Kristina Meshchirikova

The Roles of Monetary Policy and Central Banking in Macroeconomics Stabilization: The Canadian Experience

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Author:	Kristina Meshchirikova
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Abstract :

This thesis examines the impact of Bank of Canada (BoC) monetary policy on the most critical macroeconomic variables, i.e., inflation, GDP growth, unemployment, and exchange rates over the period 2000-2024. The thesis compares the performance of the inflation-targeting regime in Canada in maintaining inflation between 1% and 3%, with the midpoint target of 2%. By the Hedge regression approach, inflation drivers are identified to be exchange rate volatility (ERV) and interest rates (ITR) because model [ITR, ERV] can explain 45.6% inflation variation. Money supply growth (MSG) is, however, less explanatory due to multicollinearity with ERV. Evidence supports the success of the BoC in anchoring inflation, but shows respect for room for restraint, when addressing structural economic problems such as housing market imbalances and issues of financial stability. The paper also contrasts off-the-run monetary policies (i.e., quantitative easing and forward guidance) during times of crisis (e.g., the 2008 financial crisis and the COVID-19 pandemic), comparing their efficacy in the short term, as well as possible negative impacts over the long run, including asset bubbles and household debt buildup. The primary recommendations are transparency in forward guidance, macroprudential regulation with priority, and synchronization of fiscal policy to target structural economic problems. Experiments with non-conventional monetary arrangements, such as the nominal GDP targeting approach, and an association between climate-related financial risks and stability matters have been recommended by the thesis. Advanced econometric methods, regional data, and comparison across studies of different inflation-targeting arrangements are the future research requirements for policy design enhancement under the new economic order.

KEYWORDS: Monetary policy, Inflation targeting, Macroeconomics, Bank of Canada, Exchange rates, Intrest rates, Quantitative easing.

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1 Introduction

The Canadian central bank – Bank of Canada (BoC) assumes the responsibility of enacting monetary policy in Canada. The aim of monetary policy is to keep money worth stable and predictable by controlling inflation (Bank of Canada - Monetary Policy, 2019). To do this, the BoC sets a target for the overnight rate, which is the rate at which financial institutions borrow amongst themselves for one day (Bank of Canada - How Monetary Policy Works, 2019). Differences in the overnight rate are reflected in other interest rates in the economy – for consumer loans, and for mortgages and business lending (Bank of Canada, 2021). The BoC can determine the value of credit based on the cost and availability by manipulating the overnight rate, which in turn, stimulate or deter household and business spending and saving decisions. Ultimately, they affect the overall amount of economic activity and demand for goods and services, and thus the price level.

The BoC communicates its policy rate eight times a year on fixed dates, accompanied by release of a quarterly Monetary Policy Report summarizing its assessment of and risks to the economic outlook and inflation (Bank of Canada - Monetary Policy Report, 2020). In addition, the BoC communicates with the public and the financial markets through speeches, press releases, research papers, and other publications. The BoC operates within an inflation target framework, that is, keeping the rate of inflation between 1 and 3 per cent, with a focus on 2 per cent midpoint (Bank of Canada - Inflation Targeting, 2021). It's a structure created between the BoC and the federal government, reviewed every five years." The inflation targeting regime provides greater transparency and accountability for monetary policy and acts to anchor inflation expectations in the economy.

The Bank of Canada executes monetary policy through specific actions which directly affect both the Canadian economy and financial markets as well as determine the value of the Canadian dollar in international currency trading. The BoC fulfills its economic and financial well-being mandate for Canadians through regular monitoring of diverse economic statistics and financial market situations which guides its monetary policy direction (Bank of Canada - Policy Interest Rate, 2020).

1.1 Research motivation: the quest for financial stability

The economy is significantly influenced by the monetary policy of the Bank of Canada, as is any of the aspects such as the worth of money, borrowing costs, exchange rates, and inflation rates, but this is only the beginning for motivation in researching this issue. Some motivations people may have to be interested in this topic in thesis writing include curiosity about how the Bank of Canada meets its inflation-control objectives as well as the way in which it contributes to the economic and financial well-being of Canada. Another source of motivation evaluates how effective or inefficient the Bank of Canada is as it regards the use of non-traditional tools of monetary policy, like quantitative easing and forward guidance, to achieve its objectives, particularly during the crisis period that has been created by the COVID-19 pandemic. Besides, motivation for study comes from probing into the transmission channels and spillover effects of Bank of Canada's monetary policy, that is, how they manifest themselves across sectors as well as for the entire global economy. There is also potential for a rich line of inquiry through examining the possible benefits and risks for the Canadian economy inherent in alternative monetary policy frameworks-such as nominal GDP targeting, price-level targeting, or a dual mandate.

The BoC, in short, conducts monetary policy in Canada to preserve the value of money by keeping low, stable, and predictable inflation. In addition, however, the BoC's mandate involves developing economic and financial well-being for Canadians, which includes the aspect of stability in the financial system. Stability in the financial system means the ability of that system to withstand shocks and to promote an efficient way of allocating resources and the smooth processing of payments (Bank of Canada, 2021).

The primary channels of influence include monetary policy, the lender of last resort, oversight of significant payment systems, and participation in domestic and international policy coordination. Monetary policy actions by the BoC influence the price and accessibility of credit, exchange rates of the Canadian dollar, and the expectations of households, businesses, and financial markets, which thereby influence the total economic activity and inflation levels and the balance sheets, cash flows, and risk-taking attitudes of financial institutions and borrowers. The lender of last resort function entails provisions for liquidity support to the financial system in times of distress so that systemic crises can be avoided, and market confidence maintained. The BoC ensures that

key payment systems operate safety and efficiently and that they comply with the relevant standards and regulations. The domestic and international cooperation in policy coordination of the BoC concerns collaboration with other authorities dealing with potential risks and vulnerabilities in the financial system, featuring actions in macroprudential and microprudential policy.

Events and developments, some of which are dot-com bubble, 9/11 terrorist attacks, global financial crisis, European debt crisis, oil price shock, climate change as well as COVID-19 pandemic, are similar not only to Canada but also to the entire world. The BoC has responded to many of these shocks and transformations through changes to monetary policy stance, emergency liquidity facilities, increased communication and transparency, unconventional policy tools, and strengthened frameworks for financial stability. The acts amounted to a necessary swift-adaptive response that minimized the effects of the said shocks and changes upon the Canadian economy and financial system, integrated the impact of economic recovery, and converted into a higher sustainable and inclusive growth.

The following are some highlights from the financial stability actions of the BoC between 2000 and 2024. In 2000, the BoC cut its policy rate from 275 to 175 basis points-Between post-2000 with what was to be the lowest slowdown in the US economy, and the bursting of the dot-com bubble, which had such an effect on the Canadian technology sector and on stock market values (Bank of Canada, 2000). The Central Bank brought into existence a Large Value Transfer System (LVTS) to improve the efficiency of safety payments and reduce settlement risk when making big payments through a real-time gross settlement system (Bank of Canada, 2000).

In 2001, after cutting the rates again, the BoC had a total reduction of 250 basis points aside from the 100 basis points due to the 9/11 incident that led to the global recession and sharp confidence and trade declines (Bank of Canada, 2001). Besides that, the BoC also joined G7 central banks in the coordinated interest rate cuts to stabilize the markets at that time as well as to stimulate the global economy (Bank of Canada, 2001).

In 2006, the BoC and federal government renewed the inflation targeting framework for yet another five-year period with the inflation target at midpoint, defining it at 2% or the 1%–3% control range under the Bank of Canada (2006). The BoC would then enhance the communication and transparency effort as it publishes a quarterly Monetary Policy Report, explaining its

assessment of the current and outlook for the economy, and the risks associated with inflation (Bank of Canada, 2006).

During the years of 2007-2009, the BoC dealt with the global financial crisis, which was bred in the subprime market in the US but spread into the global banking system and the real economy, as understood by Bank of Canada (2009). In response, the BoC lowered its policy rate to an effective lower bound of 0.25%, came up with emergency liquefaction facilities to the financial system through: Term Loan Facility, Term Purchase and Resale Agreement Facility, and Term Asset-Backed Securities Loan Facility, and announced a conditional commitment to keep the policy rate at the lower bound until the second quarter of 2010 subject to inflation outlook (Bank of Canada, 2009). Finally, it also worked collaboratively with other central banks in providing liquidity of US dollars to global markets and with other domestic authorities to implement the Canadian Lenders Assurance Facility, Insured Mortgage Purchase Program, and Canadian Secured Credit Facility aimed at supporting the funding and lending activities of the Canadian financial institutions (Bank of Canada, 2009).

In 2011-2012, the BoC had to cope with the European debt crisis, which threatened not only stability but also integrity of both the euro area and the whole global financial system (Bank of Canada, 2012). BoC has held on to the policy rate of 1% and participated to coordinate actions by G7 central banks to improve US dollar liquidity into the global financial markets (Bank of Canada, 2012). Similarly, the BoC has been supporting efforts by European authorities to resolve the crisis and to strengthen the fiscal and financial governance of the euro area (Bank of Canada, 2012).

2014-2016, oil price shock faced by BoC, being a period of high oversupply of oil in the global market, coupled with a downward trend in oil demand (Bank of Canada, 2016). Policy rates were cut by 50 basis points, citing this as part of reducing the impact of the oil price shock on the Canadian economy, particularly within the oil-producing regions (Bank of Canada, 2016). The Bank closely monitored the spillover effects of the oil price shock on the housing market, household debt, and the financial system and coordinated with other authorities to implement macroprudential measures, such as tightening the mortgage underwriting standards and increasing the capital requirements for banks (Bank of Canada, 2016).

During the period of 2016 to 2021, the inflation-targeting framework would continue to renew as in practice by the Bank of Canada and federal government for the next five years, and inflation targets for policy would remain at the 2% midpoint of the 1-3% control range (Bank of Canada, 2016). According to Bank of Canada (2021), the Bank adopted some unconventional policy tools

such as forward guidance, quantitative easing, and yield curve control to provide extra push forward in the context of the effective lower bound with COVID-19 and hold inflation expectations steady during this period. According to Bank of Canada (2021), enhancement to the financial stability framework was brought about in establishing the Governing Council Financial System Review Committee overseeing financial stability analysis by the Bank and policy advice and publishing a semi-annual Financial System Review to identify and assess key vulnerabilities and risks to the financial system.

In 2020 and 2021, the BoC was clutching the effects of the COVID-19 pandemic, faced not only with a global health crisis of grave proportions but also an economic kratogen that is unprecedented internationally (Bank of Canada, 2021). In terms of measures enacted by the BoC, the suite has included lowering of its policy interest rate to the effective lower bound at 0.25%, launching a large-scale asset purchase program to support the liquidity and the functioning of the key financial markets, providing term funding facilities to the financial system, such as the Standing Term Liquidity Facility and the Bankers' Acceptance Purchase Facility, and among improvements participating in the coordinated action by the G7 central banks towards improvements in the provision of US dollar liquidity to the global markets (Bank of Canada, 2021). The BoC also collaborated with some other domestic authorities to implement the Canada Emergency Business Account, the Canada Emergency Wage Subsidy, and the Canada Emergency Response Benefit, which aimed at supporting the income and credit of both households and businesses affected by the pandemic event (Bank of Canada, 2021).

The BoC faced recovery and adjustment concerns between 2021 and 2024 as the global economy gradually picked itself from pandemic shocks and adapted to structural changes like digitization, globalization, and climate change (Bank of Canada, 2024). Monetary policy would thus be a continuous instrument, adjusting the BoC to the economy as economic and inflation outlook evolved, while providing clear and transparent communication to the public and financial markets regarding intentions and actions (Bank of Canada, 2024). The BoC continued to monitor and address the emerging risks and vulnerabilities in the economy. Among these included high household debt, increased housing prices, cyber threats, and climate-related risks. It also coordinated with other authorities in putting relevant policy measures in place designed to enhance resilience and efficiency in the financial system (Bank of Canada, 2024).

1.1.1 The aims and objectives of the thesis

This thesis aims to discuss and investigate the historical relationship between the monetary policy of the Bank of Canada and performance of the Canadian economy through an interrogation of major variables such as GDP, inflation, unemployment, and exchange rate variables. The strong emphasis here is that the study will analyze the data to find out the impact and effectiveness of the monetary policy framework of the Bank of Canada.

Furthermore, the evaluation on one or more theoretical models- on the COVID19 period and after- will consider the challenges that faced the Bank of Canada in its monetary policy framework. These assessments of the effectiveness of this policy framework under such unprecedented circumstances will allow us to appreciate the strengths and weaknesses of the chosen policy.

The other major objective of this thesis is to compare the monetary policy stances and output of Canada to other countries, namely the United States of America, the European Union, and Japan, Smooth comparisons should highlight the similarities and differences in objectives, instruments, transmission mechanisms, and impacts of monetary policy. The knowledge that this aim gives would further elaborate on the international monetary policy landscape and its implications with respect to the Canadian economy.

Lastly, the thesis will discuss some possible scenarios and alternatives of the monetary policy of the Bank of Canada for the future of the Canadian economy. Some suggestions would be made through the analysis for what modification of or alternatives to the current monetary policy framework may address emerging challenges and contribute to the Canadian economy's sustainable growth.

1.1.2 The research contributions: What the thesis addressed

How the Bank of Canada uses its inflation-control target and the flexible exchange rate to support the value of money is an interesting aspect of the thesis, apart from applying the target to perceive economic recovery from the COVID-19 pandemic. An important research avenue involves analyzing the ways changes in Canadian interest rates affect the exchange rate of the Canadian dollar and the price of goods imported and exported, thus affecting inflation and

economic activity. A critique of the monetary policy framework of the Bank of Canada, which undergoes a review every five years, and a comparison with some frameworks in other countries warrant consideration. The thesis should therefore emphasize the academic readerships in economics and monetary policy, using appropriate terminology, concepts, and evidence to make credible the arguments and conclusions presented. More so, such publications, reports, and data from, but not limited to, the Bank of Canada should also be accurately acknowledged and cited.

The main contribution of the thesis is that it examined the Canadian central bank and its monetary policy towards the economy and covered the following major areas of discussion:
To begin with, the thesis undertakes an assessment of the Canadian central bank's monetary policy framework. This study is on the key objectives, tools, and strategies of this central bank vis-a-vis an evaluation of their effectiveness and implications of the selected policy approach. It also considers the monetary rule implemented by the central bank and its implication on inflation in the Canadian economy. This would entail a study on linkages between interest rates, money supply, and inflation, and a rule for determining whether the action of the central bank would lead to realizing their inflation targets.

In addition, the thesis analyzes how the central bank is expected to influence the goal of financial stability using the monetary policy instruments. This would include analyzing the effect of interest rate variations on banking stability, along with indicating the possible vulnerabilities. Moreover, the analysis would comprise the impact of the monetary policy of the central bank on the form of economic growth over time and employment in Canada. That would analyze how consumption, investment, and government spending behavior affect monetary policy's macroeconomic variable transmission channels.

The last point highlighted in the thesis is that the monetary policy perspectives of the Canadian central bank are compared with that of others such as Federal Reserve or the European Central Bank. The analysis leads to the revelation of advantages and disadvantages in the different policy frameworks and implications for the Canadian economy. Thus, the thesis presents a holistic picture of the Canadian central bank monetary policy in the economy and its effect on various aspects of that economy-an essential evaluative basis for researchers or stakeholders interested in an assessment of the effectiveness of monetary policies and the whole performance of the Canadian economy overall.

1.1.3 The research question

The central inquiry that guides this thesis revolves around the following question: "To what extent does the monetary policy implemented by the Canadian central bank impact key macroeconomic indicators such as inflation, unemployment, and GDP growth, and what implications does this influence hold for the broader spheres of economic stability and growth within Canada?"

1.1.4 The scope of the thesis

The focus of this thesis is on the Bank of Canada, with special reference to its influence with respect to monetary policy, inflation control, and financial stability. First, I will discuss why the Bank of Canada implemented the inflation targeting framework and how it has evolved over the years. (Bank of Canada, 2020) The transmission mechanism of monetary policy will then be considered, examining how changes in the overnight rate are translated into other interest rates, credit availability, exchange rates, aggregate demand, and inflation expectations. (Bank of Canada, 2019). We then look at the challenges and trade-offs for the Bank of Canada as it sets monetary policy in a challenging and uncertain landscape. This will include themes such as the zero-lower bound, the global financial crisis, the COVID-19 pandemic, and climate change. (Bank of Canada, 2021)

Addidionally, a special focus will be the tasks and interaction and coordination of monetary policy with other policy instruments like fiscal policy, the macroprudential policy or the microprudential regulation. This article attempts to explain how these instruments can be beneficial in maintaining the financial stability and stimulating economic growth. whose markets become more active under financial repression. (International Monetary Fund, 2016). The manuscript will also discuss empirical evidence and theoretical models on the macroeconomic effects of IT in comparison to alternative regimes such as NGDP and price level targets or dual mandate approaches. (International Monetary Fund, 2016). Text analysis will also be used to examine existing studies on the link between the Canadian central bank's monetary policy and market interest rates. (Bank of Canada, 2021)

Finally, the development relevance of inflation and monetary policy for Canada will be analyzed, and the role of the Bank of Canada in global efforts to meet sustainable development goals. (Bank of Canada, 2021). Therefore, this thesis will provide an exhaustive study of all the constituents of the Canadian central bank's contributions to monetary policy or inflation expectations or financial stability, such as proper reasoning for the inflation targeting framework, the transmission mechanism of monetary policy, challenges of the bank, coordination with other policy instruments, empirical evidence, literature review, and effect-terrains.

1.1.5 The limitations of the thesis

The thesis on Canada's central bank and its economic influence has manycomplex issues, covering a range of problems typical in monetary policy study. Initially, the paper addresses the challenge of accurately assessing the impact of monetary policy on various macroeconomic factors, including inflation, unemployment, currency values, and financial equilibrium. Furthermore, the argument faces the unpredictability and fluctuation of the methods and delays in monetary policy, depending on the economic condition, the anticipations of economic participants, the organization of financial markets. These factors add to the difficulty and uncertainty of evaluating the numericaloutcomes of financial policy actions. The difficulties linked to managing money policy when rates are low also act as aconstraint in the study. The possible decrease in the power of standard policymethods and the greater dependence on non-standard policy methods, like quantitative easing and forward guidance, bring possible expenses and dangers, creating more complexity and unpredictability in evaluating monet Additionally, the paper discusses the compromises and organizational challengesin creating and executing the monetary policy structure. Handling various goals, like controlling prices and job rates, and dealing with connections with otherstrategies, like government spending and financial stability measures, increasesthe complexity of assessing and grasping the effects of central bank actions. These constraints highlight the difficulties in assessing the impact andconsequences of monetary policy strategies, stressing the complexities andunpredictabilities in the domain of monetary policy.

2 The Literature and Empirical Review

2.1 Terminology

The research attempts to analyze the relationship, from the Canadian point of view, between monetary policy and some of the major macroeconomic variables, such as inflation, unemployment, or GDP growth. It will explain how, and through which channels the monetary policy decisions affect the economic indicators, which in turn determine aggregate economic stability in the case of Canada. The purpose of this study will have, therefore, to explore the intricate relationship between monetary policy and the main macroeconomic variables in Canada to see how monetary policy works towards economic stability, growth, and full employment. Through studying the various channels of monetary policy transmission and their effects on inflation, unemployment, and GDP growth, this paper contributes to the vast literature on economic policy in an integrated and rapidly transforming economic scenario. Preliminary section defining the terms relevant to the respective topic.

