rate effect. Budget deficits raise wages, so individuals' income rises and they have more money for consumption and more money for investment because governments are engaged in deficit spending. More investment means more labour demand in the labour market. It reduces the unemployment rate (Baumol et al., 2010). The crowding-in effect is a good thing instead of a burden compared to the crowding-out effect. Thus, individuals within the economy have more income and fewer individuals are unemployed (Baumol et al., 2010). This means that there can be a positive impact of increasing the budget deficit, in order to ensure that there is the ability to increase employment and in the long-term make the economy grow through consumption.

Budget Deficit and Inflation Rate Based on the Level of Seigniorage:

Although the money we use today is not currency coins, the public still believes that a higher budget deficit will cause a higher inflation rate based on historical experiences (i.e., the simplified principle of balancing the pocket book). Donovan (2015) as a historian, like the public, believed the inflationary effect of budget deficit is based on historical events. In the history of towns and cities, he found that there were two historical events to support the views of the inflationary effect of a budget deficit. One is the Dionysius event. Dionysius, an Elder of Syracuse, who ran a Greek colony on the island of Sicily, developed two ways to finance its budget deficit at no cost. One was to stamp each one-drachma coin as being worth two drachmae. Another was to make an issue of tin coins and insist they should be accepted as having the same value as silver drachma. The money supply was increased and it created higher inflation because of the budget deficit financed by the new money. Interestingly, the same kind of historical event happened in ancient China. During the Chin dynasty's war against the invading Mongols, the budget deficit was financed by printing money. Paper money was being accepted at 1 percent of its face value by 1214. By 1224, the latest iteration was worth 80,000,000 of the 1214 notes. Again, the budget deficit increased inflation. This is an example of a link between budget deficits and inflation, because there is a closed and simple economy (i.e., there is not a complex economy that challenges the presumed causal link).

According to Baumol et al. (2010), these various monetarist oriented studies ignored two facts: firstly, the economy is far away from its high-employment level. In low-employment countries, because the aggregate supply curve is a horizontal line instead of a vertical line in the AS-AD model, when we suppose that the government runs budget deficits, the overall real output rises and, thus, would not necessarily show an increase in the price level. Hence, there is no causal

connection between budget deficit and inflation rates in the AS-AD model without the assumption of output being at its potential level. Secondly, nowadays money is not only currency coins but it is also a number in the balance sheet of the banking system. All transactions are a balance sheet operation conducted on the Internet through computers now. This violates the basic assumption of the quantity theory of money as described by monetarists. Therefore, the money supply immediately adjusts endogenously instead of exogenously.

Sill (2005) as a monetarist examined the empirical and theoretical links between the budget deficit and the inflation rate based on the level of seigniorage. At the beginning of the study, he found that there was no link between budget deficits and the inflation rate in developed countries such as the United States. However, in less developed countries he found that there was a statistically significant link between budget deficits and the inflation rate. By the end, he concluded that monetary policy, independently or dependently, is the key determinant of links between the budget deficit and the inflation rate. If monetary policy is independent and non-accommodative, governments must pay the current budget deficit by issuing bonds based on the future budget surplus, so the quantity of money in circulation is constant and there will be no links between the budget deficit and the inflation rate. By contrast, if the monetary policy is dependent and accommodative, governments could use the policy to help finance the deficit by receiving seigniorage revenue, so the quantity of money in circulation increases and there will be links between the budget deficit and the inflation rate. Thus, the more complex, open and interconnected the economy, the less persuasive the argument that there is a link between budget deficits and inflation rates.

Fischer et al. (2002) supported this view based on their study on the links between budget deficit and seigniorage revenue in a sample of 133 countries in the period 1960 to 1995. There were 25

high-inflationary countries defined as when the 12-month inflation rate rises above 100 percent. In high-inflation countries, the relationship between the budget deficit and seigniorage was strong in the short and long runs. High-inflation was associated with poor macroeconomic performance. Seigniorage increased as inflation rose until the seigniorage revenues reached its maximum level. The model found that seigniorage revenues were maximized when the inflation rate reached 174 percent. The deficit-inflation link for the whole sample was significant in the cross-section regression analysis. Their results showed that a 1 percentage point increase of the ratio of budget deficit to GDP in the high inflation countries leads to an increase in the inflation rate by 4.2 percentage points. However, there was no obvious relationship between the inflation rate and budget deficit in the low-inflation countries. Therefore, there are limited instances when there is a proven causal relationship between budget deficits and inflation. This discussion will now engage with studies that have engaged in large scale and complex testing of the causal link between budget deficits and interest rates.

Challenging the Links between Budget Deficits and Interest Rates and between Budget Deficits and Inflation – Large Scale Causality Testing:

Catão and Terrones (2003) re-examined the issue with a larger scale of data and a new modelling approach to look at the effects of budget deficits on a sample of 107 countries over 1960-2001. They used the inflation rate, the budget deficit, GDP, and narrow money to test the relationship between the budget deficit and inflation in the so-called mean group (MG) and a maximum likelihood-based “pooled mean group” (PMG) estimates model associated with an autoregressive distributed lag (ARDL) structure. The results also showed that the estimated effect of changes of budget deficits on inflation is statistically significant for developing countries, but not among

advanced economies. This supports the rationale that the less complex the economy, the higher the link between budget deficits and inflation rate.

Guess and Koford (1986)'s results support this view. They investigated the causal relationship between budget deficits and inflation by using the Granger causality test. They collected data for 70 OECD countries for the period 1949-1981 and defined two kinds of budget deficits. One is the real deficit (nominal balance divided by the GNP deflator), the other is a deficit as a share of national product (GNPD). Each proposition is tested with six lag variables. Based on their Granger causality test results, they concluded that deficits are affected by the increase in inflation rates, while deficits do not cause changes in inflation. They also found that changes in prices lagged one year may still influence budget deficits, and so cannot be ignored as a statistically significant determinant of budget deficits. The causal relation probability exceeds 0.5. At the same time, however, they rejected the hypothesis that deficits cause inflation at the 0.05 level across the 70 OECD countries. They concluded that deficits are never a statistically significant determinant of inflation.

Seccareccia and Sood (2000) also found the same results that there is no connection between deficit and inflation for the G7 countries excluding Japan. After choosing the appropriate model based on the unit root tests, Granger causality tests were done for the G7 countries excluding Japan using annual data from the early 1950s to 1990-96 that were available from the Organization for Economic Cooperation and Development (OECD). They did not find any evidence of a cointegration relation either between deficits and changes in the consumer price index (CPI) or between the deficit to GDP ratio and inflation rate. Moreover, there was no evidence of an intertemporal causal relation between the deficit to GDP ratio and inflation for any of the six countries. Tiwari et al. (2015) used two new tests as the bootstrap causality and

Granger causality test to distinguish short and long-run causality between budget deficits and inflation rate. They also found no causal relationship from budget deficits to inflation for nine EU countries during the period of 1990-2013 using quarterly data. The implication is that there is not a causal link between inflation and budget deficits when there is more complex testing with a large scale in a manner.

Some studies support the view that the more complex is the economy, the higher the link between budget deficits and interest rates. David and Manmohan (2011) used panel dataset for the G7 countries for the period 1960-2005. Their results suggested a statistically and economically significant impact of the budget deficit on interest rates. A 1 percent increase of GDP in the budget deficit leads to an increase in the long-term interest rate by 8 basis points. Aisen and Hauner (2008) re-examined the issue with a larger scale of data and a new modelling approach, using the system of Generalized Method of Moments (GMM), to look at the effects of budget deficits. Similar results were obtained from their overall findings, but the interest rates effect of budget deficit was different across periods. The results implied that budget deficits had a negative impact on interest rates during the 1985-1994 period but a positive effect during the 1995-2006 period.

Akinboade's (2004) results supported this view. He explored the causal connection between budget deficits and interest rates in South Africa using the London School and Granger causality tests. There were two interest rates to be examined. One was the Commercial rate, and another was the government bond rate. The study covered the 1964-99 period. The results suggested that there is no directional causal connection between budget deficits and interest rates in South Africa. Thus, once again including complex characteristics of the modern economy challenges the causal link between budget deficits and interest rates in the long term.

In fact, Chakraborty (2012) used the asymmetric vector autoregressive (VAR) models to estimate and found that the interest rate is not affected by changes in the budget deficit over the periods 2006-April to 2011-April in the case of India. However, a reverse causality was detected from interest rates to budget deficit. It again supported the views of Baumol et al. (2010). This means that it may be valid to increase the budget deficit in the short term, in order to get long term growth (i.e., there is no effect on the long-term interest rate). Therefore, the attempt to balance the budget to stimulate growth by avoiding the crowding-out effect of consumption and investment may be fundamentally flawed. This study will move on to explore a number of studies that challenge the traditional causal relationship, especially linked to austerity in the post-Global Financial Crisis Era.

Interest Rates, Budget Deficits and Financial Crisis:

The problem is that the desired effect of interest rates being lessened through balancing the budget may not appear, because there is a complex framework (as seen in recent austerity measures). The Global Financial Crisis illustrates this, because the traditional responses of bankers, the financial markets and the Treasury did not have the desired effect due to a number of competing factors at play (Boyer, 2012). Boyer (2012) writes that "the independent conservative central banker was in charge of defending price stability and the orthodoxy forbade it to buy or to accept as collateral any low-quality financial asset. Paradoxically, a low-inflation regime enabled a long period of low interest rates, which triggered the diffusion of very large leverage ratios in order to sustain high rates of return, especially in the financial sector" (p. 284). The operation of this paradox meant that there was a bubble burst in a manner that governments could not envisage, which meant that it was necessary to be innovative and to address the new challenges. Unfortunately, these new challenges had been addressed largely by policies that

remained embedded in traditional theories (Boyer, 2012). Nonetheless, there is the same problem which arises with the adoption of austerity, which has been a disaster in Greece and other EU states (Laski & Podkaminer, 2012). The implication is that the traditional economic links between the inflation rate and budget deficit are overly simplified, which means that economic theory may have to be rethought.

Iceland:

The fact that there have been different impacts on interest rates and economic stabilisation in the wake of austerity with the purpose to reduce budget deficits illustrates that the simple link identified in previous studies may not be correct (Boyer, 2012; Taylor et al., 2012). The example of Iceland, which is a country that has stabilised, is interesting, because it did not press for quick 'fiscal consolidation'. (Wade & Sigurgeirsdottir, 2012, pp. 142-143). The implication is that alternative economic factors were implemented to promote growth, which are traditionally associated with higher interest rates (Mankiw, 1998) that did not materialise.

As an example, new measures of control were implemented that did not necessitate restrictive fiscal austerity measures (Boyer, 2012). This is seen in Iceland, which "supported controls on capital outflows; and it brought in technical experts to help restructure the banks" (Wade & Sigurgeirsdottir, 2012, p. 143). These controls could have been associated with measures to restrict fiscal spending and balancing the budget, but due to the nature of Iceland's economy it was not plausible or there could have been continued collapse (Wade & Sigurgeirsdottir, 2012). Arguably, the use of budget balancing techniques and holding interest rates down, in order to prevent inflation in Greece and other Eurozone countries have not been completely successful (i.e., intrinsically different economic characteristics impact the relationship between the budget deficit and inflation) (Laski & Podkaminer, 2012; Callinicos,

2012). The example of Iceland supports this, because in addition to controls, there was also protection of the welfare state (Laski & Podkaminer, 2012).

Ireland:

Austerity models may be dangerous because they can prevent economic growth (Kinsella, 2012). The Irish model has not taken the traditional path to austerity; rather it has taken the expansionary fiscal contractions model, which has been described as "shaky at best" (Kinsella, 2012, p. 234). This is because there is a contradictory framework in place, but this model may be successful because Ireland is a small country (Kinsella, 2012). The approach to growth in the 1980s after a financial crisis was different, because it reduced "fiscal expenditure in a small open economy openly courting foreign direct investment with friendly taxation rates when the rest of the world is growing and one is receiving transfers from other states whilst reducing costly unemployment through emigration" (Kinsella, 2012, p. 234). This form of growth illustrates that there is a complex framework of interconnectedness in place, which means that balancing the budget deficit will not be sufficient to stabilise the Irish economy. Kinsella (2012) argues that "it is hard to see Ireland recovering in the short term as a result of austerity measures alone, with many commentators arguing that the time frame of the resolution of these problems is in decades, not years… We are not a role model, but a cautionary tale" (p. 234). Thus, it is important to ascertain whether balancing the budget will help a state to escape a financial crisis, and if it is then there must be consideration of all the other interconnected factors to create a successful model to promote growth (Carrick-Hagenbarth & Epstein, 2012; Kinsella, 2012).