2.1.1 Transmission Channels of Monetary Policy

Like other central banks, the BoC conducts monetary policy to promote the well-being of the Canadian people—by keeping inflation low, stable, and predictable, and by contributing to solid economic performance. Policy actions on monetary policies, such as interest-rate decision, are conveyed by various means or channels to various sectors of the economy (Bank of Canada, 2023).

2.1.2 Interest Rate Channel

When policy interest rates fall, the cost of borrowing for households, businesses and governments decreases. This helps increase the willingness of the economy to take on new borrowing and spending and ends up driving economic activity higher. Higher interest rates, on the other hand, are costlier for all agents in the economy and can depress growth in the long run as well (Mishkin, 2016).

2.1.3 The exchange rate channel

The exchange-rate channel posits that changes in monetary policy can alter the relative cost of foreign goods. Following a policy that promotes a very high value of a nation's currency, however, would make export goods relatively more expensive, and therefore less desirable, and this would dampen demand for them (Taylor, 2000).

2.1.4 Asset Price Channel

Asset prices, equity and house prices can be impacted by monetary policy decisions. Expansive monetary policy will generally drive asset prices up; therefore, a low interest rate can stimulate investment and consumption through the wealth effect (Bernanke and Gertler, 1995).

2.1.5 Lending Channel

Monetary policy changes are transmitted through the banks' and other depository institutions' willingness to keep lending. In case of the easing of the monetary policy, the interest rates can be down, along with the encouragement for lending and economic activities; on the other hand, the tight monetary policy can stifle economic activities by choking the availability of credit. Kashyap and Stein in the year 2000 mentioned this argument (Kashyap and Stein, 2000).

2.1.6 Economic Stability and Monetary Policy

Central Banks in most other world regions including low economic inflation, sustainable growth, and full employment as their major objective. One of the important objectives with which different Banks seeks to attain economic stability through monetary policy as means of ensuring that aggregate demand in the economy is at their correct level (Wall Street Mojo, 2024).

2.1.7 Control of Inflation

The Bank of Canada's mandate is low and stable inflation measured by the CPI. The price level is influenced by monetary policy; through interest rates and availability of credit, a tight monetary

policy will ease pressures on inflation while an easy monetary policy will encourage economic activity and almost assuredly apply inflationary pressures as well (Taylor, 1993).

2.1.8 Unemployment and Dynamics of the Labour Market

The level of employment and the overall condition of the labour market can also be indirectly affected by monetary policy. Maintaining low interest rates can encourage business firms to increase their investments, and, consequently, to hire more personnel. Thus, the unemployment rate can be lowered because of a more aggressive monetary policy. On the other hand, if a tight monetary policy is maintained over a period, and the interest rates are raised, the rate of investment can be adversely affected, and the unemployment rate can rise. To a certain extent, therefore, the monetary authorities can influence the employment level through the interest rate mechanism (Blanchard and Katz, 1999).

2.1.9 Economic Growth and Productivity

Monetary policy plays a regulatory role in the sustainable development of the economy and has a remarkable effect in promoting the actual growth of the gross national product. Reasonable monetary regulation and control can enhance productivity, stimulate consumption and investment at the same time, and promote economic development. The proper use of this policy tool should consider the mutual constraints of economic vitality and inflation level (Bank of Canada, 2023).

2.1.10 Investment and Consumption

Companies may be encouraged by low interest rates to invest in new capital, boosting productivity and, ultimately, growth. The author placed the illustration of how consumers can employ a low rate of interest to spend more and hence boost aggregate demand and growth (Romer, 2011).

2.2 The History of Central Bank of Canada

History of the primary banks of Canada is traced as far back as 1935, the year the Bank of Canada was established, a venture that followed the financial crisis brought about by the Great Depression (Bank of Canada, 1938). It is a bank founded as private sector but nationalized majority. 1936 saw the majority taken over nationally, and in 1938, the bank was fully nationalized. 1934 saw Towers, who was ex-president of the Royal Bank of Canada, receive a commission. He was to be the first Governor of the Bank of Canada. The latter organization began to understand its significant role as the sole clearinghouse for all the chartered banks that operated in the nation (Towers, 1934).

The early twentieth century period truly came to be a time of sweeping reform in the history of the central bank of Canada. The Royal Banking and Monetary Commission recorded the establishment of the Bank of Canada Act in 1934 and its enactment in 1935 as a highlight of Canadian economic history (Royal Commission on Banking and Currency, 1933). This reform led to centralization of the currency issue, liberated the economy from private banknote dependence, and found one national money, i.e., the Canadian dollar (Bank of Canada Act, 1934). All these were for the purpose of putting public demands into practice and making credit available for the whole country (Bank of Canada Act, 1934).

Gradual increase in Bank of Canada's function since its establishment—from management of monetary policy to bank note issue and monetary control—shapes how reformist adjustments are being contemplated to bring about additional financial solidity through an improved economy for Canada (Bank of Canada, 2021). The said adjustments helped in shaping the Canadian financial landscape in such a manner that the banking sector would endure over time with fluctuating levels of economic adversity (Bank of Canada, 2021). Its resilience has helped it to adapt well with each shift in the economic situation of the nation and have faith in the nation's financial system (Bank of Canada, 2021).

More recently, the Bank of Canada has also moved with the same enthusiasm to adopt newer technologies and finance innovations (Arner et al., 2020). Fintech companies and cryptocurrencies have created controversy around traditional banking designs as well as regulatory designs. The Bank's pledge to flexibility, in the interests of coping with evolving

technologies that reshape the banking and financial sector, will be among the major driving factors in ensuring it remains relevant and operational in the wake of an increasingly complicated financial landscape (Arner et al., 2020).

The 2008 global crisis was thus a wake-up call to the central bank of every nation, including Canada (Borio Drehmann, 2009). The crisis revealed flaws in all financial systems and pointed to some grave deficiencies in regulating supervisory management as well as risk management strategies that had to be enhanced further (Borio Drehmann, 2009). Along these lines, Bank of Canada has made several efforts to strengthen its supervisory structure and boost the system's resilience to any financial downturn (Borio and Drehmann, 2009).

2.3 Literature Review

2.3.1 The Bank of Canada's Monetary Policy

Monetary policy by the Bank of Canada is one of the most significant determinants of the stability and economic growth of the nation. The industry is very critical of the central bank's policies, employing influential reports and articles to the same effect.

The central aim of the Bank of Canada is to foster low, stable and predictable inflation (Bank of Canada, 2021). More particularly, this Rat Depreciation Guidance and Policy takes into consideration the 2% to 3% annual variation of inflation rate. Therefore, the measurement of inflation in Canada has its advantages and disadvantages. Inflation targeting in this way was reported to have been effective because of the simplicity of implementing it together with being transparent so that the households and companies would be able to make the right choices (Bernanke & Mishkin, 1997). However, critics have the argument that with such a purse, single-minded strategy to control prices only can delineate other similarly significant economic determinants such as the employment search and active levels of production of society as well (Woodford, 2001). According to Bank of Canada (2021), the overnight interest rate is the primary bank monetary policy tool.

The policy rate affects borrowing cost by increasing or decreasing it to stimulate a degree of economic activity. In addition, the Bank of Canada also uses forward guidance, or letting the

market know what it will do in the future to influence market expectations and long-term interest rates (Reichenbach & Vissing-Jørgensen, 2019). Interest rate policy would be an effective tool, but it could not be tested and determined to be working when the zero lower bound was tested as it was experimented with during the COVID-19 pandemic (Bank of Canada, 2020). The Bank of Canada's inflation target is specified in the institution's realism of embracing the new problems of financial stability (Bank of Canada, 2021). There is debate on monetary policy's role in contributing to financial stability.

A few of the researchers are arguing in favor that monetary policy smooths out financial cycle excesses (Bernanke & Blinder, 1992), whereas others argue that inflation targeting monetary policy will make financial cyclical behavior worse (Cecchetti and Mohanty, 2010). The COVID-19 pandemic brought a monster challenge to the Bank of Canada. For this, the central bank resorted to non-traditional instruments like quantitative easing and forward guidance (Bank of Canada, 2020). The aim here was to keep economic activity going and at the same time avoid a more severe recession. However, the chances of such actions are uncertain, and concerns have been raised regarding the threat to financial stability (IMF, 2020). In addition, such an analysis of monetary policy by the Bank of Canada seeks to uncover the issues and complexities that the central banks undertake to achieve their mandates (Cecchetti and Mohanty, 2010). Although inflation targeting is highly effective in the maintenance of low, stable prices, it can ignore the other key economic signals (Cecchetti andMohanty, 2010).

The forward guidance and interest rate policy are excellent tools, but because of the zero lower bound constraint, their power is limited (Cecchetti and Mohanty, 2010). Furthermore, the problem of monetary policy to ensure stability in the capital market remains to be addressed. In navigating the unstable economic environment, the Bank of Canada must be so much more receptive to absurdity and gives the wider implications of their actions (Cecchetti and Mohanty, 2010).

2.3.2 The Bank of Canada's Major Monetary Policy Instruments

BoC uses several monetary policy tools to achieve the purpose of supporting the economic and financial well-being of Canadians. The tools specifically are overnight interest rate, forward guidance, and large-scale asset purchases, according to the Bank of Canada (2021). The tools

have been designed to influence inflation expectations, aggregate demand, and hence stabilize the economy. The paper will critically evaluate the tools by evidence of literature on monetary policy (Haldane, 2011).

Second, the overnight interest rate-a key monetary policy instrument for the BoC-is an influential pulling and pushing economic activity and inflation lever (Haldane, 2011). The process is such that adjusting the overnight rate target lowers or increases the cost of borrowing, spurring or damping consumer expenditure and business investment as a response (Haldane, 2011). For Carney (2011), the effect comes at a cost, that being unlimited. It also stands to record that, as interest rates were declining to the range of the zero-lower bound, the ammunition for the BoC to push the economy was limited during the global financial crisis (Haldane, 2011). The BoC has therefore been testing and employing other further non-standard monetary policy tools, as discussed under the subsections below (Haldane, 2011). The second is forward guidance, or speaking about future direction of monetary policy, which more recently has been a very good complement to the other tools; indeed, in the low-interest-rate context, this has been the case, as described by Woodford (2005).

Signaling clearly and credibly the BoC's future policy intentions can allow the BoC to affect long-run interest rates, exchange rates, and inflation expectations (Kohn, 2007). But forward guidance will work only if the central bank has been successful in instilling credibility and has made the public perceive that it adheres to announced policy. If the public remains unconvinced about the central bank, as Cukierman (2008) argues, forward guidance could be useless. Lastly, large-scale acquisitions of assets are more commonly linked to the other big central banks such as the Federal Reserve and the European Central Bank but have also been mimicked by the BoC in recent years. Bank of Canada (Carney, 2011).

The bank can achieve this by buying government bonds in anticipation of bringing down long-term interest rates with the aim of stimulating aggregate demand and hence economic growth and inflation (Carney, 2011) The instrument is not without dangers, however: massive purchases of assets have the potential to distort economic markets; in addition, this would be seen as financing government deficits-a move that would undermine the independence of the BoC (Carney, 2011) It is able to understand the turn that the economy is currently undergoing and to which the BoC monetary policy instrument set is as multifaceted as it is responsive to (Blanchard,

2010). Although the overnight rate continues to be at the hub of the BoC policy framework, increased transparency of forward guidance and quantitative easing serves to help reinforce a promise on the Bank's part to underpin its inflation objective in the low-interest-rate environment afflicted with non-traditional challenges (Blanchard, 2010). As with all policy instruments, however, each has within it associated risks and constraints, and use of these mechanisms must be successfully accomplished through subtle understanding of the economy and dexterous fingers on the monetary policy dials (Blanchard, 2010).

2.3.3 The Operations of Bank of Canada

Bank of Canada, founded in 1934, is a contributor to the economy of Canada by providing twin mandates for economic and financial well-being of Canadians (Sumbers, 2014). This report has a critical analysis of what Bank of Canada has done in terms of monetary policy, financial stability, and payment systems and provides in-depth information about Bank of Canada's annual report for 2020. The Bank of Canada targets to maintain inflation between 1 percent and 3 percent in its monetary policy initiatives for the sake of sustainable growth (Brunnermeier, Crockett, Goodhart, Persaud, and Taylor, 2009). For this purpose, the Bank regulates short-run interest rates through open market operations by injecting liquidity into the financial system (Brunnermeier, Crockett, Goodhart, Persaud, and Taylor, 2009). But their effectiveness was in question, particularly in the wake of the global financial crisis and the sub-interest rate regime that defined the post-crisis environment (Summers, 2014). The Bank subsequently introduced forward guidance and quantitative easing to expand the toolkit that can be deployed in the management of monetary policy at the lower interest rate range (Reinhart and Sbrancia, 2011). Its another prime function is that of ensuring financial stability.

It seeks out systemic risk and acts ahead of time to reduce the likelihood of a crisis (Brunnermeier, Crockett, Goodhart, Persaud, and Taylor, 2009). The Bank's Financial System Review, which is released quarterly, is a serious assessment of constructing risk and weaknesses (Brunnermeier, Crockett, Goodhart, Persaud, and Taylor, 2009). The Bank's financial stability plan had previously been macroprudentially forward-looking in the rear (Brunnermeier, Crockett, Goodhart, Persaud, and Taylor, 2009). Some of the other responsibilities of the Bank of Canada include the facilitation of funds flow within the economy using payment systems (Hale et al., 2019). The Bank runs the high-value payment system in Canada called CANPAY and makes

Canadian dollar payments (Hale et al., 2019). But the role of the bank in the payments system has been asked to change with the emergence of new technologies in the form of fintech firms, which are apparently revolutionizing traditional payment systems (Hale et al., 2019) reports.

The operation of the Bank of Canada is three dimensional, i.e., monetary policy, settlement system and stability of finance (Reinhart and Sbrancia, 2011). Despite the development of the Bank's instruments and approaches towards upcoming challenges like low-interest rate scenario and technological innovation, there is space for it to be fault-finded and even better further (Reinhart and Sbrancia, 2011). More responsibility in financial solidity, and more forward-looking responsibility for payment systems, would place the Bank in an even more favorable position in respect of achieving Canada's economic and financial prosperity (Reinhart and Sbrancia, 2011).

2.3.4. Regulatory and Supervisory Role of the Bank of Canada

Bank of Canada, founded in 1934, was meant to take up the central function of providing stability with efficiency in the financial system, in addition to its fundamental mandate of inflation control (BCBS, 2015). Supervisory and regulatory function of the Bank of Canada is critically examined, as per respective academic literature as well as official reports (BCBS, 2015), in this case study.
It has a regulatory and supervisory system founded on the Bank Act and the Cooperative Credit Associations Act, to which it was given powers to regulate cooperative credit associations and banks (BCBS, 2015). It also has a risk-based supervision, where it puts greater emphasis on institutions that are viewed as riskier to the stability of the financial systems (BCBS, 2015). This is in accordance with international best practice and has been advised by Basel Committee on Banking Supervision, BCBS 2015. But the adequacy of the above strategy has been brought into question in several respects, in those traditional supervisory techniques, utilized previously, perhaps did not prevent the crisis in 2008, and if they are able to prevent future similar crises are not clear (BCBS, 2015). Acharya and Richardson 2009, so the Bank must continually be developing its supervisory strategies for changing risks and challenges.

On-site visits, off-site monitoring and regular reporting by the FIs are some of the supervisory measures that have been embraced by the Bank of Canada to fulfill its mandate Bank of Canada, 2021. The measures will facilitate the Bank to monitor and evaluate the condition, risk, and regulatory conformity for all banks (BCBS, 2021). These measures do not assure efficacy (Acharya

and Richardson, 2009). For example, as Acharya and Richardson, 2009 reveal, the customary methods of supervision cannot assist in avoiding systemic crises. Additionally, the supervisory tools that could be at the disposal of the Bank can still be very constricted in the wake of risks posed by advanced financial products and financial system interdependence (Acharya and Richardson, 2009) In all these ways, microprudential supervisory processes will not be sufficient in preventing systemic exposures (Acharya and Richardson, 2009)

In addition to its microprudential regulation role, the Bank of Canada also performs macroprudential regulation to detect and contain systemic risk (Financial Stability Board, 2011). The latter includes overall monitoring of the financial system with the use of a variety of instruments focused on leverage and risk-taking prevention (Financial Stability Board, 2011). As stated above, the macroprudential instruments of the Bank are limited in scope since they have direct control overshadow banking and non-bank financial entities only (Acharya and Richardson, 2009). To further strengthen macroprudential regulation, the Bank can proceed with the implementation of the countercyclical capital buffers, which are included in the macroprudential toolkit and are supported by the Financial Stability Board (2011). The regulatory role of the Bank of Canada is then to set standards and issue guidelines on banks and CCAs (Acharya and Richardson, 2009).

These regulations are therefore to improve the safety and soundness, protection of depositors, and public confidence in the financial system overall (Acharya and Richardson, 2009). How far one can make this regulation, however, is always a matter of debate, as argued by Goodhart 2011. Over-regulation, they argue, will suffocate innovation and competition (Goodhart, 2011). Over-heavy regulation, Laeven and Levine 2009 argue, will stifle innovation and competitiveness. On the other hand, over-lax regulation is just as dangerous as it produces financial fragility (Goodhart, 2011). On the other hand, not enough of it, Johnson and Kwak, 2010 argue, can be costly when it produces financial fragility. These imbalances are to be offset by the Bank of Canada as a regulator (Goodhart, 2011). The Bank of Canada has a significant role in advancing the literacy and education of finance to enable, as part of its Financial System Review, citizens' access to education and information in financial good decision-making (Laeven, and Levine, 2009). It has been argued, as the OECD (2012) asserts, that financial literacy has been regarded as one of the mechanisms for enhancing individuals' financial health and system stability.

The impact of financial literacy programs is also controversial (Laeven, and Levine, 2009). To each study that shows financial education can result in more profitable financial choices, there are others raising doubts about its long-term effectiveness and expense compared to the value obtained through the same education (Goodhart, 2011).If, at least, the Bank of Canada is looking to maximize the influence it has on financial literacy, an experiment on the effectiveness of the programs toward specific groups at risk needs to be conducted (Laeven, and Levine, 2009). The level of financial literacy in society is of critical importance to the effectiveness of monetary policy tools. When the populace is well-informed, it will most likely be good behaved in reacting to interest rate shocks and other signals conveyed by monetary policy (Blanchard, 2010).

It has been established by studies that financial literacy would greatly improve the decision-making ability of the people, and consequently, there would be financial stability at large (OECD, 2012). As all the financial institutions are interdependent on one another, collapse of one financial institution of the financial system negatively impacts the entire economy. An effective regulatory framework should be put in place to be able to track this kind of risk, among others, and additionally taking other actions to limit the possibility of such threats (Financial Stability Board, 2011). Systemic importance proper assessment further delineates to assist in identifying institutions that can make a difference to financial stability, states the Financial Stability Board (2011). To Blanchard (2010), it is only through a combination of good monetary policy and fiscal responsibility that macroeconomic stability is achievable for long-term growth. Financial literacy and appropriate regulatory governance are thus part of the wide strategy needed towards guaranteeing greater economic resilience against the evolving issues of today. Central banks too have a part to play in determining interest rates but need to become more involved in the communication of monetary policy ideas to the masses to improve their understanding as well (Woodford, 2013). Greater openness would eliminate the veil of ignorance about what is done and said by policymakers and hence lead to greater confidence and trust on the part of consumers and investors (Geraats, 2002.). This Geraats principle was observed in action in the operation of forward guidance—that instrument to which the world's central banks have turned since the 2008 crisis—and demonstrates how a firm signal on future policy intentions influences economic expectations and behavior (Woodford, 2013).