Summary:

The findings of Barro (1987) and traditional monetarist theories of interest rates and budget deficits appear to be valid when there is a simple model. The argument that there should be

avoidance of budget deficit would be correct in this application, but the example of Iceland and other interconnected states illustrates that stability can be achieved in other ways (Carrick-Hagenbarth & Epstein, 2012). In fact, the devastation of Greece illustrates that this simplified formula does not work (Kinsella, 2012). The protection of the welfare state meant that there was continued help for those citizens that were "finding it 'very difficult' to make ends meet, well below the European average" (Laski & Podkaminer, 2012, p. 143). This meant that this model was anything but Keynesian or classical economics. It could be argued that Iceland broke every rule, but it is the one country that recovered from a devastating failure that could have put it in the same position as Greece today. Nonetheless, it has managed to implement sustainable recovery, which is challenging traditional economics that create a simple link between budget deficits and inflation as the primary characteristics of measuring the country's health (Laski & Podkaminer, 2012). As Laski and Podkaminer (2012) say, "Iceland stands as a rebuke to the new classical economics prescription for bank bailouts and steep public spending cuts as the way to satisfy financial markets and create jobs" (p. 143). With this anecdotal evidence and the study of many surveys; the traditional monetarist links between budget deficits and inflation may not be appropriate, because modern examples of economic links are a lot more complex due to various economic factors that are intertwined. Thus, this study will now undertake a large-scale statistical testing to ascertain whether there is a causal relationship between budget deficits and interest rates in complex, open and interconnected economies in the 21st Century.

Section 3. Econometric Models: The Three-Variable VAR Models with a MWALD Test for Causality

The process of obtaining the appropriate results required that we do some diagnostic tests before doing MWALD causality tests:

1. A first step will be made to test whether the forms of variables we addressed here are stationary or nonstationary. One of the conditions of using a MWALD causality test in VAR models is to use nonstationary time-series variables. This study includes the Augmented Dickey-Fuller (ADF) test to be run for the unit root test for all variables. The null hypothesis is that the variable has a unit root and is a non-stationary series. The alternative hypothesis is that the variable has no unit root and is a stationary series.

2. A second step is to regress the forms of observations through the VAR (1) to determine the appropriate maximum lag length for the variables in the VAR models to get appropriate lags, using the usual methods. Specifically, one bases the choice of appropriate lags on the usual information criteria, such as the maximum LR index, the minimum AIC index, and the minimum SC index.

   Per Giles (2016), by using the three-variable VAR models, the author treats each variable as endogenous. Three VAR models are generally used for estimating the causal relationship existing between the dependent and independent variables to be used and can be specified as:

$$(1) y_t = c_0 + \sum_{i=1}^{m} a_i \, y_{t-i} + \sum_{j=1}^{m} b_i \, x_{t-j} + \sum_{k=1}^{m} c_i \, z_{t-k} + e_{1t}$$

$$(2) x_t = c_0 + \sum_{i=1}^{m} a_i \, y_{t-i} + \sum_{j=1}^{m} b_i \, x_{t-j} + \sum_{k=1}^{m} c_i \, z_{t-k} + e_{2t}$$

$$(3) z_t = c_0 + \sum_{i=1}^{m} a_i \, y_{t-i} + \sum_{j=1}^{m} b_i \, x_{t-j} + \sum_{k=1}^{m} c_i \, z_{t-k} + e_{3t}$$

Where c is the intercept, and the other coefficient ($a_i; b_i; and\ c_i$) measure sensitivity to a change in the short-term interest rate, inflation rate, and budget deficit to a change in the independent lag variables up to lag (i). y_t, x_t and z_t are the logarithmic form of the short-term interest rate, the logarithmic form of the inflation rate and the level of budget deficit (dependent variables). Based on the logarithmic form of each variables, we could easily transform non-linear functions like the Cobb-Douglas functions to a linear function. However, the budget deficit is not always positive, so it is impossible to transform budget deficits to a logarithmic form. It may be a better way to see how a change in the percentage in interest rate and inflation rate can influence the budget deficit in Canada because both are the growth rates of others variables. $\sum_{t=i}^{i} y_{t-i}$, $\sum_{t=i}^{i} x_{t-i}\ and\ \sum_{t=i}^{i} z_{t-i}$ are the lag variables of the short-term interest rate, inflation rate, and budget balance up to lag (i) (independent variables). e_{1t}, e_{2t} and e_{3t} are the error or disturbance terms. The three equations will be used in the causality analyses to predict the relationships among the variables under study. The a_i represents the yearly effects of the short-term interest rate while $b_i\ and\ c_i$ represents the yearly effects of the inflation rate and interest rate. The short-term interest rate, inflation rate, and budget deficit are introduced to deal with endogeneity. The vector of independent variables includes controls for its own and other variables with previous lag periods.

3. The third step is to estimate VAR models with appropriate lags and make sure that the VAR is well-specified. For example, ensure that there is no serial correlation in the residuals through the LM tests. If there is a serial correlation problems among variables, increase p until any autocorrelation issues are resolved; ensure that there is stability in the VAR models through AR roots graph. No roots lie outside the unit circle means that VAR satisfies the stability condition; ensure that there is no heteroscedasticity problem in

VAR residual through VAR Residual Heteroscedasticity with or without cross terms. If the p value is smaller than 0.05, it means that we reject the null hypothesis according to which residuals are such that there is no heteroscedasticity.

4. The four step is to re-estimate VAR models with one extra lag and do the MWALD causality test excluding the extra lag. The MWALD causality is an econometric model which allows us to test causality with non-stationary variables associated with possible co-integration, simply by running the following three regressions:

$$(4) y_t = c_0 + c_1 y_{t-i-1} + c_2 x_{t-j-1} + c_3 z_{t-k-1} + \sum_{i=1}^{m} a_i\, y_{t-i} + \sum_{j=1}^{m} b_i\, x_{t-j} + \sum_{k=1}^{m} c_i\, z_{t-k} + e_{1t}$$

$$(5) x_t = c_0 + c_1 y_{t-i-1} + c_2 x_{t-j-1} + c_3 z_{t-k-1} + \sum_{i=1}^{m} a_i\, y_{t-i} + \sum_{j=1}^{m} b_i\, x_{t-j} + \sum_{k=1}^{m} c_i\, z_{t-k} + e_{2t}$$

$$(6)\ z_t = c_0 + c_1 y_{t-i-1} + c_2 x_{t-j-1} + c_3 z_{t-k-1} + \sum_{i=1}^{m} a_i\, y_{t-i} + \sum_{j=1}^{m} b_i\, x_{t-j} + \sum_{k=1}^{m} c_i\, z_{t-k} + e_{3t}$$

The null hypothesis is that one variable does not cause another variable. The alternative hypothesis is that one variable does cause another variable. If the p value is less than 0.05, this suggests that we should reject the null hypothesis, which means that when one variable changes, the other variable will also change. If the p value is larger than 0.05, this suggests that we should accept the null hypothesis and thus, if one variable changes, the other variable will not change. Therefore, an increase in one variable may not change the other variables.

Section 4. Data: Sources, Descriptive Statistics and Trends of Data in the Case of Canada

In this paper, I accessed the short-term interest rate from the Organization for Economic Cooperation and Development (OECD). Based on the definition of the data in the sources

(OECD, 2016), short-term interest rates are the rates at which short-term government paper is issued in the market. Short-term interest rates are based on three-month money market rates where available in Canada.

The inflation rate is estimated using the consumer price index (CPI) in Canada as an annual growth rate over the 1981-2014 period. The consumer price index study carried out by the OECD every year is usually used to compute the overall consumer price index. Based on the definition of the data in the sources (OECD, 2016), inflation is measured in terms of the annual growth rate of the Consumer Price Index (CPI), 2010 base year. A consumer price index is estimated as a series of summary measures of the period-to-period proportional change in the prices of a fixed set of consumer goods and services of constant quantity and characteristics, acquired, used, or paid for by the reference population. Obviously, that is not the inflation rate that the Bank of Canada looks at or targets, but it is the most broad-based measure of the rate of change of consumer prices, which is what the usual theories about the inflationary effects of the budget balance refer to.

The budget deficit data is collected from the OECD. To choose appropriate data, I used the general government deficit, as the percentage of GDP for each year, and treated the negative original level as the budget deficit. Based on the definition of the data from the OECD, it is calculated as gross savings plus net capital transfers minus gross capital formation, followed by the subtraction of acquisitions minus disposals of non-produced, non-financial assets. This indicator is measured as a percentage of GDP. Data are under the System of National Accounts (SNA, 1993) for Canada.

Table 4.1 presents a list of logarithmic values of raw data which the study researched from the Organization for Economic Cooperation and Development. For the short-term interest

rate (LOGSR), the average maximum and minimum short-term interest rate in Canada over the period 1981 to 2014 is 2.911025 at 1981 and -0.365540 at 2009 as the logarithmic form of the average annual interest rate. For the inflation rate (LOGINF), the average maximum and minimum logarithmic rate of the inflation rate in Canada over the period 1981 to 2014 is 2.523455 at 1981 and -1.798403 at 1994 as the annual growth rate of the CPI. For the budget deficit (BD), the average maximum and minimum budget deficit as a ratio of GDP in Canada over the period 1981 to 2014 is 9.230202 as a deficit in 1992 and -2.648542 as a surplus in 2000.

Table 4.2 shows that the budget deficit is often positive, while the inflation rate and short-term interest rate are usually positive. The reason why the logarithmic form of the inflation rate and the short-term interest rate could be negative is, when the number is close to zero, the logarithmic form of the number becomes negative. The distribution of respondents among each variable are even as well. These facts show that data have a wide and varied range of observations. The mean is larger than the median for the budget balance, inflation rate, and short-term interest rate. Data have different kinds of distribution among the observations. Table 4.3 also indicates a 41.4% correlation between budget deficits and short-term interest rates and 19.3% for the correlation between budget deficits and inflation rates. Short-term interest rates and inflation rates have a positive relation with budget deficits. In terms of the correlation between inflation and budget deficits, there is also a correlation of 60.2%. A higher inflation rate has a positive relation with short-term interest rates.

Figure 4.4. The trends among raw data.

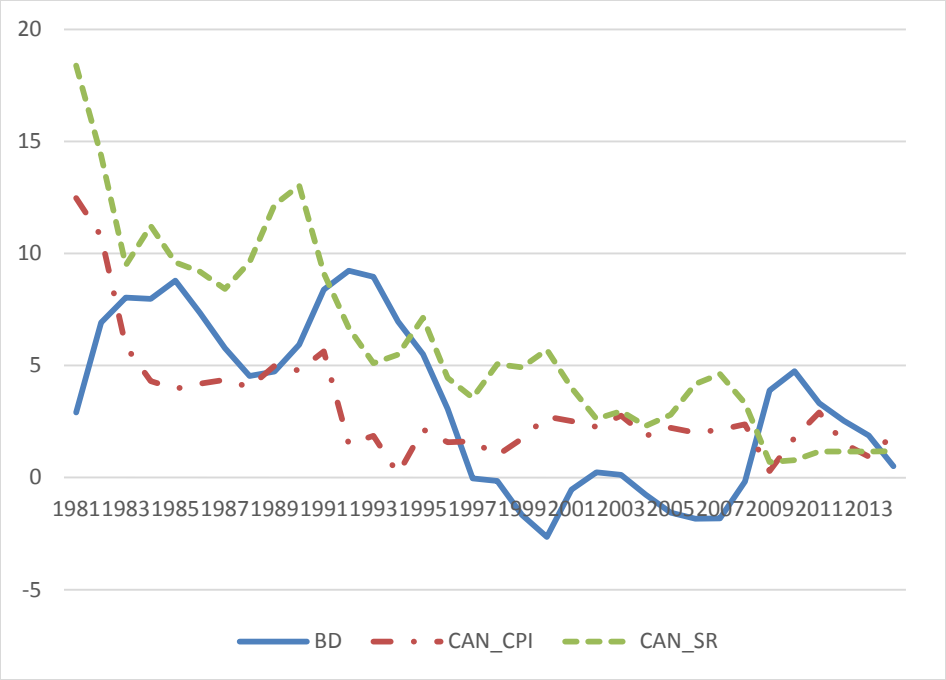
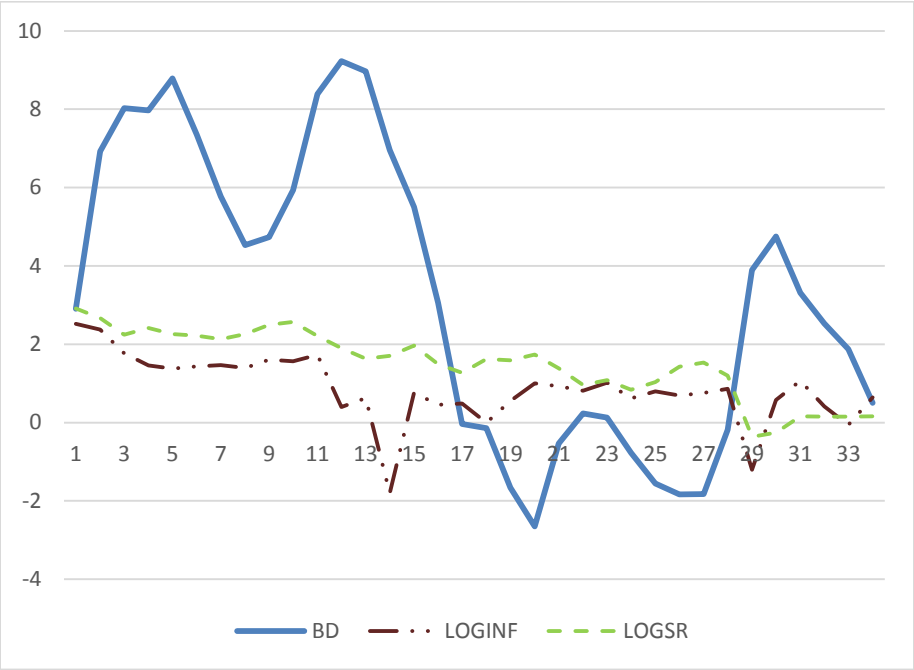