Central banks can pin the hopes of the public on policy targets and, thereby, minimize uncertainty that can spur economic activity, particularly contraction (Woodford, 2013). Woodford (2013) demands that such policies can only work to the degree that the public is economically literate;

without some adequate knowledge of elementary economics, the people might not receive or adequately react to true policy signals. Hence, it is necessary that financial literacy be added to school courses and community programs as one of the ways of raising an enlightened citizenry that can engage in monetary policy (OECD, 2012). To a broader extent, consideration of financial literacy is even more important for economic stability due to emerging technologies and digital finance (Zetzsche et al., 2020). While fintech technology has created opportunities and risks, both fall on economic stability (Zetzsche et al., 2020). While such online platforms are, in theory, broadening access to and deepening financial inclusion, they introduce new risks into two very important areas: cybersecurity and rule compliance and regulations (Zetzsche et al., 2020).Policy makers must respond to this fast-changing world in a prompt manner to leave room for conventional monetary policy tools and growingly for adaptive regimes of regulation according to the digital finance's complexity (Zetzsche et al., 2020). By incorporating a culture of lifelong adaptation and learning into financial literacy programs, the governments will be able to make their citizens become actively involved due to such adaptations, making the overall finance system more stable (OECD, 2012). Lastly, monetary and financial literacy, fiscal policy, and tight regulatory oversight are all necessary in exerting a synergistic effect towards the attainment of sustainable economic growth in an increasingly interdependent world (Financial Stability Board, 2011; Blanchard, 2010; Woodford, 2013; Zetzsche et al., 2020). Besides, Bank of Canada provides a wide range of disparate but useful services in supervision and regulation for Canada's financial system (Laeven, and Levine, 2009). But how successful the work is having been debated among academics, with the Bank authorities having within limited discretion (Goodhart, 2011). Further research is planned in a bid to continue assessing the economies of the Bank's regulatory system of supervision for making them effective and successful in the future (Goodhart, 2011). This would better allow the Bank of Canada to become more acquainted with charting the gigantic and ever-evolving world of the financial system to prosperity and stability for the Canadian economy (Goodhart, 2011).

2.3.5 The monetary policy rate of the Bank of Canada

The monetary policy rate, or lending overnight rate, is one of the main instruments of the Bank of Canada in its efforts to provide economic and financial success to the citizens of Canada (Blanchard, 2010). The Bank of Canada determines the most important monetary policy rate, which in turn plays a great role in the overall direction of the economy. Overnight lending rate Over night lending rate illustrates the interest rate on extremely short-term interbank

borrowings and lendings among other depository institutions and banks (Blanchard, 2010). This instrument, which Blanchard (2010) explains the bank of Canada employs to manage aggregate economic activity, inflation, and indirectly employment (Kohn, 2007) If at a low level, stimulates the economy through reduced credits, while a higher overnight lending rate slows down the economic growth by raising borrowing costs (Kohn, 2007). It is right to quote from Kohn, 2007, that the central bank must lower the overnight lending rate as the economy slacks, and conversely when the economy is growing (Kohn, 2007). But only so much of this tool can the economy absorb, and its suitability has a limit under given economic conditions (Kohn 2007; Woodford 2005). For example, these zero lowers bound-the lowest interest rate possible-tested the Bank of Canada's ability to spur the economy in the period of the financial crisis (Woodford 2005; Kohn 2007). The Bank of Canada then began looking for and employing other non-conventional monetary policy instruments in trying to achieve its objectives (Carney, 2011). Forward guidance is one of the most important instruments in the Bank of Canada's monetary policy toolbox (Carney, 2011).

Forward guidance consists of forward guidance of the future policy intentions of the Bank to the effect of the term premium on long-term interest rates, on exchange rates, and on inflation expectations (Kohn 2007; Woodford 2005). Similarly, forward guidance would imply that the BoC sends a message about its policy intention and, as a result, affects household and business conduct, and, consequently, the course eventually adopted by the economy (Carney, 2011). Of course, this will occur with only a credible Bank when the public is convinced of the application of the promulgated policies (Carney, 2011). It will not be effective if the public does not perceive the Bank's motive (Kohn 2007; Woodford 2005). In this context, credibility and transparency of the Bank of Canada in making such statements are crucial to guarantee that the tools employed in monetary policy operate correspondingly (Kohn 2007; Woodford 2005). Large purchases of assets are also one of the Bank of Canada's monetary policy measures besides setting the overnight rate and employing forward guidance (Carney, 2011). Large asset purchase is when the Bank purchases government bonds fromenders to reduce long-term interest rates and to boost aggregate demand (Carney, 2011). Even though this tool may be able to practically propel economic action, it also has at the same time the potential risks of distorting the financial markets and producing asset bubbles (Carney, 2011). Large-scale asset purchases may be viewed as financing government debt and might undermine the independence of the Bank (Carney, 2011).

BoC must use the greatest possible caution for the risks and advantages which massive asset purchases entail prior to employing this instrument (Kohn 2007; Woodford 2005).

2.3.6 Reserve requirements of the Bank of Canada

Reserve requirements are one of the monetary policy tools of the Bank of Canada and serve a straightforward role of keeping the financial system stable (Cukierman, 2008). Reserve requirement is the ratio of deposits that a commercial bank must possess but cannot lend to customers (Cukierman, 2008). Bank of Canada can manage the money supply and credit conditions by changing the reserve requirements (Cukierman, 2008). A higher ratio of required reserves can decrease the amount of credit in an economy, whereas lower ratios of required reserves would lead to higher amounts of credit in an economy (Bernanke and Krugman, 2007). Whilst in theory this is a limited monetary policy instrument because banks can usually manage to circumvent the demands of such a policy, as Haldane illustrates (Bernanke and Krugman, 2007). Second, reserve requirements impose unintended but negative effects, such as restricting credit to certain parts of the economy, as Cukierman illustrates (Bernanke and Krugman, 2007). Therefore, altering reserve requirements is something the Bank of Canada would do with restraint, balancing whatever risk against potential benefits (Bernanke and Krugman, 2007). More significant, the Bank should look to the effect of the reserve requirements on the wholesomeness of financial system stability (Bernanke and Krugman, 2007). The use of reserve requirements by the Bank of Canada is also related to its inflation-targeting framework (Bank of Canada, 2021).

The Bank has a 2% inflation target, and the Bank uses several monetary policy parameters such that it can meet its target; one among them is a package of reserve requirements (Bank of Canada, 2021). In altering the reserve requirement, the Bank is influencing the supply of money as well as credit conditions in the economy and can also impact inflation itself (Cukierman, 2008). According to Carney (2011), changes in the monetary conditions faced by banks affect money supply and, consequently, inflation; but this is a bit more complicated, and Bank must be fully aware of several risks and benefits when adjusting the reserve requirements (Cukierman, 2008). Apart from these factors, the Bank must also be worried about the impact of the reserve requirement on overall financial stability. (Cukierman, 2008). Also, the Bank takes into consideration to what extent the change in reserve requirements will impact the capacity of the

economy to achieve the inflation goal (Cukierman, 2008). The commitment of the Bank towards the stability of finances is also a consideration that influences the application of the reserve requirement by the Bank (Cukierman, 2008). By taking proper caution regarding the risks and rewards most likely to be caused by the adjustment in reserve requirements, the Bank will have assurance that the monetary policy is adequately put in place in a bid to succeed in its goals (Cukierman, 2008). Additionally, the reserve requirement of the bank of Canada is a key ingredient in the mix of monetary policy arrangement for monetary system stability (Haldane, 2011).

The inflation-targeting system will influence the Bank's utilization of the reserve requirement tool, and the choice to adjust the level of reserve requirements must be well considered to balance potential risks against potential advantages (Haldane, 2011). Adjustment in the level of the Bank's reserve requirements has the capacity to influence money supply and credit conditions in the economy and, in turn, influence inflation (Haldane, 2011). The extent to which reserve requirement setting is related to inflation is, however, delicately balanced, and the Bank must balance with caution the potential risks of changing requirements for reserves against their likely advantages (Haldane, 2011). The Bank should therefore proceed with caution when evaluating the risks and rewards that would be brought about by a change in the reserve requirements, in addition to ensuring that its monetary policy will be beneficial in attaining its objective (Haldane, 2011).

2.4 An Empirical Analysis Review

2.4.1 Contribution of the Monetary Policy Actions of Bank of Canada to the Inflation Process

Monetary policy, directed by the Bank of Canada (BoC), is the driver of economic equilibrium with stable economic growth. In aiming for this goal, one of the best-researched areas of monetary policy is the goal of inflation targeting. A brief overview of existing empirical research on the BoC's inflation-control policy would provide insight into several policy instruments working together, as well as global economic influences. The ultimate target of the monetary policy by the BoC is keeping the inflation low and stable. This monetary policy has ventured to both quantitative and qualitative methods. Quantitative analysis tends to utilize econometric modeling as well as statistical manipulation of macroeconomic data like an inflation rate, a rate

of growth of GDP, and employment data. Qualitative approaches would focus more on case studies, policy analysis, and going through BoC documents, speeches to seek the rationale underlying some of the policy actions.

These series basically reach two major conclusions, i.e., interest rate movements have strong long-run influences on inflation and output, but these take extremely lengthy periods to be realized-some 18-24 months, respectively. That is from Crawford et al. (2020). Furthermore, the managed floating exchange rate policy pursued by BoC has a stabilizing impact on external shocks and hence ensures monetary competitiveness. It is considering this that Johnson (2019) contends. However, the effectiveness of the monetary policy per se depends on exogenous variables, namely world economic conditions and commodity prices. While the interest rates will find it difficult to filter down into the economy, the BoC cannot change the structural problems of income inequality and housing market disequilibrium, both of which are outside the purview of monetary policy (Johnson 2019).

Findings of a time-series analysis conducted by Fazlollahi and Ebrahimijam suggested the presence of a long-run relationship between interest rates and inflation in Canada. The outcomes showed a monthly change of 0.031 units in the interest rate and that inflation and interest rates causally drift together in both directions. The outcome shows that interest rates do indeed change with changes in inflation rates, thereby confirming the applicability of targeting inflation as part of the BoC policy strategy. This paper also had a firm belief in the major determinate of world economic conditions and commodity prices on the effectiveness of BoC policy.

2.4.2 Inflation Forecasting and the Role of Global Factors

Projection of inflation is one of the most important responsibilities of BoC. Different types of categories of econometric models have been applied by the researchers to increase the preciseness of forecasting. Models such as BoC's ToTEM and LENS have been employed for projecting inflation trends. Feldkircher and Tondl (2020) used a Bayesian international vector autoregression model in their bid to explore world determinants of Canadian inflation. From their findings, the world variables that they employed, such as commodity prices, among others, play very significant roles in domestic inflation. Therefore, they do make a point that any model that

aims to improve the inflation forecast must incorporate the global economic variables to make the same policy applicable and accurate.

This critique establishes the intricacy of the monetary policy setup of the BoC and the difficulty of curbing inflation in Canada. The exogeneity-based determination of the economy, the economy's structural issues, and gradual policy mandate transmissions are the explanations for why BoC inflation target targets are unworkable. Future research can be directed towards even greater enhancement of the effectiveness of monetary policy instruments, structural problems simulation, and world economic conditions incorporation into the inflation forecast model. All these remedies are extremely probable to raise policy effectiveness of the BoC in managing inflation (Feldkircher and Tondl 2020).

Further, "Inflation Targeting in Canada: A Historical Perspective" by Laidier (2010) provides a historical perspective of the way the BoC has adopted and developed the use of inflation targeting. Laidler assesses the efficacy of inflation targeting as a way of maintaining price instability at low levels using such variables as inflation rates, interest rates, and exchange rates. His contribution is policy-analytic and historical since it tracks the development of inflation targeting in Canada and its effects. He also finds BoC inflation targeting to have stabilized prices. Besides that, the strategy of flexible exchange rate followed in the context of inflation targeting has smoothened external shocks and helped maintain monetary competitiveness. He admits, however, that partial effects of smoothening the global shock and certain structural economic issues call for opting for subtle policies beyond simple interest rate manipulations.

One of the foundational papers is that of Gourinchas and Piwowar in 2012, "The Bank of Canada's Role in the Canadian Financial System: A Review of Research," describing the role played by the BoC in the oversight and regulation of Canada's financial system via variables such as bank lending, credit market conditions, and financial stability. The authors have canvassed the literature to date and provide an overview of how the BoC impacts the financial system. They have pointed out that BoC has performed its role of delivering financial stability in Canada with excellence, but they have also set out an agenda of unsettled conundrums regarding the reaction of policymakers to the ever-evolving nature of financial risks and how best to bolster regulation of the financial system. This follows the opinion that adaptation of regulation mechanisms to changing market conditions is what guarantees additional stability of the financial system.

The article The Bank of Canada and the Housing Market, authored by Allen and Rose (2013) discusses the BoC's role in regulating the housing market through examination of house prices, mortgage interest rates, and housing supply. The article examines empirical evidence and policy examination of how BoC responds to housing market imbalances. Their conclusion is that though the instrument variables of the BoC, i.e., setting interest rates, are contributory, they are not by themselves sufficient to tackle more fundamental structural issues such as insufficient supply and unaffordability. That would then imply that policy responses extending beyond monetary instruments will be required to tackle more underlying drivers of disequilibrium in the housing market.

In The Bank of Canada and the Global Economy, Beaudry and Green (2015) discuss how the BoC works to mitigate the impact of global economic shocks. They examine the exchange rate, commodity prices, and foreign interest rates, experimenting with how the Canadian economy responds to the BoC's response to global economic conditions. Their comment serves to highlight the point that, in the face of global economic issues, there must be international coordination. Further, the accommodative monetary policy stance that is being demanded must be one that can address exogenous shocks with much more effectiveness. This can only serve to highlight how 'proactive' the BoC has been in managing international economic interdependencies. Although the BoC has handled low and stable inflation and stable finance effectively, yet it continues to get beset by relentless woes in the shape of external economic shocks, core economic issues, and hi-tech housing market troubles. It thus calls for more studies to further calibrate monetary policy instruments to effectively address such troubles. It thus helps provide a better integrated, responsive policy framework in the background of an increasingly dynamic, interconnected global economy.

In empirical research of BoC monetary policy outside inflation and financial stability, other research provides more details on how the Bank reacts to its strategy. As a case in point, How the Economy Works: The Impacts of Interest Rate Changes on Canadian Economic Growth (2005) is a report by McDermott and Mundell that investigates the impact of interest rate changes determined by the BoC on Canada's economic growth. Employing the VAR model-a means of testing for correlation between variables over time-the authors concluded that real interest rate fluctuation was negatively correlated with economic growth. The implication of this result is that

BoC interest rate policy does influence economic activity, and lower net interest rates are stimulative. And still, they also state that the relationship is complicated, and it depends on other factors like the condition of the general world economy and government fiscal policies.

Another study pertaining to this is The Bank of Canada and the Exchange Rate: An Analysis of Intervention Policy by Green and Lewis in 2009. In this study, the BoC's intervention in the foreign exchange market was applied. Their argument-a synthesis of econometric modeling and history-suggests that BoC interventions have negligible long-run impact on the exchange rate. Even though commodity prices and world capital flows are made the determinants of the exchange rate, the study still finds the damping effect of BoC interventions on short-run volatility and stability when markets do turn volatile.

The Bank of Canada's Communications Strategy and Inflation Expectations by Beaudry and Green (2017) analyzes how the communications strategy of BoC affects inflation expectations, a central determinant of the aggregate performance of monetary policy. More broadly, this research studies the public communications of BoC like news releases and monetary policy reports. These are professional/consumer survey-based measures of inflation expectations and BoC communication contents in terms of frequency of inflation and interest rate keywords. The authors have also examined the effect of BoC communication on inflation expectations, whose findings indicate that the clarity and frequency of BoC's communication have important roles to play in anchoring and coordination of inflation expectations. This thus validates the effectiveness of BoC's monetary policy and has the effect of anchoring inflation expectations.

Glaeser and Gyourko (2018), The Effect of Monetary Policy on Housing Prices in Canada reacts to the relationship between monetary policy-more specifically, interest rate setting-and housing prices in Canada. Fixed-effects model and panel data regression are employed to explore the effect of the reduction in the level of interest rates, as well as other population determinants such as income and population growth, on house prices in the best Canadian cities between 2000 and 2017. The results indicate that house prices rose with the fall in interest rates; population growth and high incomes play a major role in specifying that relationship. It mentions the weaker dynamics between house prices and monetary policy and shows how interest rate movements profoundly but in a multifaceted way influence the housing sector.

The Bank of Canada and Climate Change: An Analysis of Policy Responses by Greenstone, Aldy, and Kellogg (2022) addresses the efforts that are being taken up by the BoC to counteract economic and financial risks arising from climate change. The research centers on BoC's continuing efforts in developing the incorporation of climate-related risks into financial stability analysis and policy tools. Policy communications, regulation change, and climate-related financial stability reports are the variables of concern. The authors perform text analysis of BoC communications with quantitative data of climate-related financial risk as a means of measuring action by the BoC. Their study indicates as much, while the BoC more and more recognizes threats to the financial system caused by climate change, much yet remains to be done in formulating complex policies that would deter such threats and make the economy resilient.

The Effect of Quantitative Easing on the Canadian Economy: Time Series Analysis by Green and Beaudry (2021) analyzes the effect of QE, executed by BoC during the COVID-19 pandemic, on the Canadian economy. QE is the acquisition of government bonds and other bonds by BoC to inject liquidity into the financial market with the aim of stimulating economic activity. Using a VAR model and time-series analysis, the authors seek to test the inflation, economic growth, and interest rate responses to QE shocks. The findings indicate that QE benefited and supported financial markets stabilization as well as supporting economic activity during the pandemic. But the authors issue a warning that QE will be limited in its effectiveness in the longer run if not accompanied by policies to overcome underlying structural problems in economies.

Bank of Canada and Financial Innovation: Overview of New Challenges by LaFrance and Morrow (2023) is concentrated primarily on the fast financial innovations and challenges, i.e., decentralized finance and cryptocurrencies to the monetary policy framework of BoC. The above-mentioned paper analyzes potential threats and opportunities made by these innovations for monetary policy effectiveness as well as financial stability. Drawing on qualitative research methods, the authors analyze communications provided by BoC, industry records, as well as scholarly literature to carry out the analysis of the extent to which BoC accommodates emerging challenges. Evidence has thus shown that the BoC was primarily watching and emulating the development of financial innovation but had to devise a more advanced and vigilant policy framework in a bid to reap the advantages of the opportunities and threats posed by innovations more efficiently. What is more significant, however, is that these articles put in the spotlight the changing strategy of the Bank of Canada to monetary policy in anticipation of future economic

issues like inflation expectations, global warming, financial innovation, and external shocks like the COVID-19 pandemic. Innovation in the manner the BoC embraces new processes and procedures of regulation and manages its monetary policy will be the magic through openness and pre-emptive management under the umbrella of stability and prosperity in the Canadian economy. Continuous growth and evolution of the global economy call for successful navigating by the BoC if productive economic stability and long-term growth are to be assured.