Figure 4.4 shows that the short-term interest rate and inflation rate move closer before 2008, but there are still some large differences after 2008. The short-term interest rate decreased significantly from 1981 to 2008. The short-term interest rate for 1981 is 18.38, which is almost six times that of 2008. At the same time, the inflation rate for 1981 is 12.47, which is also almost six times that of 2008. During the twenty-seven-year period, the inflation rate also changed significantly. However, the short-term interest rate kept almost at 1.16 between 2011 and 2013 while the inflation rate decreased from 2.912135 at 2011 to 0.94 at 2013. However, Figure 4.4 shows that the budget deficits from 1981 to 2014 did not move with the short-term interest rate and inflation rate. Budget deficits are relatively unstable and they fluctuated on a large scale. For instance, the budget deficit for 2008 is -0.19 while that of 1993 is 8.96. Then, the budget deficit decreased from 6.96 in 1994 to -2.65 in 2000, which is a very large change. The lowest value of the budget deficit, -2.65, occurred in 2000. The highest value of the budget deficit occurred as 9.23 in 1992.

Figure 4.5. The trends among logarithmic rate of raw data.



According to Greene, W. H. (2016), following standard practice in empirical studies, we use our indicators in their logarithmic form. The logarithmic form of variables enables us to transform non-linear functions like the Cobb-Douglas functions to linear functions. Figure 4.5 suggests that there may be existing trends in the logarithmic form of short-term interest rates and inflation rates, but there is no trend in the actual budget deficit. Meanwhile, it violated the predictions of the economic theories based on the AS-AD model and the IS-LM model.

Section 5. Results: Empirical Analysis Using MWALD Test for Causality

Augmented Dickey-Fuller (ADF) Test for all Variables

Table 5.1.1

Results of Augmented Dickey-Fuller (ADF) Test for all Variables

Series	t-statistic	Critical	t-statistic	Critical	t-statistic	Critical	No. of

	with no intercept	(5%) with no intercept	with intercept	(5%) with intercept	with trend and intercept	(5%) with trend and intercept	differential
LOGSR(Modified AIC)	-1.805346	-1.951332	0.331843	-2.967767	-3.225831	-3.552973	Level
LOGINF(Modified AIC)	-1.808071	-1.952473	-2.960630	-2.957110	-3.203561	-3.557759	Level
BD(Modified AIC)	-1.457898	-1.952910	-1.270730	-2.967767	-1.250541	-3.574244	Level

Firstly, Table 5.1.1 is the result of the Augmented Dickey-Fuller test for the short-term interest rate, inflation rate, and budget deficit to test whether variables are stationary or non-stationary at different degree of significance. The null hypothesis is that the variable has a unit root and is a non-stationary series. The alternative hypothesis is that the variable has no unit root and is a stationary series. The study chose the lag length as the Modified Akaike index. Because the short-term interest rate and inflation rate seem to have existing trends and their means are non-zero, we use the ADF test to test variables including trends and constants. The t-statistic for the short-term interest rate (LOGSR) at -3.225831 is larger than the t-statistic critical value -3.552973 at the 5% level of significance. It accepts the null hypothesis and the fact that there is a unit root for the short-term interest rate. The short-term interest rate is a non-stationary series. The t-statistic for the inflation rate (LOGINF) at -3.203561 is larger than the t-statistic critical value -3.557759 at the 5% level of significance. It accepts the null hypothesis and the fact that there is a unit root problem for the short-term interest rate. The short-term interest rate is a non-stationary series. At the same time, the budget deficit seems to have no existing trend and its mean is non-zero, so we use the ADF test to test variables including the constant on the original

level. The t-statistic for the budget deficit (BD) at -1.270730 is larger than the t-statistic critical value as -2.967767 at the 5% level of significance in the level. We cannot reject the null hypothesis and there is a unit root for the budget deficit, so it is also a non-stationary variable in level. Therefore, because the short-term interest rate, inflation rate, and budget deficit are non-stationary series in level, we could use the MWALD causality test to test causal relationships among the short-term interest rate, inflation rate, and budget deficit in VAR models in the case of Canada over the 33-year period 1981-2014 because the MWALD causality test allows researchers to test causal relationships among non-stationary variables.

Vector Auto-Regression Estimates (VAR (1))

Secondly, Tables 5.2.1-5.2.3 and Table 5.2 show that a change in the lagged (-1) variable among the short-term interest rate and budget deficit will have a statistically significant effect on the current period values of the short-term interest rate and budget deficit but not on the inflation rate. The reasons are that they can pass the t critical value at 99% degree of significance because their t-statistics are 8.90280 and 10.9854 which are larger than the critical value of 2.449 at 99% degree of significance. We could reject individual tests of significance in which the null hypothesis is that each individual coefficient equals zero. However, through the autocorrelation test in Table 5.2.4, the three-variable VAR model with lag (-1) variables has an autocorrelation problem among the lag (-1) variables. It summarizes the lists of lags in LM tests in which the null hypothesis is no serial correlation at lag order h. Except for lag 1 among the 12 lags, other lag variables' p value is larger than 0.05, so it accepts the null hypothesis in which there is no serial correlation. In lag 1, the lag variable's p value is smaller than 0.05 as 0.0042. Hence, it rejects the null hypothesis and there is a serial correlation at lag order 1, so the results in VAR models with lag (-1) variables are not valid. However, the model is stable, based on results in

Table 5.2.5 in which all points are within the circle, so we should accept the null hypothesis in which the model has stability. Again, residual homoscedasticity is accepted based on Table 5.2.6 because the p value is larger than 0.05.

Therefore, we should choose more than lag (-1) variables adding to the VAR models. Table 5.2.7 determines the appropriate maximum-lag length at up to lag (-2) or lag (-7) for the variables in the VAR models through VAR lag order selection criteria from 1981 to 2014. The Akaike information criterion (AIC) and Schwarz information criterion (SC) indexes are at a minimum level of 3.250883 and 6.418485 at lag (-7). The sequential modified LR test statistic (each test at 5% level) (LR) index is at a maximum level of 17.48631 at lag (-2). We chose variables up to lag (-2) and tested whether the results were valid or not. If not, then we used variables up to lag (-7).

Table 5.2.7

The VAR Lag Order Selection Criteria for Three-Variable VAR Models

VAR Lag Order Selection Criteria				
Endogenous variables: BD LOGINF LOGSR				
Exogenous variables: C				

Date: 11/17/16 Time: 22:18

Sample: 1981 2014

Included observations: 27

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-130.7188	NA	4.021147	9.905097	10.04908	9.947910
1	-80.13617	86.17782	0.185976	6.824902	7.400829	6.996155
2	-68.33291	17.48631*	0.155665	6.617253	7.625126	6.916946
3	-61.54214	8.551340	0.197535	6.780899	8.220718	7.209033
4	-51.62373	10.28576	0.214341	6.712869	8.584633	7.269443
5	-34.80647	13.70295	0.157953	6.133813	8.437523	6.818826
6	-20.41285	8.529553	0.173086	5.734285	8.469941	6.547739
7	22.11307	15.75034	0.036718*	3.250883*	6.418485*	4.192777*

* 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			

Vector Auto-Regression Estimates (VAR (2)):

Thirdly, Tables 5.3.1-5.3.3 show that a change in the lag variable up to lag (-2) among the short-term interest rate, inflation rate, and budget deficit will have no statistically significant effect on the current period of the short-term interest rate, inflation rate, and budget deficit except for the effects of own lag variable (-1) on the short-term interest rate and budget deficit. The reasons are that they cannot pass the t critical value at the 99% degree of significance, but the lagged (-1) budget balance and the lagged (-1) short-term interest rate could. Their t-statistics are 7.88717 and 3.77587 which are larger than the critical value of 2.45 at the 99% degree of significance, which mean we could reject individual tests of significance in which the null hypothesis is that each individual coefficient is equal to zero.

After obtaining our results, we would carry out some diagnostic tests to see whether the assumptions of the model are valid or not. Through the test validity of the VAR models in Table 5.3.4, the three-variable VAR model with lag (-2) variables has no autocorrelation problem. Table 5.3.4 summarizes the lists of lags in LM tests in which the null hypothesis is no serial correlation at lag order h. Among the 12 lags, lag variables' p value is larger than 0.05, so it accepts the null hypothesis in which there is no serial correlation. Hence, the results in VAR models with lag (-2) variables are valid. Meanwhile, the model is stable, based on results in Table 5.3.5 in which all points are within the circle, so we should accept the null hypothesis in which the model has stability. Again, residual homoscedasticity is accepted, based on Table 5.3.6 because the p value of 0.2492 is larger than 0.05. Therefore, there is no necessary to test VAR models with lag (-7) with some diagnostic tests.

MWALD Causality Test

Table 5.4

Empirical Results in MWALD Causality Test

Dependent	Independent	Ho	Degree of Freedom	P value	Result
BD	LOGINF	Ho: $b_i = 0$	2	0.4256	LOGINF$\overset{NO}{\rightarrow}$ BD
BD	LOGSR	Ho: $a_i = 0$	2	0.5585	LOGSR$\overset{NO}{\rightarrow}$ BD
LOGINF	BD	Ho: $c_i = 0$	2	0.9378	BD$\overset{NO}{\rightarrow}$ LOGINF
LOGINF	LOGSR	Ho: a_i=0	2	0.4164	LOGSR$\overset{NO}{\rightarrow}$ LOGINF
LOGSR	BD	Ho: $c_i = 0$	2	0.1008	LOGSR$\overset{NO}{\rightarrow}$ BD
LOGSR	LOGINF	Ho: $b_i = 0$	2	0.4719	LOGSR$\overset{NO}{\rightarrow}$ LOGINF

Fourthly, the MWALD test is used to investigate Granger causal relationships among non-stationary variables associated with possibility co-integration problems. As indicated earlier, this paper investigates causal relationships among the short-term interest rate, inflation rate, and budget deficit in Canada. To investigate these MWALD causal relationships, three VAR models

with two lags are used. The number of lags (-2) is obtained by summing the rank of the VAR model and the maximum integration degree in Table 5.2.7. As depicted in Table 5.4, there is no directional causality relationships among the short-term interest rate, inflation rate, and budget deficit in the Canadian economy over the period 1981 to 2014.

Finally, the results in MWALD tests reveal the conclusions of two null hypotheses about causal relationships among inflation rate, short-term interest rate and budget deficit in Canada after 1980s. Firstly, a strong null hypothesis is that a budget deficit raises the inflation rate and interest rate based on the AS-AD model and the IS-LM model. However, the probability of the impact of a budget deficit on the short-term interest rate of 0.1008 is greater than the significant level of 0.05, so the null hypothesis can be accepted, implying that there is no causality from the budget deficit to the short-term interest rate. Meanwhile, the probability in the impact of a budget deficit on the inflation rate of 0.9378 is also larger than the significant level of 0.05, so the null hypothesis can be accepted, implying that there is no directional causality from the budget deficit to the inflation rate. A budget deficit in Canada could not raise the short-term interest rate and inflation rate.

Secondly, another strong null hypothesis is that the interest rate increases the budget deficit based on an accounting consequence of a recession economy. However, the possibility of the impact of inflation and interest rate on budget balance of 0.4256 and 0.5585 is larger than the significant level of 0.05. We should accept the null hypothesis in which there is no directional causality from one variable to another variable. The short-term interest rate does not cause the budget balance and neither does inflation. There is no causality from the short-term interest rate and inflation rate to the budget deficit. The short-term interest rate and inflation rate cannot decrease the budget deficit in Canada.

Finally, the Canadian results, taken by themselves, imply that a budget deficit is a symptom of other economic variables rather than a cause or a consequence of the short-term interest rate and inflation rate. So, if the goal of policymakers is to reduce the inflation rate and increase output, we should look to more direct problems rather than blaming the budget deficit.

Section 6. Conclusion

The aim of this study was to investigate the causal relationships among the short-term interest rate, inflation rate, and budget deficit in the Canadian economy between 1981 and 2014. Due to its non-stationary variables with possible co-integration problems, the three-variable VAR approach was used. The MWALD test presented by David Giles was used to test causal relationships among non-stationary variables in the case where there may be possible co-integration problems.