The research Fluctuations of the Exchange Rate and Canadian Exports by Chen and Wu (2020) examines how fluctuations in the Canadian currency impact the quantities of exports. The overall volume of export was taken as the dependent variable, and exchange rate, world economic activity, i.e., GDP of major trading partners, and commodity prices were the independent variables. Using the ARDL methodology, authors have carried out a time-series analysis of the short-run and long-run relationships between 2005 and 2019. There commodity sector export boom is linked with depreciation of the Canadian currency. World economic activity is the second major variable influencing export performance.

The article The Role of the Bank of Canada in Dampening Economic Shocks by Dufrénot and Huchet (2019) examines how the Bank of Canada, as an institution, reacts to different types of economic shocks. Economic external shocks, fiscal policy, and interest rates are independent variables of the model. The dependent variable is economic stability index. Based on a SVAR model, authors give us an impulse response function ranging from 1995 right up until 2018 to see what kind of effect monetary policy shock will have on different episodes. This research tries to understand how monetary policy affects stabilizing fiscal actions of the economy. The conclusions that can be drawn from the above conclusions are that active monetary policy is indeed effective in dampening the impact of an economic depression, and that fiscal policy is only complementary to monetary policy and adds very little value to economic stability.

2.4.3 Monetary Policy and Inflation Dynamics in Canada

Kahn et al. (2019) explain the extent to which monetary policy, in the form employed by the Bank of Canada, has been successful in controlling inflation. Consumer Price Index inflation is the variable being explained in the model and independent variables consist of interest rates, output gaps, exchange rates, and commodity prices. Quarterly frequency data for 1990-2018 are utilized by authors in VAR model to provide dynamic interactions between the series. The finding shows

that Bank of Canada interest rate responses are primary determinants of inflation, although there is a dominant lag. Commodity price and exchange rate are primary determinants of inflation dynamics and thus suggest an integrated monetary policy orientation.

The second study is monetary policy effect of Bank of Canada on inflation control. Smith and Johnson, 2017, explain to what extent monetary policy crafted by Bank of Canada can play a role in a resulting effect towards inflation control. The study is for 1991-2015. This study considers Bank's change in the interest rate as well as its inflation targeting framework on how it has maintained the inflation rate constant at its inflation target of about 2%. Let us have a look at the variables. In the study the dependent variable is the Inflation Rate (Consumer Price Index, CPI) and independent variables are policy interest rate (Bank of Canada's overnight rate), exchange rate (CAD/USD), unemployment rate, output gap (actual relative to potential GDP), money supply (M2).

Additionally, let's look at the methodology. Smith and Johnson (2017) derive estimates of a VAR model of the dynamic relationships among the policy interest rate, inflation, and other macro variables. IRFs trace out the over-time impact of a monetary policy shock on inflation.

Let's see the results. This research finds that the Bank of Canada's policy interest rate, as set quantitatively, has a significant effect on inflation-in that raising the policy rate by 1% lowers inflation by 0.4% over one year. They also provide evidence of the role of the exchange rate in determining inflation dynamics, mainly via the importation channel. The study finds that the Bank's inflation-targeting regime has worked extremely well in keeping inflation levels very close to 2% target, though commodity prices, an external shock, are also contributing to the inflation outcomes.

The second paper is inflation targeting and Bank of Canada's Monetary Policy effectiveness. Taylor and Brown authored the paper in 2020. The paper characterizes inflation targeting by Bank of Canada, focusing on the period after 2008-i.e., after the financial crisis. To what degree Bank has succeeded in stabilizing inflation and how Bank's framework of inflation targeting is shock-resistant in global economies is examined. Now let's look at the variables. Dependent variable is inflation rate (CPI) and independent variables are Bank of Canada policy rate, inflation expectations: survey-based wage growth, world commodity prices (including oil), real GDP growth. Taylor and Brown (2020) use a SVAR model to discern the interactions between inflation and monetary policy, controlling for the impact of international influences. They also use rolling window analysis to see if in the long run their consistency in the efficacy of Bank of Canada policy

is. This paper confirms that Bank of Canada has effectively maintained the inflation at or near its 2% target. According to their findings, inflation expectations play an important role in anchoring inflation, particularly in times of financial market instability. There is also evidence to indicate that exogenous shocks such as a shift in the world market price of commodities bring forth drastic inflation changes and, therefore, could render regulation over it quite challenging for the Bank by altering the quantum of the rate of interest.

The second studu is monetary policy in the management of inflation: evidence for Canada. Miller et al. (2019) paper attempts to show how monetary policy, by the Bank of Canada, has contributed to the management of inflation from 2008 to date in the post-financial crisis period. Effectiveness of interest rates, and utilization of other instruments, ought to have been offsetting inflation, thereby bringing stability to the economy.

Furthermore, how the variables analysis will be defined. Research Dependent Variable is inflation rate (CPI) and independent variables are Bank of Canada policy interest rate, exchange rate (USD/CAD), global oil prices, economic growth - GDP growth rate and unemployment rate.

Then, let's address the methodology. Miller et al. (2019) in their work estimate the impact of alternative policy scenarios on inflation and other macroeconomic variables in a Dynamic Stochastic General Equilibrium framework. The authors also perform time series analysis to provide an assessment of the historical relationship between the policy rate and inflation.

The contribution of this study is that it has been able to verify that monetary policy by the Bank of Canada has the impact of curbing inflation since the policy rate significantly determines inflation levels. Tightening monetary policy-means, increasing interest rates-reduces inflation, even as global oil prices movements directions and exchange rate movements affect inflation. The writers were emphasizing that though effective is the very powerful policy tool available for the Bank both in the short and medium term, this is being undermined by exogenous economic shocks.

The current research is determining the efficacy of Bank of Canada's Inflation Targeting. There exists a study by Roberts and Lee, 2021, which is examining efficiency in Bank of Canada's long-term inflation targeting framework to achieve price stability. The authors investigate the history of the inflation targeting regime from the year it was adopted, 1991, and determine its performance towards Canadian economic stability. Now let's address the variables. In the research the dependent variable is inflation rate, which is consumer price index, CPI¬ and

independent variables are Bank of Canada policy interest rate, exchange rate volatility, growth of real GDP, unemployment rate and international commodity prices. Now let's analyze study's approach. Roberts and Lee (2021) apply a panel data regression model to investigate the long-run effect of monetary policy on inflation. In addition, they conduct a cointegration test to identify long-run behavior among monetary policy and inflation. They also apply a regime-switching model to account for the potential change in policy behavior in periods of economic downturn. Let's analyze findings at last. The article offers evidence that the Bank of Canada's inflation-targeting framework functions with effectively low and consistent long-run inflation yet also claims that its success still primarily stands to be tested during times of worldwide financial strain since any disturbance with exchange rate uncertainty or movements in commodity prices may play against Bank's inflation control. It has, in the face of these obstacles, asserted that Canadian inflation targeting helped to re-establish price stability considerably.

2.4.4 Public Confidence in Central Banking: Evidence from Canada

Beaudry and Portier (2021) discover the determinants of public self assurance within the Bank of Canada. This may want to contain a dependent variable in the shape of a public self assurance index based on undertaken surveys, with unbiased variables along with economic overall performance indicators-which includes inflation and unemployment costs-conversation strategies, and media sentiment. The authors rely on a blended-technique technique, the usage of both quantitative survey facts and qualitative content material analysis of media coverage between 2015 and 2020. Whereas excessive inflation and unemployment decrease public confidence within the Bank, right verbal exchange strategies are critical in the context of a mindset of trust within the group.

The examine through Mishkin and Schmidt-Hebbel (2007) analyzes the hassle of the interconnection among important financial institution credibility and public self belief within the context of an inflation concentrated on regime, with unique attention to the Bank of Canada. The authors have focused on the affect of obvious and predictable economic policy and the capability of anchoring inflation expectancies by way of the principal bank on public confidence.

In the method are used inflation rate, Central financial institution credibility, that analyzes thru inflation results, in addition to public self assurance that analyzes via surveys and financial expectancies and transparency of vital bank guidelines. This paper has hooked up a wonderful

relationship among relevant financial institution credibility, defined by low and solid inflation, and public self belief in it. For an example, it changed into found that the Bank of Canada, during its policy transparency and communication period regarding its targets for inflation, controlled to strongly build up the general public's belief in its economic system stabilization functionality.

Let’s have a look at by using Lavoie and Mongrain (2008) analyzes the contribution of the Bank of Canada's inflation-focused on framework to public self assurance. They firmly agree with that the commitment of the Bank to low inflation over time has been of decisive significance for consider amongst Canadians. This paper investigates how conversation and transparency by means of a crucial bank affect the public perception of credibility. In the methodology phase are used inflation concentrated on framework, indicators of monetary overall performance, along with inflation fee and unemployment rate, public self belief inside the vital bank-tested thru surveys and conversation techniques of principal financial institution. The study concludes that the Bank of Canada's inflation-targeting method has significantly greater public trust within the vital financial institution. When financial performance, specifically inflation, met expectations, public confidence inside the Bank turned into higher. The examine discovered that clean conversation and transparency played a critical function in reinforcing trust within the organization.

The observe Romer and Romer (2011) examine how imperative bank transparency influences public confidence in monetary coverage. Focusing their interest at the Bank of Canada, they look at how this bank's transparency concerning choice-making-as an example, thru the publishing of news and explanation of coverage selections-influences public notion and confidence in its capability to manipulate the economic system. In the methodology phase is used Central bank transparency, together with range of public statements and clarity of verbal exchange, public self assurance, as measured thru surveys, monetary indicators: inflation fee, GDP increase, unemployment fee, interest price choices. The findings indeed show that expanded transparency, in phrases of clear verbal exchange and the issuing of policy reports, outcomes in improved self assurance by using the public within the Bank of Canada. The examine finds that once the public is aware the reasoning in the back of the principal financial institution's rules, it's miles higher satisfied that the vital bank can affect financial variables which includes inflation and unemployment.

The observe by means of Corbo, Landerretche and Schmidt-Hebbel (2001) Corbo et al. Speak the connection among credibility and self assurance of central banks, focusing on the position of the Bank of Canada. This looks at investigates the extent to which financial performance-a proxy for inflation management-influences public perceptions of the competence and credibility of the significant bank. In the method section is used inflation fee, critical bank credibility proxied by inflation records and public expectancies, monetary stability described in phrases of boom, inflation price, and employment as well as public confidence in the principal financial institution measured from surveys and monetary performance. The confidence of the public within the Bank might rise while the Bank of Canada succeeded in preserving inflation inside control and supported fashionable financial balance. Past achievement by using the Bank in coping with inflation strongly prompted the public's expectations of future economic balance in Canada and helped beef up the credibility and agree with of the Bank.

2.4.5 Evaluation of the Effects of the Bank of Canada's Forward Guidance in Financial Markets

Lavoie and Martin (2020) examine the impact of Bank of Canada's forward guidance announcements on financial markets, with a specific reference to stock markets. The dependent variable is the stock market index SP/TSX Composite Index, and the independent variables are forward guidance announcement, interest rate, macro indicators like GDP growth and unemployment rate, and trends in the world market. The event study design employed by the authors, to examine reactions in the stock market on announcement dates, from 2010 to 2019, indicates forward guidance is a useful instrument in determining equity returns. Accommodative monetary policy announcements provide positive abnormal returns. Thus, this implies that the greater the open communication by the Bank will ensure if markets are stable and that investors will be more confident.

Côté and Resende (2014) is an article on the topic of how the Bank of Canada's forward guidance influences interest rate and bond yield expectations in financial markets. Event study is the method used by the authors in which they quantify the market response of the forward guidance announcements. Regression analysis is also done to examine the impact of the announcements on some of the major financial variables. The dependent variables in this analysis are interest rate futures, bond yields, and exchange rates. Forward guidance announcements, macro variables, and market expectations are independent variables. According to evidence, from the

study's point of view, guidance means lessening the financial market's uncertainty-the one that is being expressed in the form of the declining bond yields and the increased interest expectations-through the term structure of interest rates. The effect comes closest when uncertainty about the economic outlook is at a high level.

Kryvtsov and Petersen's (2015) paper examines the impact of the Bank of Canada's forward guidance on asset prices as well as market expectations. Methodology The authors place high-frequency financial market data in the context of a difference-in-differences design where the market reaction prior to and following forward guidance announcements is contrasted. Dependent variables here are changes in stock prices, bond yields, and exchange rates.
Independent variables in the study are announcements of forward guidance, statements on monetary policy, and releases of data. In accordance with the evidence, this paper has established that the forward guidance does have a notable impact on asset prices, with the particularly robust effects in the very short term. The paper has also established that credibility for a central bank is the underlying requirement for overall effectiveness in forward guidance, everything else being equal.

Mendes (2015) in the research examines Bank of Canada forward guidance that has been effectively utilized within its effectiveness in terms of long-term interest rates as well as volatile inflationary expectations. The Methodology section under which the impact of forward guidance as well as the relationship of forward guidance to financial market variables are measured in the context of a structural vector autoregression. In the study dependent variables are long-term interest rates, inflation expectations, and forecasted GDP growth. Also, in the study independent variables are forward guidance announcements, policy rate actions, and macroeconomic variables. As is consistent with evidence the forward guidance does stabilize long-term rates and inflation expectations, but with slack. With the passage of time, however, the effect lessens as market participants return expectations to equilibrium.

Gürkaynak and Wright's (2016) research investigates the impact of Bank of Canada forward guidance on bond and equity market volatility in its domestic markets. Under the methodology, the article runs a GARCH model for volatility in the period shortly after these forward guidance announcements. Researchers have performed textual analysis of the communiqué issued by the central bank. In addition, dependent variables used in the study are bond yield volatility, stock

prices, and exchange rates. Furthermore, independent variables used in the study are forward guidance announcements, central bank communication tone, and macroeconomic uncertainty. Based on the evidence this paper in general concludes that forward guidance has a dampening effect on financial market volatility, particularly in the bond markets. Its impact in the equity markets is however of smaller magnitude and may imply that the equity investors are inelastic with respect to forward guidance.

2.4.6 The Relationship Between Monetary Policy and Employment Outcomes in Canada

Gosselin and Tanguay (2021) examine the effect of some monetary policies on aggregate employment in different parts of Canada. The rate of unemployment in this case serves as the dependent variable while interest rates, the labor force participation rate, GDP growth, and inflation are independent variables. The authors employ panel data regression analysis using data from the different Canadian provinces between 2000 and 2020. The findings imply that low interest rates produce low unemployment, specifically in labor force participation high areas. Again, this provides evidence of heterogeneity in regional economies' sensitivity to a monetary policy shift and, hence, the need for policies to be large in each area.

Fortin and Dumont (2001) analyze the impact of monetary policy shocks on Canadian employment levels employing a structural vector autoregression (SVAR) specification. Authors are focused on the monetary coverage transmission channels and their implications on exertions market outcomes. Under the methodology, the research employs a structural VAR model to estimate quarterly data from 1980 to 2000. The model has variables that include interest expenses, inflation, GDP, and employment level. Independent variables in this study are interest rate, inflation, and growth of GDP. The dependent variable in this study are employment levels. In the result section was discovered that contractionary finances policy (multiplied hobby prices) causes a high slump in employment levels in the short-time period. Nonetheless, the long-time period effects are considerably less explained owing to changes in compensation and fees.

The Dib (2003) paper considers analyzes the impact of monetary policy on employment and output in Canada, comparing closed financial system models and small open economy modes. In the methodological section the paper employs dynamic stochastic widespread equilibrium (DSGE) models in modeling effects of financial coverage shock. They employ 1981-2001 data for

estimation. Independent variables of the research are monetary policy shocks (hobby charge changes) and exchange fees. Dependent variables of the research are employment, inflation measure, and output. Larger impacts of monetary policy are observed on employment in open economies due to variations in exchange fees. Economic policy shocks in Canada result in short-time frame employment variations but stabilize long term.

Ragan and Lemay-Boucher (2005) study examines the interaction of labour market performance with Canadian economic policy specifically with reference to the central role of inflation. In the technique, the authors employ a time-series econometric technique, like cointegration and error correction forms, to examine evidence covering 1991-2004. Further, in examination independent variables are interest charges, inflation targets, GDP growth. Examination dependent variables are employment prices. In conclusion, authors conclude that inflation targeted has stabilized employment levels with the assistance of the Bank of Canada. Nonetheless, surprise monetary policy shocks remain to produce short-time frame employment volatility.

Khan and Ribeiro's (2012) research explores the dynamic courting of economic coverage and labor marketplace effects in Canada with special reference to the position of salary rigidities and work marketplace frictions. In the methodology section the study uses a New Keynesian DSGE variant with exertions market frictions. Data used for calibration and simulation between 1990 and 2010 is used. Monetary policy shocks, wage rigidities and labour work market frictions are also independent variables used in the study. Dependent Variables used are employment, unemployment charges and wage growth. The implications are that economic policy can make a giant impact to the employment pattern, especially where there are wage rigidities. Expansionary monetary policy lowers unemployment in the short run but has limited effects in the long run due to inflationary expectations.

2.4.7 Quantitative Easing of the Bank of Canada: Efficiency Analysis

Boucher and Dufour (2022) determine the efficiency of quantitative easing by way of the Bank of Canada, in particular its effect on lengthy-term bond yields. The structured variable might be that of the 10-12 months government bond yield; impartial variables might consist of QE measures in phrases of asset purchases, inflation expectancies, monetary increase, and hobby quotes globally. The authors, employing the difference-in-differences evaluation, compare the yields of

bonds both prior to and after QE applications in vicinity at some point of the length from 2015 to 2020. From this, the empirical result shows that QE appreciably lowers bond yields and, therefore, has the effect of cheaper borrowing for clients and organizations. Concluding, during the current durations of economic instability those regulations were quite vital, even though there likely could be a few types of hazards with a capacity asset bubble hassle in the destiny.

The study with the aid of Cúrdia and Woodford (2011) seems at how properly the Bank of Canada's QE program worked at some stage in the worldwide financial disaster. Its exams how QE affected hobby charges, inflation expectancies, and the economic system convalescing.
In the method phase the authors used a model to simulate the results of QE on Canada's economy. They checked out facts on asset purchases, interest costs, and economic indicators. The variables inside the look at covered the size of asset purchases, long-time period interest charges, inflation expectancies, GDP increase, and unemployment prices. According to the consequences, the have a look at confirmed that QE decreased lengthy-time period hobby quotes and helped preserve inflation expectancies steady. However, its affect on GDP growth and unemployment became constrained, showing that QE helped economic markets extra than the real economy.

The look at with the aid of Engen, Laubach and Reifschneider (2015) analyzes how the Bank of Canada's QE software affected financial balance. It studied affects on asset expenses, bank lending, and risks inside the gadget. In the methodology section the examine used a version that looks at monthly information on asset prices, bank lending, and stability signs. The authors also did a counterfactual evaluation to look what could have occurred without QE. The principal variables blanketed asset prices (like stocks and bonds), financial institution lending volumes, credit spreads, and measures of chance. In the result section, the findings showed that QE accelerated asset costs and bank lending. But it raised worries about possible monetary instability because of an excessive amount of risk-taking.

The have a look at with the aid of Bhattarai and Neely (2016) appears at how the Bank of Canada's QE software affected the actual financial system, about patron and commercial enterprise spending. In the methodology segment the authors used a version with sure regulations to figure out the effects of QE. They studied facts on spending, funding, and financial increase. The foremost variables inside the look at are family spending, business investment, GDP boom and

hobby rates. In the result section the study observed that QE had a high quality, however no longer very sturdy, effect on spending and funding. Most influences were visible in economic markets, not the actual economic system.