According to the results, the budget deficit does not influence the short-term interest rate and inflation rate. We conclude that the macroeconomic harmfulness of budget deficits has not been shown with regards to the inflation rate and short-term interest rate after the 1980s, which would suggest that much of the traditional literature may provide a misleading interpretation of the role of budget deficits in a modern monetary economy. Thus, current efforts to reduce the budget deficit in order to reduce the inflation rate and increase output seems unreasonable. Policymakers should look to more direct problems about economic growth of output in Canada. At the same time, the reverse causal mechanism would advise that neither inflation nor interest rates, but some other variables, may lead to changes in the budget deficit in Canada. If Canada continues to set target goals such as reducing inflation and increasing output, we have to advise policymakers to look to more direct problems as to why the growth of the economy is slowing down in Canada, rather than blaming the budget deficit. In other words, the interconnectedness

of several economic factors requires that there is a specific and innovative policy that challenges traditional monetarist theories (i.e., the Canadian government should look to Iceland where a specific, innovative and non-traditional policy was implemented to stimulate growth and promote sustainability in the markets after a devastating crash).

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Appendix:

Table 4.1

Raw Data

obs	BD	LOGINF	LOGSR
1981	2.902040	2.523455	2.911025
1982	6.923441	2.376669	2.665505
1983	8.029002	1.768762	2.247689
1984	7.970138	1.459726	2.417883
1985	8.791648	1.376757	2.261351
1986	7.352083	1.433842	2.217889
1987	5.769977	1.471579	2.129372
1988	4.528981	1.393328	2.262804
1989	4.736288	1.606157	2.499528
1990	5.932782	1.564540	2.566586
1991	8.389524	1.727375	2.209396
1992	9.230202	0.398865	1.898681
1993	8.963911	0.623303	1.629820
1994	6.957633	-1.798403	1.702511
1995	5.507176	0.764891	1.964423
1996	3.062578	0.451414	1.492694
1997	-0.038832	0.483176	1.269099

1998	-0.143178	-0.004065	1.623026
1999	-1.661297	0.550917	1.592314
2000	-2.648542	1.000426	1.740200
2001	-0.531344	0.926289	1.387198
2002	0.234730	0.814654	0.964581
2003	0.127408	1.014710	1.086682
2004	-0.770295	0.619102	0.838062
2005	-1.558120	0.794598	1.032035
2006	-1.832990	0.694159	1.429626
2007	-1.824431	0.760050	1.531501
2008	-0.184945	0.863004	1.198270
2009	3.891180	-1.205751	-0.365540
2010	4.748726	0.574855	-0.253783
2011	3.316476	1.068886	0.156424
2012	2.530601	0.415863	0.148301
2013	1.878085	-0.063694	0.152227
2014	0.501560	0.645340	0.159546

Table 4.2

The Descriptive Statistics of Raw Data

Date: 11/17/16 Time: 17:24			
Sample: 1981 2014			
	BD	LOGINF	LOGSR
Mean	3.267123	0.855729	1.493145
Median	3.189527	0.804626	1.607670
Maximum	9.230202	2.523455	2.911025
Minimum	-2.648542	-1.798403	-0.365540
Std. Dev.	3.761940	0.842924	0.871353
Skewness	0.063194	-0.921374	-0.554830
Kurtosis	1.641618	5.230349	2.452209
Jarque-Bera	2.636664	11.85775	2.169514
Probability	0.267581	0.002661	0.337984
Sum	111.0822	29.09478	50.76693
Sum Sq. Dev.	467.0223	23.44717	25.05543
Observations	34	34	34

Table 4.3

The Correlation of Raw Data

	BD	LOGINF	LOGSR
BD	1.000000	0.193872	0.414943
LOGINF	0.193872	1.000000	0.602444
LOGSR	0.414943	0.602444	1.000000

Table 5.2.1

Dependent Variable is Short-Term Interest Rate as LOGSR

Independent Variables	Coefficient	t-Statistic
LOGSR(-1)	0.918982	8.90280
LOGINF(-1)	-0.067838	-0.70599
BD(-1)	0.014660	0.78546
C	0.050226	0.37642
R-squared:0.831103	Sample: 1982-2014	Observations: 33

Table 5.2.2

Dependent Variable is Inflation Rate as LOGINF

Independent Variables	Coefficient	t-Statistic
LOGSR(-1)	0.294465	1.42882
LOGINF(-1)	0.240082	1.25144
BD(-1)	-0.009517	-0.25539
C	0.178527	0.67016
R-squared:0.248163	Sample: 1982-2014	Observations: 33

Table 5.2.3

Dependent Variable is Budget Deficit as BD

Independent Variables	Coefficient	t-Statistic
LOGSR(-1)	0.404761	0.94815
LOGINF(-1)	0.639958	1.61042
BD(-1)	0.847932	10.9854
C	-0.735607	-1.33307
R-squared:0.857793	Sample: 1982-2014	Observations: 33

Table 5.2.4

The Autocorrelation Test for Three-Variables VAR Models with Lag (-1) Variables

VAR Residual Serial Correlation
LM Tests
Null Hypothesis: no serial
correlation at lag order h
Date: 11/17/16 Time: 22:06
Sample: 1981 2014
Included observations: 33

Lags	LM-Stat	Prob
1	24.67632	0.0034
2	7.989315	0.5352
3	13.45143	0.1432
4	5.996890	0.7402
5	10.67306	0.2988
6	6.659765	0.6725
7	1.490641	0.9972
8	4.614798	0.8665
9	5.033629	0.8314
10	4.323398	0.8889
11	3.795748	0.9243
12	5.207969	0.8158

Probs from chi-square with 9 df.