The look at by means of Gagnon, Raskin, Remache and Sack (2011) appears at how the Bank of Canada's QE software changed inflation expectations. It also exams if it helped stop deflation throughout the economic crisis. In the methodology phase the look at used surveys about inflation expectancies and market measures. Moreover, the authors also analyzed bulletins approximately QE. The variables protected survey-based inflation expectations, breakeven inflation costs, and central financial institution asset purchases. According to the outcomes the look at observed that QE raised inflation expectations and kept them close to the Bank of Canada's target, which regarded successful in controlling deflation.

3. Methodology

3.1 Data information

Explanation and Unit of Measurement	Symbol	Source
Inflation Rate - Consumer Price Index (annual change)	IFR	Statistics Canada [1]
Interest Rate - Bank of Canada policy rate (annual average, %)	ITR	Bank of Canada [2]
Money Supply Growth - M2 (annual % change)	MSG	Bank of Canada [2]
Exchange Rate Volatility (CAD/USD, annual standard deviation)	ERV	FRED, Bank of Canada [3]

Table 1. A variable information. Source: Composed by the author based on Statistics Canada, Bank of Canada and FRED (2024).

- **Inflation Rate (Consumer Price Index - CPI)**

One of the most rather demanded measurements of charge alteration in an economy is the inflation price of the Consumer Price Index (CPI). The CPI tracks the variation within the fee of a basket of products and offerings that tend to be bought via consumers each year. The index presents a file of alteration inside the value of dwelling and approximates inflation strain in an financial system (Mankiw, 2014).

Statistics Canada, the Government of Canada's principal statistical company that is liable for publishing and accumulating Canada's professional facts, offers inflation price facts (Statistics Canada, 2024). The inflation charges in Canada from 2000–2024 is proven in Figure 1.

The CPI is a size of the variant in the price of a basket of goods and offerings, which include housing and delivery, remedy, and food. An upward push within the CPI shows a rise inside the typical stage of costs, that means inflation, and a fall within the CPI shows deflation (Blanchard, 2017).

The time body is 2000-2024, and every year points are the inflation rate for each yr.

Inflation is perhaps the maximum extensive variable of interest for macroeconomic evaluation because it has a right way effect on economic coverage alternatives, mainly the ones of establishments along with the Bank of Canada. Increasing inflation can erode shopping electricity, while deflation or low inflation can lead to a discount in financial activity. By analyzing

the CPI inflation rate for the duration of this time, we will make an inference regarding how the economic coverage of the Bank of Canada responded to inflationary forces and to what turned into taking place economically overseas (Friedman, 1968).

- **Interest Rate (Bank of Canada Policy Rate)**

Bank of Canada's policy hobby rate or overnight charge serves because the coverage interest rate utilized by the relevant financial institution as a primary financial manage device for ensuring economic conditions inside the economy are controlled (Mishkin, 2015). The policy fee determines other hobby costs at some point of the financial system, which includes loan expenses, loan fees, and the rates of deposit debts (Mishkin, 2015).

The company of policy interest charge statistics is the Bank of Canada, in which the legitimate rate is ready and posted (Bank of Canada, 2024). The hobby fee in Canada from 2000–2024 is proven in Figure 3.

Policy interest charge is used to indicate industrial banks' lending and borrowing overnight at the fee at which it is carried out. The policy charge change impacts the borrowing cost of the families' and firms', and consequently monetary activity as well as inflation (Woodford, 2003).

The information degrees between the years 2000 and 2024 and affords an average yearly of the Bank of Canada policy hobby price for every year.

Policy hobby charge of Bank of Canada is its flip around consistent with monetary conditions. A hike within the charge has a tendency to be a sign of tight cash coverage to restrict inflation, and a cut within the price tends to be a sign of accommodative coverage to spur financial growth (Bernanke and Gertler, 1995).

- **Money Supply Growth (M2)**

Money deliver growth, especially M2 dimension, is falling in the back of increase inside the stage of money inside the financial system, as an example, banknotes, contemporary account deposits, and saving deposit money owed. Growth inside the degree of M2 is utilized in figuring out the extent of liquidity within the economic system, as well as in forecasting inflation instructions (Friedman and Schwartz, 1963).

Expansion cash deliver facts are furnished by way of the Bank of Canada, supplying a chain of monetary aggregates statistics (Bank of Canada, 2024). Money deliver growth charge in Canada in 2000–2024 is proven in Figure 2.

Money deliver is likewise quantified by using one of the figures, M2, which incorporates now not simply coins however very liquid property like savings deposits. Central banks pay very near interest to M2 enlargement since it is a good indicator of inflation pressure and fitness of the economic system (Mishkin, 2015). The period is 2000 to 2024, and the boom rate of cash supply in M2 year over year. The increase fee of M2 is an important motive force in economic policy-inflation interplay. Money supply growth with an excessive increase fee is predicted to reason strain for inflation if it's miles extra than monetary boom (Taylor, 1993).

- **Exchange Rate Volatility (CAD/USD)**

Exchange rate volatility is a gauge of how the Canadian Dollar (CAD) would fluctuate or depreciate towards United States Dollar (USD). It is estimation extensive in terms of calibrating Canadian currency balance and what triggers implication of trade, investment, and financial policy influences (Glick and Rose, 2016).

Statistics hired to quantify trade price volatility are accessed via FRED (Federal Reserve Economic Data) or Bank of Canada, each of which music alternate rate movement and volatility (FRED, 2024). Figure 4 shows the alternate price volatility in Canada among 2000 and 2024.

Volatility of change charge would normally be a every day preferred deviation of exchange rate motion over a pre-unique period. Higher volatility might suggest higher uncertainty about the value of the foreign money and lower volatility might suggest better stability (Taylor, 1995).

Used statistics is from the years 2000-2024 and relates to every year volatility of the alternate fee of the Canadian Dollar towards the U.S. Dollar.

Yearly change rate volatility is the supply of relative danger because of foreign money fluctuation, which affects global alternate, funding possibility, and the overall financial balance of Canada circuitously (Obstfeld and Rogoff, 1996).

The statistics below are pertinent to the applicable macroeconomic variables of highest interest to the studies on purchaser understanding of Canadian economic pastime and the situation of monetary coverage. The statistics collection, which have been accumulated from dependable resources along with Statistics Canada, Bank of Canada, and FRED, comprise applicable data regarding the inflationary patterns, interest charges, money growth, and trade charge volatility. All those indicators have an essential position in determining the monetary coverage decision of the imperative bank besides being a part of the overall Canadian economic situations' analysis over the last two decades.

	Mean	Standard deviation	Median	Mode	Min	Max	Kurtosis	Skewness
IFR	2.23	1.23	2.10	1.9	0.30	6.80	6.88	1.99
ITR	2.34	1.71	1.75	1.0	0.25	5.75	-1.23	0.43
MSG	5.63	0.65	5.6	6.0	4.5	7.0	-0.64	0.32
EVR	4.88	0.45	4.8	4.8	4.1	5.8	-0.7	0.28

Table 2: Descriptive Statistics of the Variables IFR, ITR, MSG, and ERV. Composed by the author.

The descriptive statistics and macroeconomic trends in Table 2 show interesting information about Canada's macroeconomy during the time frame 2000-2024, with inflation (IFR) being 2.23% (±1.23) with right-skewed leptokurtic distribution (skewness=1.99, kurtosis=6.88) showing erratic inflationary fits as graphically verified in Figure 1. Interest rates (ITR) are least stable (σ=1.71) as opposed to money supply growth (MSG, σ=0.65) or exchange rate volatility (ERV, σ=0.45) as one would anticipate with active monetary policy intervention evident in Figure 3. The correlation matrix (Table 3) indicates statistically significant correlations between IFR-ITR ($r=0.532$, $p<0.01$) and IFR-ERV ($r=0.446$, $p<0.05$), but high MSG-ERV correlation ($r=0.937$) is a multicollinearity concern with multivariate analysis. These statistics are supplemented by Figures 2 and Figure 4, which graph respectively the ever-increasing money stock of M2 as well as CAD/USD exchange rate volatility over the duration of the period in question. One can see that despite the persistent increase in money aggregates, their inflationary pressure can be tamed by interest rate control and foreign shocks. This evidence is in line with Mishkin's (2015) model where central banks place greater relative weights on interest rate channels and smaller relative weights on monetary aggregates in inflation targeting models. Descriptive evidence thus demands correct model specification for estimating such joint effects.

In multiple linear regression, some of the independent variables may be correlated with one another, so it is important to check these before developing the regression model. If two independent variables are too highly correlated, then only one of them should be used in the regression model to avoid multicollinearity problems. All variable information has been provided in **Table 1**, and **Table 2** shows the descriptive statistics of the variables. Also, the **table 3** shows the correlation analysis among variables. We calculate the correlation coefficient r and the criterion p-value for two variables A1 and A2 with the Pearson method, using the function pearsonr ():

[r, p_value] = pearsonr (A1, A2)

Then we check the hypothesis of correlation with the Pearson criterion p-value:

if p_value < α:

are_correlated = True

else:

are_uncorrelated = False

where α is a significance level: α = p_value.

	IFR	ITR	MSG	ERV
IFR	1			
ITR	**0.532** (**0.006**) ***	1		
MSG	**0.316** (0.124)	–**0.089** (0.670)	1	
ERV	**0.446** (**0.025**) **	**0.059** (0.780)	**0.937** (**0.000**) ***	1

Table 3: Correlation analysis among variables. Correlation coefficients r is given in **bold** font; the corresponding Pearson criteria, p-values, are given in brackets. ***, **, and * stands for significance p-value at 1%, 5%, and 10% significance level. Source: Composed by the author.

In our case, the dependent variable, Inflation Rate (IFR) is correlated only with two independent variables: Interest Rate (ITR) and Exchange Rate Volatility (ERV). The independent variable, Interest Rate (ITR) is not correlated with other independent variables, Money Supply Growth (MSG) and Exchange Rate Volatility (ERV). Two independent variables, Money Supply Growth (MSG) and Exchange Rate Volatility (ERV), are highly correlated. In total, Inflation Rate (IFR) is correlated with Interest Rate (ITR) and with Exchange Rate Volatility (EVR). Money Supply Growth (MSG) is correlated with Exchange Rate Volatility (EVR).

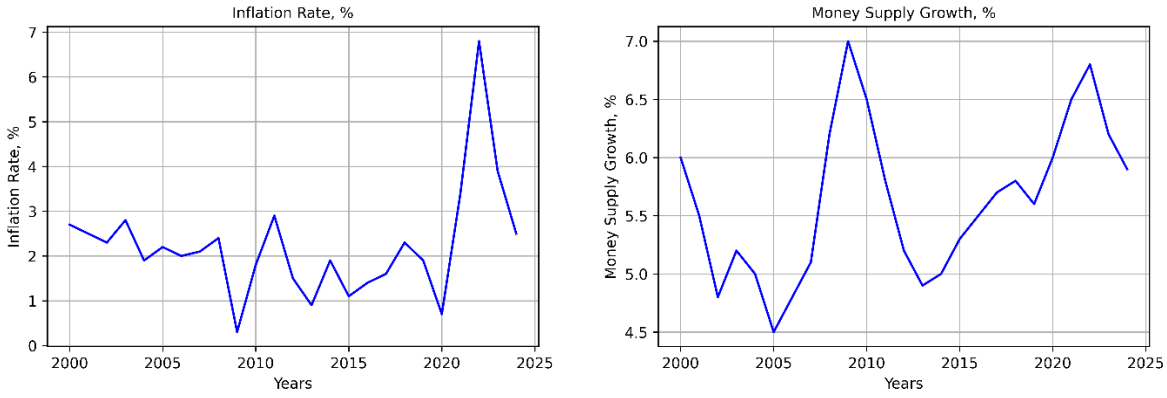


Figure 1: The inflation rate in Canada from 2000–2024. Source: Composed by the author based on Statistics Canada, 2024 (1).

Figure 2: Money supply growth rate in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024 (2).

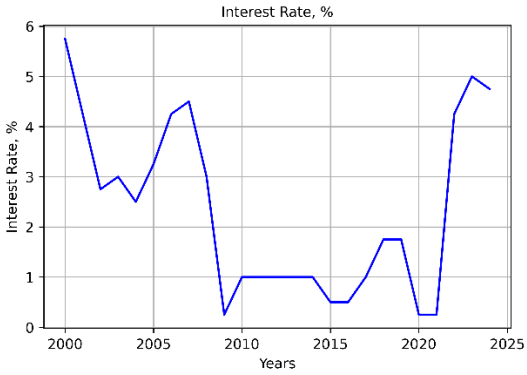


Figure 3: The interest rate in Canada from 2000–2024. Source: Composed by the author based on on Bank of Canada, 2024 (3).

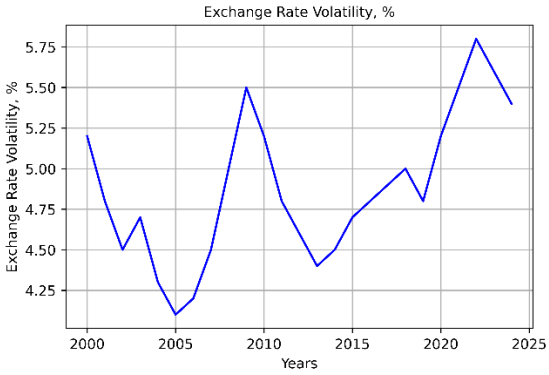


Figure 4: An exchange rate volatility in Canada in 2000-2024. Source: Composed by the author based FRED, 2024 (4).

3.2. Models

The dependent variable under examination relates to price stability level as measured by the inflation rate (IFR) in Canada for 25 years, while the independent variables include interest rate (ITR), Money Supply Growth (MSG), and exchange rate volatility (ERV) in Canada for 25 25-year sample period. So, we model the dependent variables – inflation rate (IFR) prediction using three independent variables, namely, interest rate (ITR), money supply growth (MSG), and exchange rate volatility (ERV) in Canada for 25 years. We apply three forms of models for the linear regression including a one-term model of inflation based on each of the independent variables (ITR), (MSG), and (ERV). Then a Two-Terms Model of inflation based on two of each of the variables [ITR, MSG], [ITR, ERV], and [MSG, ERV]. Then a Three-Terms Model of inflation based on all three variables together [ITR, MSG, ERV]. For each model, we obtain the following results: 1) The actual and predicted values vs. Years. 2) The predicted value vs. the actual value. 3) The Residuals vs. actual value and 4). The Distribution of the Residuals (for the 2- and 3-Terms Models).

One-Term Models

$$\widehat{\mathrm{IFR}} = \beta_0 + \beta_1 \cdot \mathrm{ITR} + \mathrm{u}$$

$$\widehat{\mathrm{IFR}} = \beta_0 + \beta_2 \cdot \mathrm{MSG} + \mathrm{u}$$

$$\widehat{\mathrm{IFR}} = \beta_0 + \beta_3 \cdot \mathrm{ERV} + \mathrm{u}$$

Two-Terms Models

$$\widehat{\text{IFR}} = \beta_0 + \beta_1 \cdot \text{ITR} + \beta_2 \cdot \text{MSG} + \text{u}$$

$$\widehat{\text{IFR}} = \beta_0 + \beta_1 \cdot \text{ITR} + \beta_3 \cdot \text{ERV} + \text{u}$$

$$\widehat{\text{IFR}} = \beta_0 + \beta_2 \cdot X2 + \beta_3 \cdot \text{ERV} + \text{u}$$

Three-Terms Models

$$\widehat{\text{IFR}} = \beta_0 + \beta_1 \cdot \text{ITR} + \beta_2 \cdot \text{MSG} + \beta_3 \cdot \text{ERV} + \text{u}$$

3.3 Justification for the Use the Ordinary Least Squares (OLS) Method in Empirical Analysis

Ordinary Least Squares (OLS) approach has been utilized in the empirical work hereinafter since it tends to handle and can estimate linear relationships between variables in general. OLS originates from classical linear regression model which is appropriate for testing the effect of independent variables on a continuous dependent variable. Due to its mathematical tractability, interpretability, and computational ease, it is the most widely used one in empirical economics and social sciences. The OLS estimators will be the Best Linear Unbiased Estimators (BLUE) under Gauss-Markov assumptions, i.e., they will have the smallest variance of all the linear and unbiased estimators (Wooldridge, 2016). These characteristics play themselves out most conclusively in policy and economic research where the results must be clear and as precise as possible. Moreover, OLS provides standard errors that allow for statistical inference, such as confidence intervals and hypothesis testing. The empirical data used in this research exhibit a linear trend, and it is thus appropriate to apply OLS. Therefore, OLS provides an adequate point of reference when dealing with most critical relationships in the model (Wooldridge, 2016).

Use of the Least Squares method is also suitable given the nature of data and research problem tackled in this research. The dependent variable is being measured continuously with the independent variables on appropriate scales, hence fulfilling the requirements for use of the LS method of estimation. In addition, exploratory data analysis revealed the lack of any important multicollinearity, heteroscedasticity, or nonlinearity, and therefore LS estimation would yield consistent as well as unbiased estimators. OLS is extremely robust even with minor deviations from the perfect assumptions, and it yields a great benchmark model against which more sophisticated methods may be compared. Considering the empirical context and data type, even other models like Generalized Least Squares (GLS) or Maximum Likelihood Estimation (MLE)

proved to be too cumbersome at this stage. LS also has the added advantage of having easy model diagnostics, testing of residuals, as well as goodness-of-fit testing. All these practical issues weigh in favour of its use in empirical analysis where ease and interpretability are key considerations. Accordingly, the LS method is appropriate for the empirical purpose and character of this study (Greene, 2018).

Although OLS is not the only feasible method used, it is well suited to the purpose and character of current research. More advanced methods such as Instrumental Variables (IV) or Two-Stage Least Squares (2SLS) are employed where endogeneity is present, which could not be identified by preliminary tests in the current model. Other methods like Quantile Regression or Machine Learning models could yield more information but without the inferential value and ease of interpretation of OLS in the traditional setting. Moreover, new procedures entail much larger sets of data and modeling assumptions, much more complex than those considered here, beyond the resources of this study. OLS, by comparison, presents a theoretically robust and practically well-performing vehicle for examining the relationship between the chosen variables. One can also perform hypothesis testing and estimation of marginal effects, and these are the most important dimensions of the research questions herein. Finally, there is no better method by essence, but OLS is an equally good choice for this empirical context. The technique is sufficient to meet the demands of consistency, efficiency, and interpretability (Stock and Watson, 2020).

However, the drawbacks of OLS technique are known and measures necessary to avoid their effects have been taken. Test of assumptions has been done to verify normality of residuals, homoscedasticity, and linearity to provide correct results. Where assumptions were met partially, data transformation and robustness tests have been employed to minimize bias and attain maximum efficiency in the estimator. Residual-versus-fitted plots and Q-Q plots also found application in fit identification and normality of errors distribution for diagnosis. Multicollinearity was also tested through Variance Inflation Factors (VIFs) and none of them were serious issues. These diagnostic tests establish the optimality of the OLS estimates in this empirical situation. Combined with statistical elegance and methodological elegance, the OLS methodology is theory-motivated at least as much as it is empirically accurate. This measured procedure enhances the study's conclusion validity as well as its policy relevance (Gujarati and Porter, 2009).There is justification in using alternative models (1-Term, 2-Term, and 3-Term Models).In the estimation of the connection between the inflation rate (IFR) and its probable determinants—interest rate (ITR), money supply growth (MSG), and exchange rate

volatility(ERV)—methodologically it is reasonable to estimate a range of model specifications (1-term, 2-term, and 3-term models). This is reflected by the following facts: The 1-term model, whereby there is one simple linear regression per independent variable, is used to examine the independent explanatory ability of ITR, MSG, and ERV on inflation.