Table 5.2.5

The Stability Test for Three-Variable VAR Models With up to Lag (-1) Variables

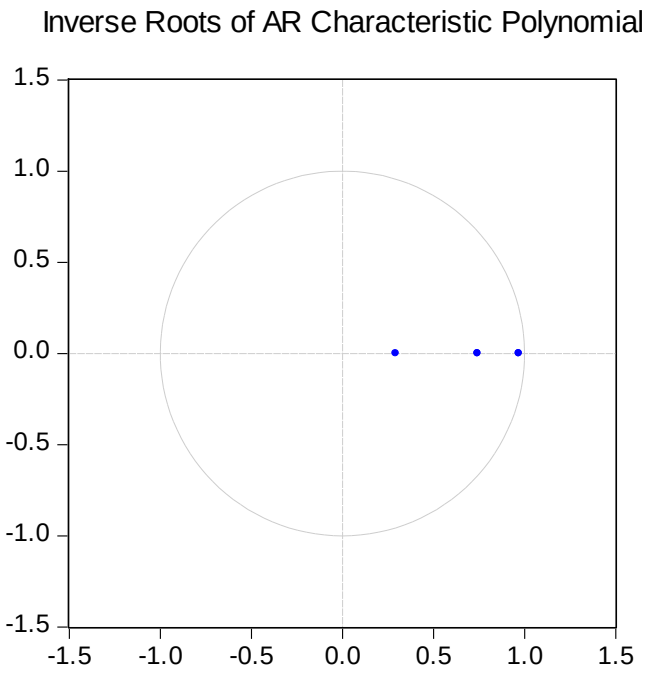

Table 5.2.6

The Heteroscedasticity Tests Without Cross Terms for Three-Variable VAR Models With up to Lag (-1) Variables

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)					
Date: 11/17/16 Time: 22:13					
Sample: 1981 2014					
Included observations: 33					
Joint test:					
Chi-sq	df	Prob.			
45.23447	36	0.1391			
Individual components:					
Dependent	R-squared	F(6,26)	Prob.	Chi-sq(6)	Prob.
res1*res1	0.120867	0.595764	0.7309	3.988600	0.6782
res2*res2	0.130860	0.652437	0.6879	4.318375	0.6337
res3*res3	0.093508	0.447001	0.8404	3.085771	0.7980

res2*res1	0.189345	1.012139	0.4390	6.248386	0.3959
res3*res1	0.069105	0.321683	0.9196	2.280453	0.8922
res3*res2	0.066336	0.307877	0.9271	2.189073	0.9015

Table 5.3.1

Dependent Variable is Short-Term Interest Rate as LOGSR

Independent Variables	Coefficient	t-Statistic
LOGSR(-1)	0.898147	3.77587
LOGSR(-2)	-0.074645	-0.31721
LOGINF(-1)	-0.048916	-0.45749
LOGINF(-2)	0.110694	1.10381
BD(-1)	-0.071644	-1.40733
BD(-2)	0.096442	1.96875
C	0.045666	0.32437
R-squared:0.853996	Sample: 1983-2014	Observations: 32

Table 5.3.2

Dependent Variable is Inflation Rate as LOGINF

Independent Variables	Coefficient	t-Statistic
LOGSR(-1)	0.630513	1.26809
LOGSR(-2)	-0.470320	-0.95616
LOGINF(-1)	0.061814	0.27657
LOGINF(-2)	0.250482	1.19490
BD(-1)	0.044073	0.41416

BD(-2)	-0.048467	-0.47332
C	0.300930	1.02259
R-squared:0.240842	Sample: 1983-2014	Observations: 32

Table 5.3.3

Dependent Variable is Budget Deficit as BD

Independent Variables	Coefficient	t-Statistic
LOGSR(-1)	0.787517	1.00619
LOGSR(-2)	-0.372018	-0.48047
LOGINF(-1)	0.031056	0.08827
LOGINF(-2)	0.432483	1.31065
BD(-1)	1.321165	7.88717
BD(-2)	-0.521912	-3.23796
C	-0.506231	-1.09282
R-squared:0.857793	Sample: 1982-2014	Observations: 33

Table 5.3.4

The Autocorrelation Test for Three-Variable VAR Models with Lag (-2) Variables

VAR Residual Serial Correlation LM Tests			
Null Hypothesis: no serial correlation at lag order h			
Date: 11/18/16 Time: 08:52			
Sample: 1981 2014			
Included observations: 32			
Lags	LM-Stat	Prob	

1	7.258592	0.6102	
2	6.285892	0.7110	
3	15.72508	0.0728	
4	7.076865	0.6291	
5	11.25932	0.2584	
6	10.34203	0.3235	
7	2.516541	0.9804	
8	2.667457	0.9760	
9	10.89389	0.2831	
10	13.75426	0.1313	
11	4.145185	0.9016	
12	9.622032	0.3819	
Probs from chi-square with 9 df.			

Table 5.3.5

The Stability Test for Three-Variable VAR Models With up to Lag (-2) Variables

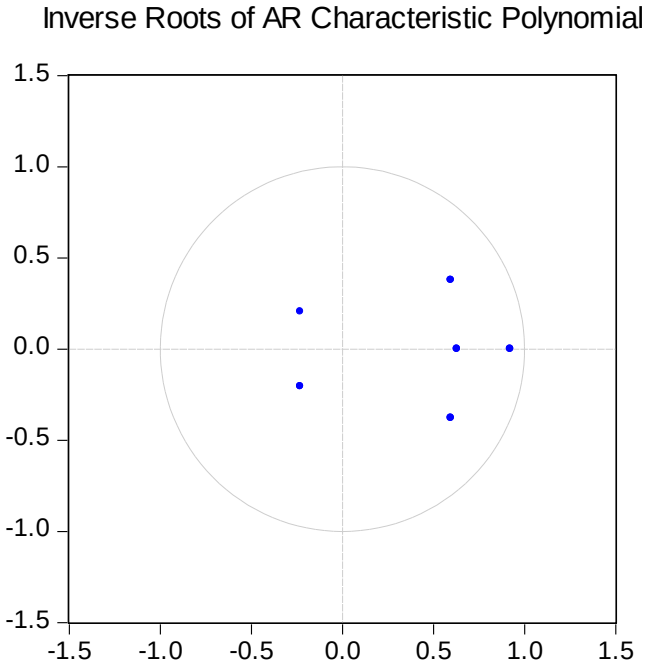

Table 5.3.6

The Heteroscedasticity Tests Without Cross Terms for Three-Variable VAR Models with up to Lag (-2) Variables

VAR Residual Heteroscedasticity Tests: No Cross Terms (only levels and squares)

Date: 11/18/16 Time: 08:54

Sample: 1981 2014

Included observations: 32

Joint test:

Chi-sq	df	Prob.
79.72242	72	0.2492

Individual components:

Dependent	R-squared	F(12,19)	Prob.	Chi-sq(12)	Prob.
res1*res1	0.330857	0.782878	0.6618	10.58743	0.5646
res2*res2	0.459435	1.345701	0.2726	14.70192	0.2581
res3*res3	0.240113	0.500309	0.8893	7.683609	0.8093
res2*res1	0.252381	0.534500	0.8658	8.076180	0.7791
res3*res1	0.265224	0.571517	0.8385	8.487153	0.7460
res3*res2	0.252393	0.534535	0.8658	8.076574	0.7791