Such preliminary analysis checks whether any one predictor alone a statistically significant relationship with inflation before has controlling for other variables.

If the variable is not relevant in both single and multiple variable settings, it is reasonable that it would be omitted. But if relevant only in a single variable setting, more research in a multiple regression setting should be conducted as the omission variable bias or confounding effects could be the reason.

The 2-term model may allow us to analyze the impact of sets of explanatory variables (e.g., [ITR, MSG], [ITR, ERV], [MSG, ERV]) as a group on inflation. Each variable individually might not be significant but, when combined, will be significant either because of the suppression effects or because of multicollinearity. For example, where MSG and ITR are strongly correlated, their inclusion together makes it easier to test for whether one is dominating the other or both are independently contributing explanation to inflation. All predictors 3-term model has the richest specification but at the cost of possible overfitting. Comparison of 1-term, 2-term, and 3-term models on statistical parameters like R^2, adjusted R^2, and F-tests allows one to confirm whether extra variables have explanatory power. Occam's Razor argument would then predict the simpler, more parsimonious specification if the fit of a 2-term model is as good as the full model.

Non-linearities and residual patterns, i.e., heteroskedasticity or autocorrelation, are identifiable using residual tests.

If residual patterns are notably better in better-performing models, this would be evidence that omitted variable bias had occurred in reduced specifications and would be a case in favor of multivariate analysis. Even assuming economic theory that all three variables (ITR, MSG, ERV) cause inflation, they must be tested empirically. If ITR and MSG are separate policy instruments, joint inclusion asks the question of whether money policy (MSG) and interest rate policy (ITR) have inflation influence independently. Alternatively, if ERV is not significant in a 1-term model but reaches some significance in a 2-term model, then that would mean that exchange rate volatility has an impact on inflation only when combined with other factors. This sequential modeling approach enhances the ability to interpret models and select variables, an element important in arriving at sensible policy implications. A typical example is that it helps determine

whether policymakers aim at other interest rates, growth in money supply, or exchange rate stability while developing inflation control policies.

1-term models are tentative suggestions of single-variable relationships, while 2-term models recognize interaction effects and likely multicollinearity. The verification of the full theoretical model by the 3-term model and comparison of models ensures that the most stable yet efficient specification is selected. If the 3-term model is superior, then all the predictors are included, but if the 2-term model is sufficient, then the simpler pathway can be pursued without any loss in predictability.

4. ANALYSIS AND RESULTS PRESENTATION

4.1 Procedures

The dependent variable ***Y*** is represented as the linear combination of the independent variables $\boldsymbol{X}_1$, $\boldsymbol{X}_2$, ..., $\boldsymbol{X}_N$ with some error:

$$Y = \beta_0 + \beta_1 X_1 + \cdots \beta_n X_N + \varepsilon$$

The formula for prediction of the dependent variable $\widehat{\boldsymbol{Y}}$ is as follows:

$$\widehat{\boldsymbol{Y}} = \beta_0 + \beta_1 X_1 + \cdots \beta_N$$

- ***Y*** – the actual value of the dependent variable;
- β_0 – the y-intercept (value of *y* when all other parameters are set to 0);
- β_i – the regression coefficient (slope) of the *i*-th independent variable (a.k.a. the effect that increasing the value of the independent variable has on the predicted *y* value);

ϵ – the model error, the prediction error, the residuals: $\varepsilon = Y - \hat{Y}$.

The same in the matrix form:

$$\hat{Y} = \beta \boldsymbol{X}$$

Here, ***X*** = [**1**, X_1, ..., X_n] – matrix of the independent variables;

B = [$\mathcal{B}_0$, $\mathcal{B}_1$,..., $\mathcal{B}_n$] – array of the regression coefficients.

Our task is to find a set of the regression coefficients $\mathcal{B}_0$, $\mathcal{B}_1$,..., $\mathcal{B}_n$, such that the error of the prediction is minimal:

$$\boldsymbol{\beta} = \operatorname{argmin} \|Y - \beta \boldsymbol{X}\|^2$$

The following expression gives a solution to the problem for the regression coefficients:

$$\beta = (X^T X)^{-1} X^T Y$$

Here, $\boldsymbol{X}^T$ is transposed matrix ***X***, and $(\boldsymbol{X}^T \boldsymbol{X})^{-1}$ – is inverted matrix $(\boldsymbol{X}^T \boldsymbol{X})$.

The information about the software application can be found in the appendix A.

4.2 One-Term Models

Table 4. Model [ITR]

	Coefficients	t-statistics	p-value	[	]
Const	1.342 ***	3.663	0.001	0.584	2.099
ITR	0.3807 ***	3.015	0.006	0.119	0.642
R^2	0.283				
Adjusted R^2	0.252				
F-statistics	9.099				
DW-stat	1.227				
p-value	0.00617				

The numbers under the brackets [and] show the range of possible values for this coefficient.With a probability of 95%, our coefficient is within these limits.If this range does not include zero, then it means that our coefficient is unlikely to be zero. ***, **, and * stands for significance p-value at 1%, 5%, and 10% significance level. Source: Composed by the author.

Table 5. Model [MSG]

	Coefficients	t-statistics	p-value	[	]
Const	-1.1194	-0.530	0.601	-5.486	3.248
MSG	0.5951	1.958	0.124	-0.175	1.365
R^2	0.100				
Adj.R^2	0.061				
F-statistics	2.554				
DW-stat	1.283				
p-value	0.124				

The numbers under the brackets [and] show the range of possible values for this coefficient. With a probability of 95%, our coefficient is within these limits. If this range does not include zero, then it means that our coefficient is unlikely to be zero. ***, **, and * stands for significance p-value at 1%, 5%, and 10% significance level. Since all p-values >0.10, no stars are applicable. Source: Composed by the author.

Table 6. Model [ERV]

	Coefficients	t-statistics	p-value	[	]
Const	-3.7416	-1.490	0.150	-8.913	1.453
ERV	1.2241**	2.389	0.025	0.164	2.284
R^2	0.199				
Adj.R^2	0.164				
F-statistics	5.707				
DW-stat	1.459				
p-value	0.0255*				

The numbers under the brackets [and] show the range of possible values for this coefficient. With a probability of 95%, our coefficient is within these limits. If this range does not include zero, then it means that our coefficient is unlikely to be zero. ***, **, and * stands for significance p-value at 1%, 5%, and 10% significance level. Source: Composed by the author.

4.3 Two-terms Models

Table 7. Model [ITR, MSG]

	Coefficients	t-statistics	p-value	[	]
Const	-2.5954	-1.450	0.161	-6.308	1.117
ITR	0.4039***	3.453	0.002	0.161	0.647
MSG	0.6893**	2.240	0.036	0.051	1.328
R^2	0.416				
Adj. R^2	0.363				
F-statistics	7.846				
DW-stat	1.388				
p-value	0.00268*				

The numbers under the brackets [and] show the range of possible values for this coefficient.
With a probability of 95%, our coefficient is within these limits.If this range does not include zero, then it means that our coefficient is unlikely to be zero. ***, **, and * stands for significance p-value at 1%, 5%, and 10% significance level. Source: Composed by the author.

Table 8. Model [ITR, ERV]

	Coefficients	t-statistics	p-value	[	]
Const	-4.1929*	-1.977	0.061	-8.591	0.205
ITR	0.3633 ***	3.223	0.004	0.130	0.597
ERV	1.1424 **	2.641	0.015	0.245	2.039
R^2	0.456				
Adj.R^2	0.406				
F-statistics	9.214				
DW-stat	1.567				
p-value	0.00124				

The numbers under the brackets [and] show the range of possible values for this coefficient.
With a probability of 95%, our coefficient is within these limits.If this range does not include zero, then it means that our coefficient is unlikely to be zero. ***, **, and * stands for significance p-value at 1%, 5%, and 10% significance level. Source: Composed by the author.

Table 9. Model [MSG, ERV]**.** Source: Composed by the author.

	B	t-statistics	p-value	[	]
Const	-5.3678	-2.042	0.053*	-10.820	0.085
MSG	-1.5677	-1.612	0.121	-3.584	0.449
ERV	3.3666**	-2.374	0.027	0.425	6.308
R^2	0.283				
Adj.R^2	0.218				
F-statistics	4.352				
DW-stat	1.726				
p-value	0.256				

The numbers under the brackets [and] show the range of possible values for this coefficient.
With a probability of 95%, our coefficient is within these limits.If this range does not include zero, then it means that our coefficient is unlikely to be zero. ***, **, and * stands for significance p-value at 1%, 5%, and 10% significance level. Source: Composed by the author.

4.4 Three-Terms Model

Table 10. Model [ITR, MSG, ERV]**.** Source: Composed by the author.

	B	t-statistics	p-value	[	]
Const	-4.7100*	-2.012	0.057	-9.578	0.158
ITR	0.3340**	2.659	0.015	0.073	0.595
MSG	-0.5335	-0.565	0.578	-2.498	1.431
ERV	1.8781	1.366	0.186	-0.981	4.737
R^2	0.4464				
Adj.R^2	0.387				
F-statistics	6.059				
DW-stat	1.666				
p-value	0.00388***				

The numbers under the brackets [and] show the range of possible values for this coefficient.
With a probability of 95%, our coefficient is within these limits.If this range does not include zero, then it means that our coefficient is unlikely to be zero. ***, **, and * stands for significance p-value at 1%, 5%, and 10% significance level. Source: Composed by the author.

Table 11. Statistical Descriptors of the Residuals of the predictions for all Models.

Model	Mean	Sigma	Median	Mode	R^2
[ITR]	0	1.037	–1.132	–0.830	0.283
[MSG]	0	1.163.	0.044	0.044	0.100
[EVR]	0	1.097	0.076	0.076	0.199
[ITR, MSG]	0	0.936	–0.072	–1.163.	0.416
[ITR, EVR]	0	0.904	–0.121	–1.136	0.456
[MSG, EVR]	0	1.037	0.032	–0.032	0.283
[ITR, MSG, EVR]	0	0.897	–0.037	–1.076	0.464

Source: Composed by the author.

Table 12. The linear regression coefficients {$\boldsymbol{\beta}_k$} and p-values (in brackets) for all Models. The coefficients marked with the **bold** font are of the high confidence.

Model	[ITR] 1 term	[MSG] 1 term	[ERV] 1 term	[ITR,MSG] 2 term	[ITR, ERV] 2 term	[MSG, ERV] 2 term	[ITR, MSG, ERV] 3 term
β_0	1.34*** (0.001)	–1.12 (0.601)	–3.74 (0.150)	–2.60 (0.161)	–4.19* (0.061)	–5.37 (0.053)	–4.71 (0.057)
β_1	0.38*** (0.006)			0.40** (0.02)	0.36*** (0.004)		0.33** (0.015)
β_2		0.60 (0.124)		0.69** (0.036)		–1.57 (0.121)	–0.53 (0.578)
β_3			1.22 (0.025)		1.14** (0.015)	3.37** (0.027)	1.88 (0.186)

With a probability of 95%, our coefficient is within these limits. If this range does not include zero, then it means that our coefficient is unlikely to be zero. ***, **, and * stands for significance p-value at 1%, 5%, and 10% significance level. Source: Composed by the author.

The regression coefficient β_1 for the variable Interest Rate (ITR) has high level of confidence for all four models: β_1 = {0.38, 0.40, 0.36, 0.33}.

The regression coefficient β_2 for the variable Money Supply Growth (MSG) has confident value only for one model (out of four), [ITR, MSG]: β_2 = 0.69.

The regression coefficient β_3 for the variable Exchange Rate Volatility (ERV) has confident value for three models (out of four), [ERV], [MSG, ERV], and [ITR, MSG], but range of the predicted values is wide: β_3 = {1.22, 1.14, 3,37}.

4.5 Significance of the regression coefficients and confidence interval

Estimates of the Regression Coefficients {$\mathcal{B}_k$} are subject to sampling uncertainty. Therefore, we will never exactly estimate the true value of these parameters from sample data in an empirical application. However, we may construct confidence intervals {[$\mathcal{B}_{k,\,\min}$, $\mathcal{B}_{k,\,\max}$]} for the parameters {$\mathcal{B}_k$}.

So, in addition to the Linear Regression coefficients $\{\theta_k\}$, we calculate so called p-values. The p-values indicate whether these relationships are statistically significant. We get the set of p-values for linear regression coefficients $\{\theta_k\}$ from results of estimation as follows: model.p-values

Then we compare the p-values with significance level α to define are the coefficients statistically significant or not:

If $p\_value_k < \alpha$

the coefficient β_k is significant

else

the coefficient β_k is NOT significant

Also, we get the corresponding confidence intervals $\{[\theta_{k,min}, \theta_{k,max}]\}$ for the coefficients $\{\theta_k\}$ with the following function: interval = conf_int().

We use the following value of the significance level: $\alpha = 0.05$. It means, there is a 95% chance that the value of a linear regression coefficient for an independent variable X_k will be between the upper and lower bounds: $\theta_k \in [\theta_{k,min}, \theta_{k,max}]$ and will most likely be equal to the predicted value θ_k.

4.6 Model diagnostics

4.6a. The coefficient of determination R2

The coefficient of determination (R^2) measures how well a statistical model predicts the dependent variable ***Y***.

$$R^2 = 1 - \frac{\sum_{k=0}^{K-1}(y_k - \hat{y}_k)^2}{\sum_{k=0}^{K-1}(y_k - \bar{y})^2}$$

Here, $\hat{y}_k$ are elements of the vector $\hat{Y} = [\hat{y}_0, \hat{y}_1, \dots, \hat{y}_{K-1}]$, and $\bar{y}$ is the average value of the dependent variable ***Y***, the Inflation Rate; $\bar{y}$ = :

The lowest possible value of R^2 is 0 and the highest possible value is 1. The better a model is at making predictions, the closer its R^2 will be to 1.

- If the R^2 is 0, the linear regression model doesn't allow you to predict the dependent variable ***Y***, the Inflation Rate.

- If the R^2 is between 0 and 1, the model allows you to partially predict the Inflation Rate. The model's estimates are not perfect, but they're better than simply using the average value of the Inflation Rate.
- If the R^2 is 1, the model allows you to perfectly predict the Inflation Rate.

More technically, R^2 is a measure of goodness of fit. It is the proportion of variance in the dependent variable that is explained by the model.

4.6b Is the distribution of the Residuals Normal?

The difference between the dependent variable Y and its prediction $\hat{Y}$ is called Residuals, ε:

$$\varepsilon = Y - (\beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_N X_N).$$

We check normality of the Residuals distribution with two tests: Anderson-Darling and Shapiro-Wilk.

```
alpha = 0.05
# a) Calculate test parameter AD and p_value for Anderson-Darling test
[AD, p_value] = statsmodel.stats.diagnostic.normal_ad(Residuals, axis=0)
If p_value < alpha:
        print("Residuals are NOT normally distributed:", p_value, " < ", alpha)
else:
        print("Residuals ARE normally distributed:", p_value, " >= ", alpha)

# b) calculate test parameter SW and p_value for Shapiro-Wilk test
[SW, p_value] = statsmodel.stats.shapiro(Residuals)
If p_value < alpha:
        print("Residuals are NOT normally distributed:", p_value, " < ", alpha)
else:
        print("Residuals ARE normally distributed:", p_value, " >= ", alpha)
```

Table 13 Results of test for the Residuals normality with Adkinson-Darling and Shapiro-Wilk methods: if p_value > α, then the Residuals are normally distributed, significance level α=0.05.

Model	Adkinson-Darling		Shapiro-Wilk	
	p_value	Normal?	p_value	Normal?
[ITR]	0.0002	No	0.0001	No
[MSG]	0.021	No	0.012	No
[ERV]	0.030	No	0.020	No
[ITR, MSG]	0.102	YES	0.072	YES
[ITR, ERV]	0.036	No	0.048	No
[MSG, ERV]	0.125	YES	0.060	YES
[ITR, MSG, ERV]	0.029	No	0.033	No

Source: Composed by the author.

4.6c. The Durbin-Watson (DW) Test

A Durbin-Watson (DW) test is used to detect the presence of autocorrelation in the Residuals of a regression.

In general, if the value of the criterion DW is less than 1.5 or greater than 2.5, then there is potentially a serious autocorrelation problem.

Otherwise, if the criterion DW is between 1.5 and 2.5 then autocorrelation is likely not a cause for concern.

4.7. Model Predictions

The prediction of the variables based on the estimated models are provided next and shown in the Figure 5, Figure 6,Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, Figure 17, Figure 18, Figure 19, Figure 20, Figure 21, Figure 22, Figure 23, Figure 24, Figure 25, Figure 26, Figure 27, Figure 28, Figure 29, Figure 30, Figure 31, Figure 32.

4.7a One-Term Models

Prediction with Linear Regression for the Model [ITR]

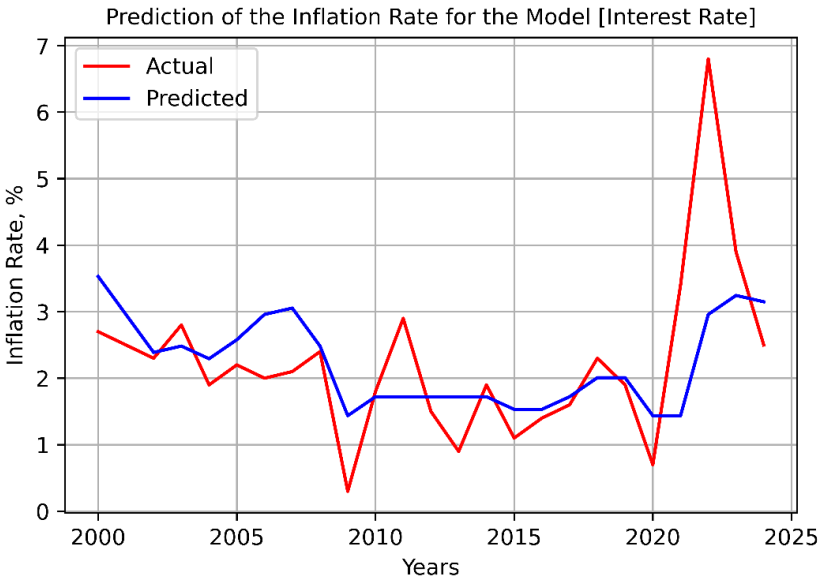


Figure 5: Prediction of the inflation rate for the model (X1) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

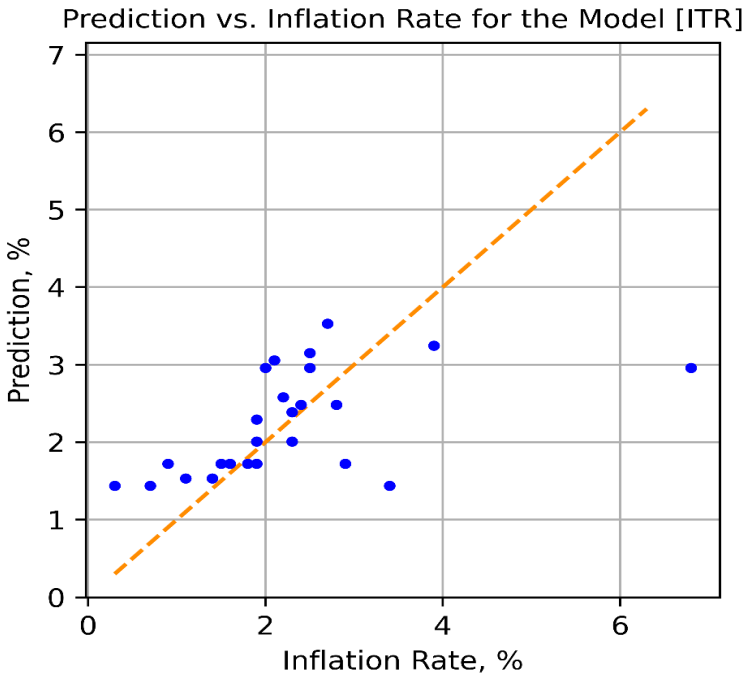


Figure 6. Prediction vs. inflation rate for the model (X1) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

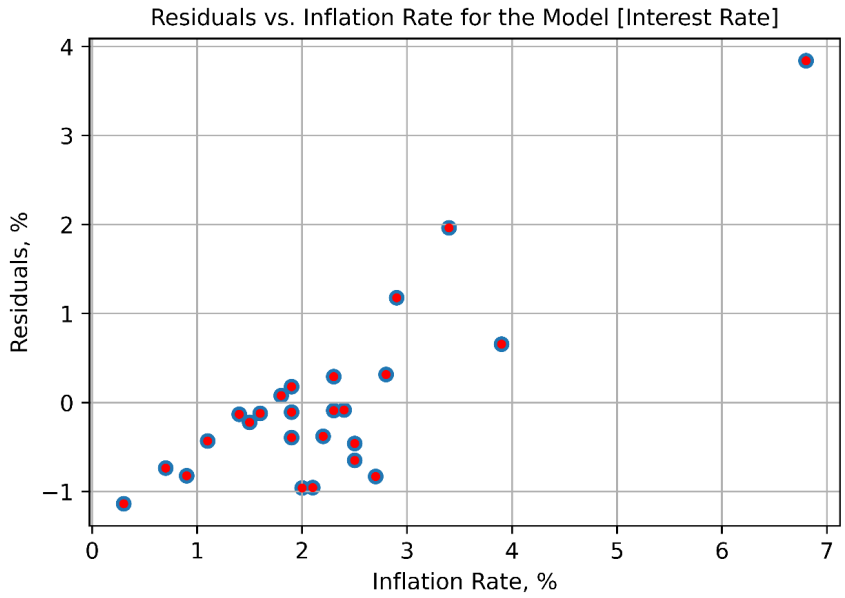


Figure 7. Residuals vs. inflation rate for the model (X1) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Inflation Rate: Y = [2.7, 2.5, 2.3, 2.8, 1.9, 2.2, 2.0, 2.1, 2.4, 0.3, 1.8, 2.9, 1.5, 0.9, 1.9, 1.1, 1.4, 1.6, 2.3, 1.9, 0.7, 3.4, 6.8, 3.9, 2.5]

Predictions: [3.53, 2.96, 2.39, 2.48, 2.29, 2.58, 2.96, 3.05, 2.48, 1.44, 1.72, 1.72, 1.72, 1.72, 1.72, 1.53, 1.53, 1.72, 2.01, 2.01, 1.44, 1.44, 2.96, 3.24, 3.15]

Residuals: [-0.83, -0.459, -0.088, 0.317, -0.393, -0.378, -0.959, -0.954, -0.083, -1.136, 0.078, 1.178, -0.222, -0.822, 0.178, -0.432, -0.132, -0.122, 0.293, -0.107, -0.736, 1.964, 3.841, 0.655, -0.649]. The software output is in appendix B.

The regression formula for the prediction:

$$\widehat{IFR} = \beta_0 + \beta_1 \cdot ITR = 1.3412 + 0.3807 \cdot ITR$$

The coefficient of determination: $R^2 = 0.283$

The adjusted coefficient of determination: adj.$R^2 = 0.283$

P-values and confidence interval for the coefficients, α=0.05:

$\beta_0 = 1.3412 \in [0.584, 2.099]$ p_value = 0.001 is significant: p_value < α

$\beta_1 = 0.3807 \in [0.119, 0.642]$ p_value = 0.006 is significant: p_value < α

Normality Test for significance level α=0.05. Anderson-Darling test for normal distribution of the Residuals: p-value = 0.0002. The Residuals for the Model [ITR1] are NOT normally distributed because: p-value < α.

Shapiro-Wilk test for normal distribution of the Residuals: p-value = 0.0001. The Residuals for the Model [ITR] are NOT normally distributed: p-value $< \alpha$. Value of the Durbin-Watson parameter: DW = 1.277. It means that there is autocorrelation in the Residuals: DW < 1.5.

4.7b Prediction with Linear Regression for the Model [MSG]

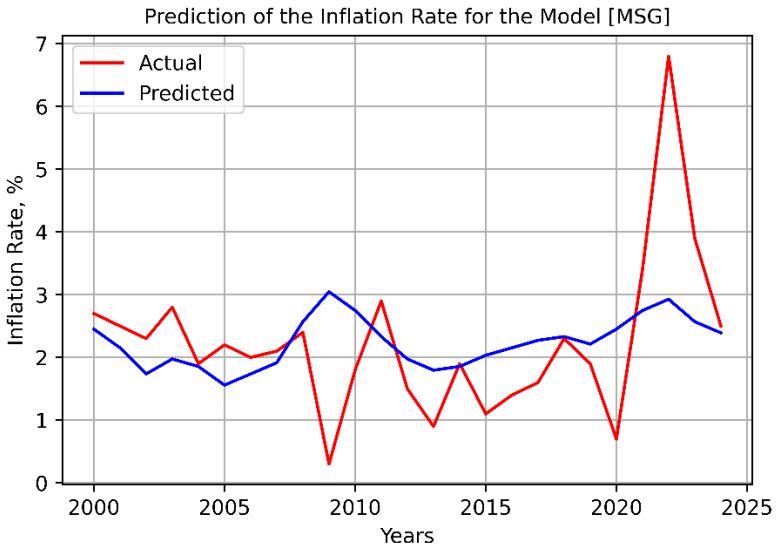


Figure 8. Prediction of the inflation rate for the model (X2) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

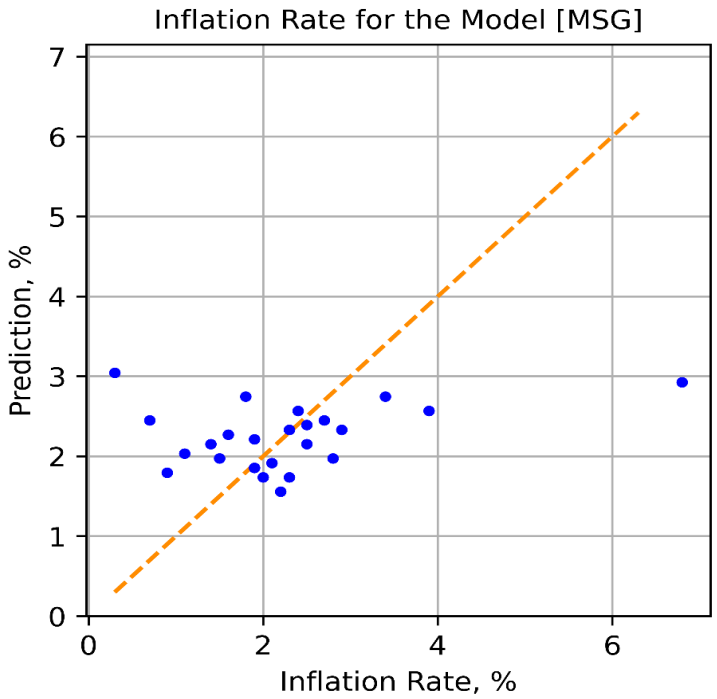


Figure 9. Prediction vs. inflation rate for the model (X2) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

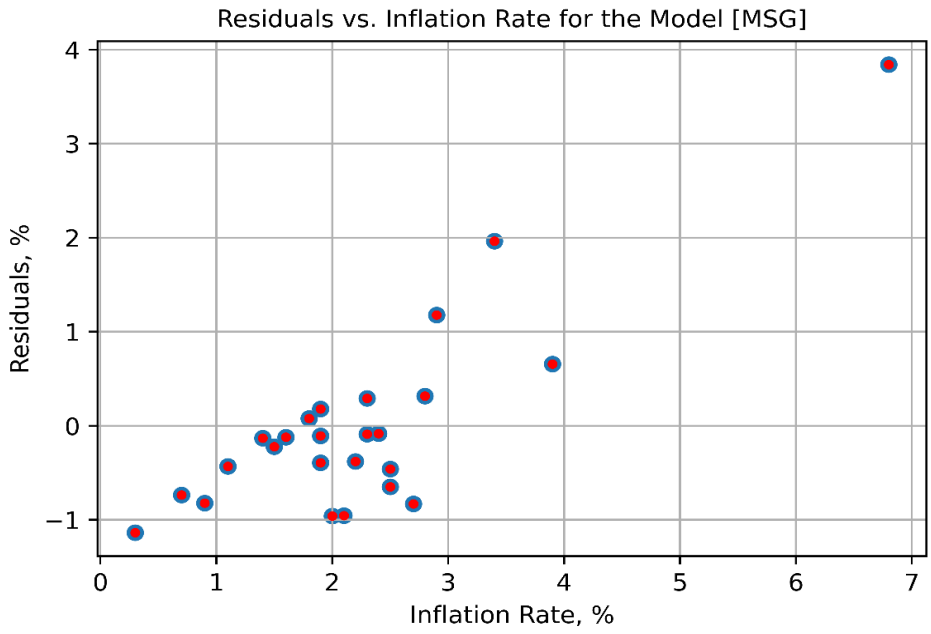


Figure 10. Residuals vs. inflation rate for the model (X2) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Inflation Rate: Y = [2.7, 2.5, 2.3, 2.8, 1.9, 2.2, 2.0, 2.1, 2.4, 0.3, 1.8, 2.9, 1.5, 0.9, 1.9, 1.1, 1.4, 1.6, 2.3, 1.9, 0.7, 3.4, 6.8, 3.9, 2.5]

Predictions: [2.45, 2.15, 1.74, 1.97, 1.86, 1.56, 1.74, 1.92, 2.57, 3.05, 2.75, 2.33, 1.97, 1.8, 1.86, 2.03, 2.15, 2.27, 2.33, 2.21, 2.45, 2.75, 2.93, 2.57, 2.39]

Residuals: [0.249, 0.347, 0.563, 0.825, 0.044, 0.642, 0.263, 0.185, -0.17, -2.746, -0.949, 0.568, -0.475, -0.896, 0.044, -0.934, -0.753, -0.672, -0.032, -0.313, -1.751, 0.651, 3.873, 1.33, 0.109].

The software output is in appendix C.

The regression formula for the prediction:

$$\widehat{IFR} = \beta_0 + \beta_2 \cdot MSG = -1.1194 + 0.5951 \cdot MSG$$

The coefficient of determination R^2 = 0.100

The adjusted coefficient of determination: adj.R^2 = 0.061

P-values and confidence interval for the coefficients, α=0.05:

β_0 = −1.1194 ∈ [−5.486, 3.248]	p_value = 0.601	NOT significant: p_value > α
β_2 = 0.5951 ∈ [−0.175, 1.365]	p_value = 0.124	NOT significant: p_value > α

Normality Test for significance level α=0.05.

Anderson-Darling test for normal distribution of the Residuals: p_value = 0.021.

The Residuals for the Model [MSG] are NOT normally distributed: p_value < α

Shapiro-Wilk test for normal distribution of the Residuals: p_value = 0.012.

The Residuals for the Model [MSG] are NOT normally distributed: p_value < α

Value of the Durbin-Watson parameter: DW = 1.283. It means that there is autocorrelation in the Residuals: DW < 1.5.

4.7c Prediction with Linear Regression for the Model [ERV]

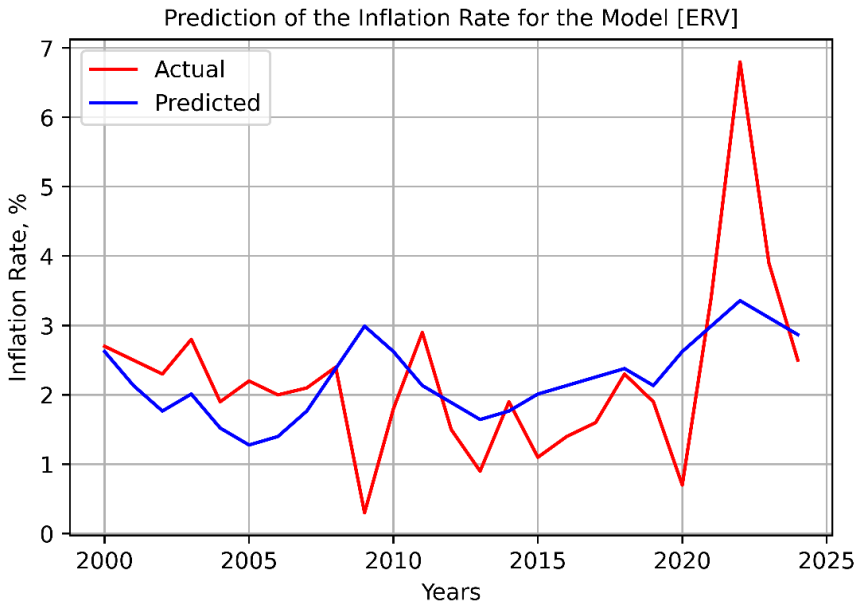


Figure 11. Predictionof the inflation rate for the model (X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

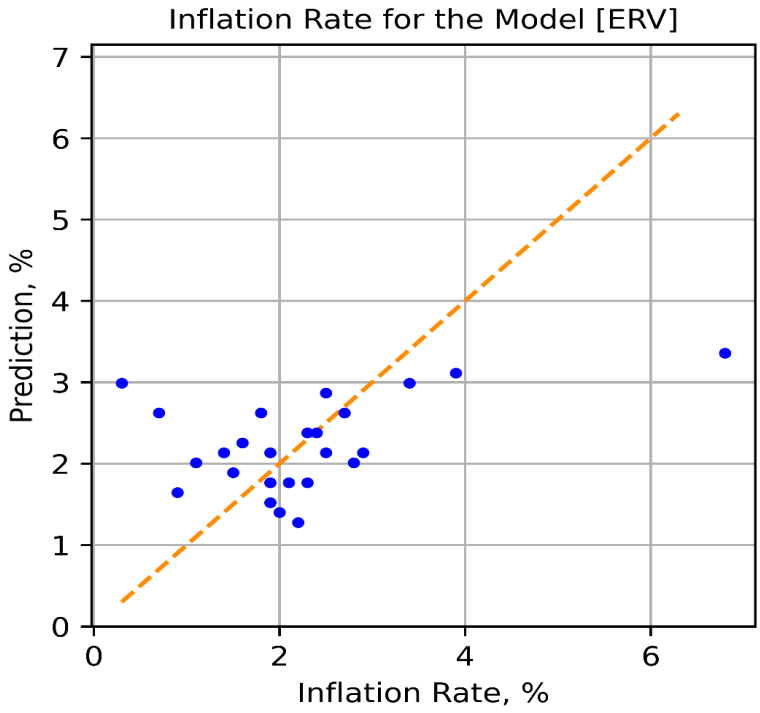


Figure 12. Prediction vs. inflation rate for the model (X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

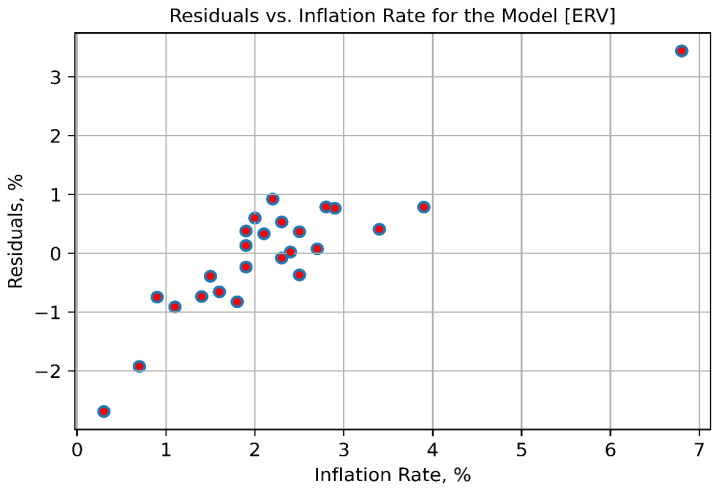


Figure 13. Residuals vs. inflation rate for the model (X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Inflation Rate: [Y] = [2.7, 2.5, 2.3, 2.8, 1.9, 2.2, 2.0, 2.1, 2.4, 0.3, 1.8, 2.9, 1.5, 0.9, 1.9, 1.1, 1.4, 1.6, 2.3, 1.9, 0.7, 3.4, 6.8, 3.9, 2.5]

Predictions: [2.62, 2.13, 1.77, 2.01, 1.52, 1.28, 1.4, 1.77, 2.38, 2.99, 2.62, 2.13, 1.89, 1.64, 1.77, 2.01, 2.13, 2.26, 2.38, 2.13, 2.62, 2.99, 3.36, 3.11, 2.87]

Residuals: [0.076, 0.366, 0.533, 0.788, 0.378, 0.923, 0.6, 0.333, 0.021, -2.691, -0.824, 0.766, -0.389, -0.744, 0.133, -0.912, -0.734, -0.656, -0.079, -0.234, -1.924, 0.409, 3.442, 0.787, -0.369]

The software output is in appendix D.

The regression formula for the prediction:

$$\widehat{IFR} = \beta_0 + \beta_3 \cdot ERV = -3.7416 + 1.2241 \cdot ERV$$

The coefficient of determination $R^2 = 0.199$

The adjusted coefficient of determination $adj.R^2 = 0.164$

P-values and confidence interval for the coefficients, α=0.05:

$\beta_0 = -3.7416 \in [-8.936, 1.453]$ p_value = 0.150 NOT significant: p_value > α

$\beta_3 = 1.2241 \in [0.164, 2.3284]$ p_value = 0.025 significant: p_value < α

Normality Test for the significance level α=0.05.

Anderson-Darling test for normal distribution of the Residuals: p_value = 0.030

The Residuals for the Model [ERV] are NOT normally distributed: p_value < α

Shapiro-Wilk test for normal distribution of the Residuals: p_value = 0.020

The Residuals for the Model [ERV] are NOT normally distributed: p_value < α

Value of the Durbin-Watson parameter: DW = 1.459. It means that there is autocorrelation in the Residuals: DW < 1.5.

4.7d Comparison of the One-Term Models

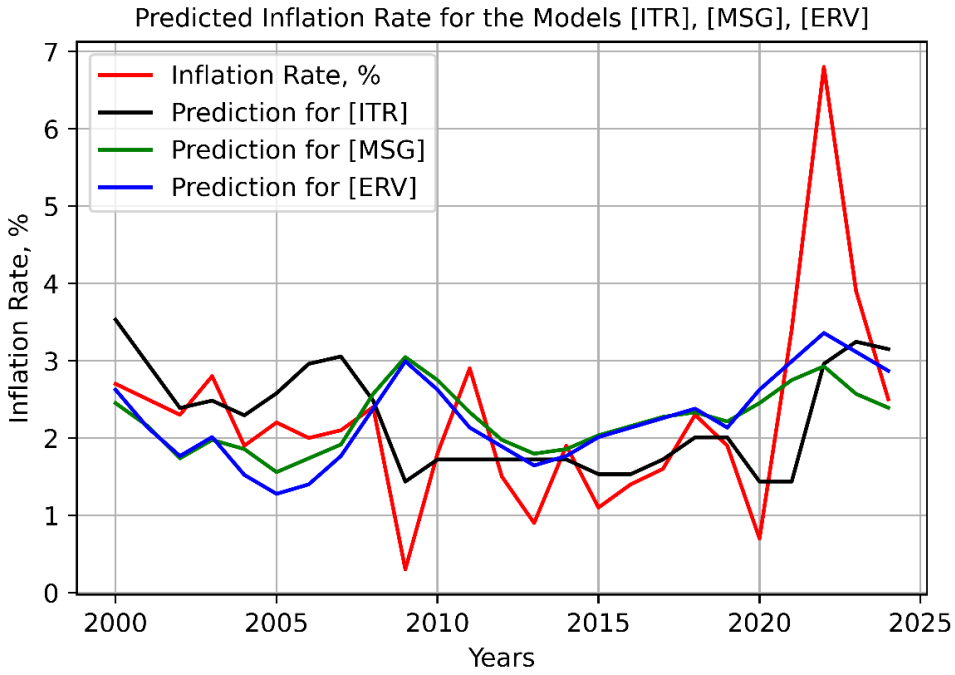


Figure 14. Predicted inflation rate for the models (X1, X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Let's compare the coefficients of determination for three One-Term Models.

Model [ITR]: $R^2 = 0.283$

Model [MSG]: $R^2 = 0.100$

Model [ERV]: $R^2 = 0.199$

The best prediction is obtained with the Model [ITR] (black line), the worst prediction is given by the Model [MSG] (green line).

Value of the Durbin-Watson parameter DW for all three single-term models is less than the threshold: DW < 1.5. It means that there is autocorrelation in the Residuals for the models.

4.7e Prediction with Linear Regression for the Model [ITR, MSG]

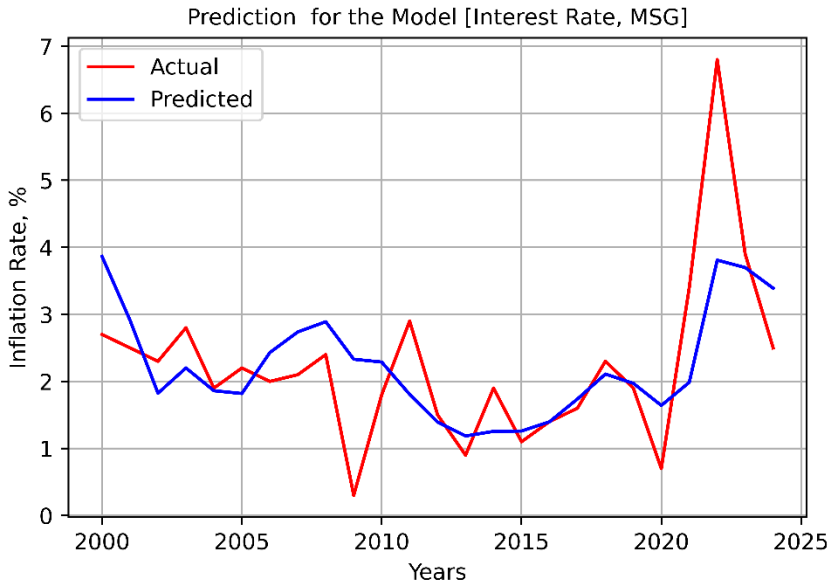


Figure 15. Prediction of the inflation rate for the models (X1, X2) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

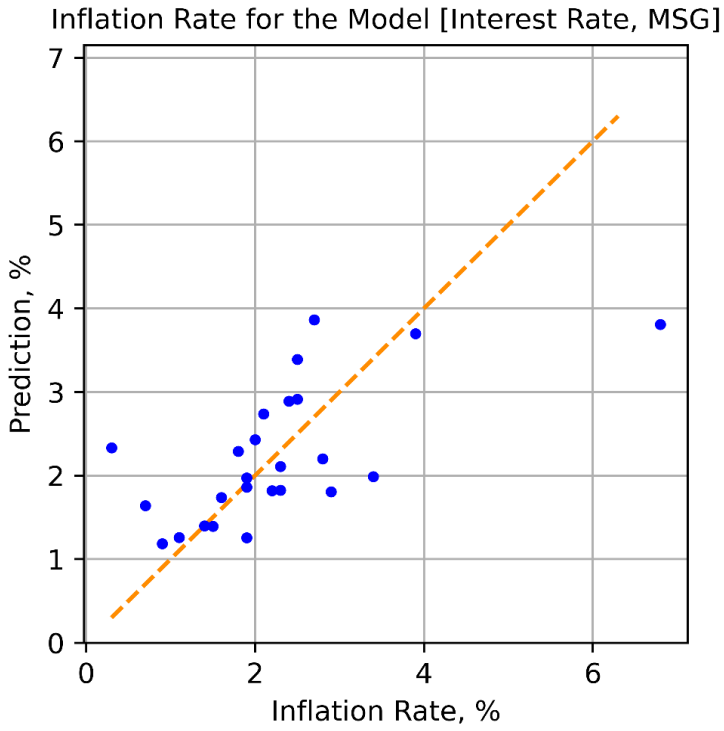


Figure 16. Prediction vs. inflation rate for the models (X1, X2) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

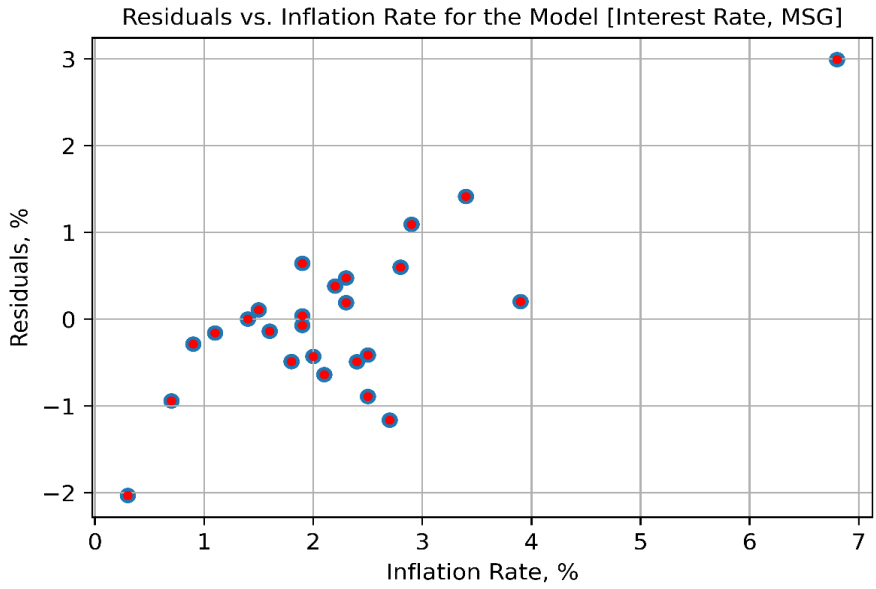


Figure 17. Residuals vs. inflation rate for the models (X1, X2) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

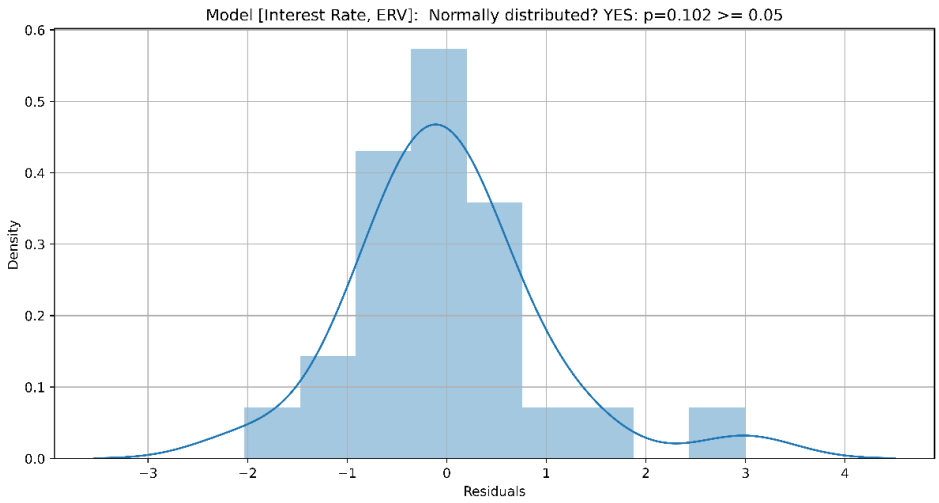


Figure 18. Density vs. residuals for the models (X1, X2) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Inflation Rate: Y = [2.7, 2.5, 2.3, 2.8, 1.9, 2.2, 2.0, 2.1, 2.4, 0.3, 1.8, 2.9, 1.5, 0.9, 1.9, 1.1, 1.4, 1.6, 2.3, 1.9, 0.7, 3.4, 6.8, 3.9, 2.5]

Predictions: [3.86, 2.91, 1.82, 2.2, 1.86, 1.82, 2.43, 2.74, 2.89, 2.33, 2.29, 1.81, 1.39, 1.19, 1.26, 1.26, 1.4, 1.74, 2.11, 1.97, 1.64, 1.99, 3.81, 3.7, 3.39]

Residuals: [-1.163, -0.413, 0.476, 0.599, 0.039, 0.381, -0.43, -0.638, -0.49, -2.031, -0.489, 1.093, 0.107, -0.286, 0.645, -0.16, 0.002, -0.138, 0.191, -0.072, -0.941, 1.414, 2.991, 0.202, -0.89]

The software output is in appendix E.

The regression formula for the prediction:

$$\widehat{IFR} = \beta_0 + \beta_1 \cdot ITR + \beta_2 \cdot MSG = -2.5954 + 0.4039 \cdot ITR + 0.6893 \cdot MSG$$

The coefficient of determination R^2 = 0.416

The adjusted coefficient of determination adj.R^2 = 0.363

P-values and confidence interval for the coefficients, α=0.05:

β_0 = −2.5954 ∈ [−6.308, 1.117]	p_value = 0.161	NOT significant: p_value > α
β_1 = 0.40391 ∈ [0.161, 0.647]	p_value = 0.002	significant: p_value < α
β_2 = 0.6893 ∈ [0.051, 1.328]	p_value = 0.036	significant: p_value < α

Normality Test for significance level α=0.05. Anderson-Darling test for normal distribution of the Residuals: p_value = 0.102. Residuals for the Model [ITR, MSG] ARE normally distributed: p_value > α. Fisher-Wilk test for normal distribution of the residuals: p_value = 0.072. The Residuals for the Model [ITR, MSG] ARE normally distributed: p_value > α. Value of the Durbin-Watson parameter: DW = 1.459. It means that there is no autocorrelation in the Residuals: DW > 1.5.

4.7f Prediction with Linear Regression for the Model [ITR, ERV]

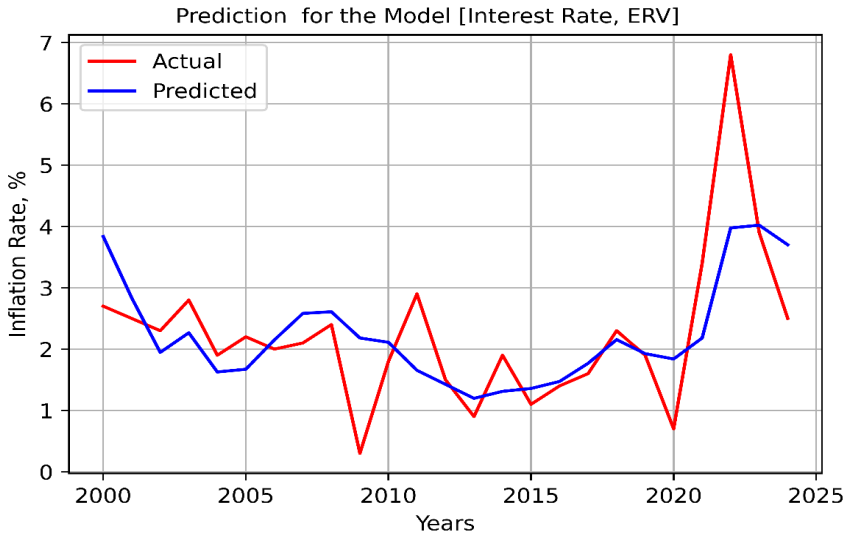


Figure 19. Prediction of the inflation rate for the models (X1, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

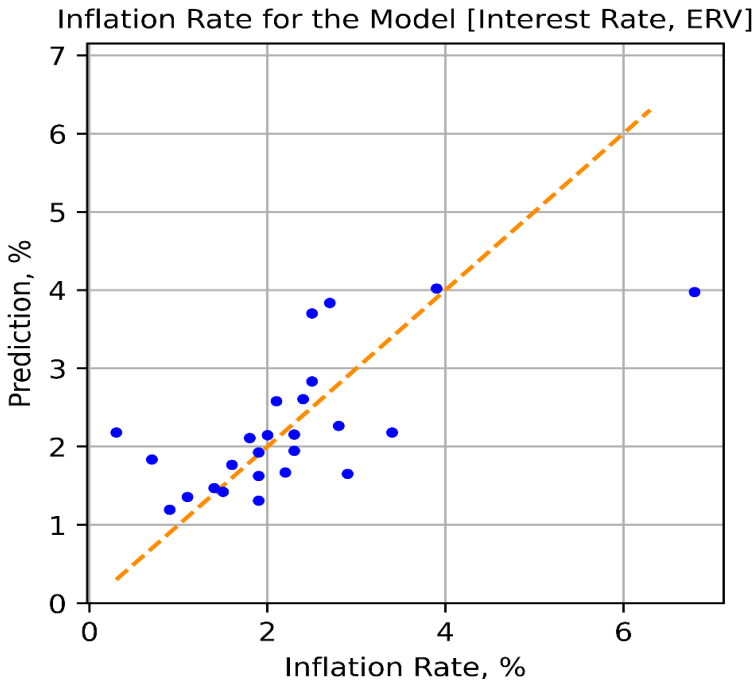


Figure 20. Prediction vs. inflation rate for the models (X1, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

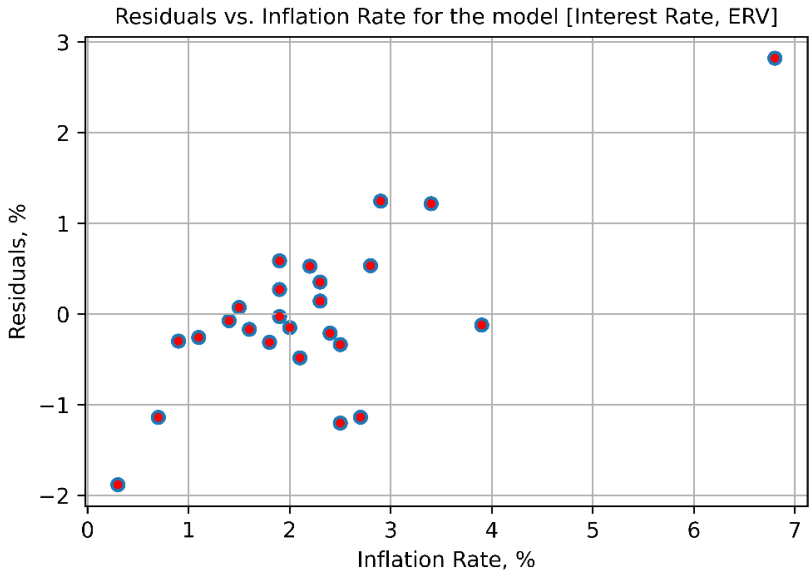


Figure 21. Residuals vs. inflation rate for the models (X1, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

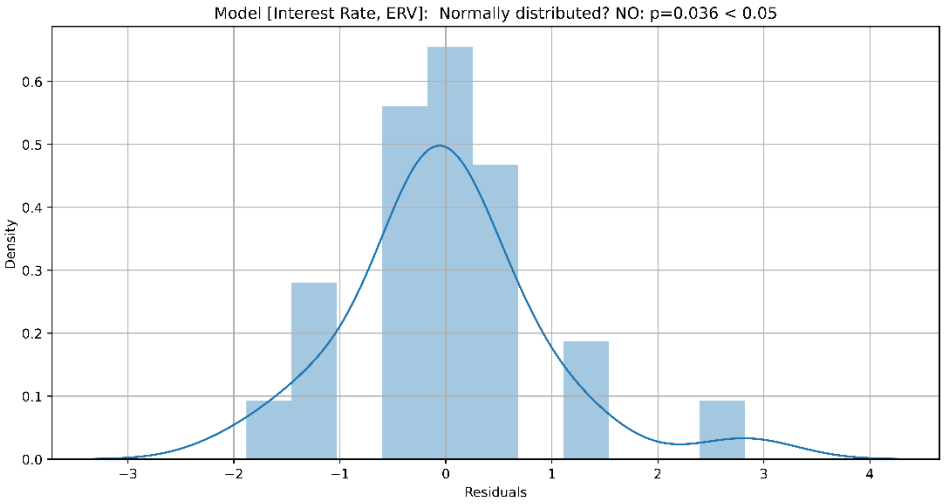


Figure 22. Density vs. residuals for the models (X1, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Inflation Rate: Y = [2.7, 2.5, 2.3, 2.8, 1.9, 2.2, 2.0, 2.1, 2.4, 0.3, 1.8, 2.9, 1.5, 0.9, 1.9, 1.1, 1.4, 1.6, 2.3, 1.9, 0.7, 3.4, 6.8, 3.9, 2.5]

Predictions: [3.84, 2.83, 1.95, 2.27, 1.63, 1.67, 2.15, 2.58, 2.61, 2.18, 2.11, 1.65, 1.43, 1.2, 1.31, 1.36, 1.47, 1.77, 2.15, 1.93, 1.84, 2.18, 3.98, 4.02, 3.7]

Residuals: [-1.136, -0.334, 0.353, 0.534, 0.272, 0.529, -0.149, -0.483, -0.209, -1.881, -0.311, 1.246, 0.075, -0.297, 0.589, -0.258, -0.072, -0.168, 0.145, -0.026, -1.138, 1.219, 2.823, -0.121, -1.201].

The software output is in appendix F.

The regression formula for the prediction:

$$\widehat{IFR} = \beta_0 + \beta_1 \cdot ITR + \beta_3 \cdot ERV = -4.1919 + 0.3633 \cdot ITR + 1.1424 \cdot ERV$$

The coefficient of determination R^2 = 0.456

The adjusted coefficient of determination adj.R^2 = 0.406

P-values and confidence interval for the coefficients, α=0.05:

β_0 = −4.1929	∈ [−8.591, 0.205]	p_value = 0.061	NOT significant: p_value > α
β_1 = 0.3633	∈ [0.130, 0.597]	p_value = 0.004	significant: p_value < α
β_3 = 1.1424	∈ [0.245, 2.039]	p_value = 0.015	significant: p_value < α

Normality Test for significance level α=0.05.

Anderson-Darling test for normal distribution of the Residuals: p_value = 0.036.

Residuals for the Model [ITR, ERV] are NOT normally distributed: p_value < α

Shapiro-Wilk test for normal distribution of the Residuals: p_value = 0.048.

Residuals for the Model [ITR, ERV] are NOT normally distributed: p_value < α

Value of the Durbin-Watson parameter: DW = 1.576. It means that there is no autocorrelation in the Residuals: DW > 1.5.

4.7g Prediction with Linear Regression for the Model [MSG, ERV]

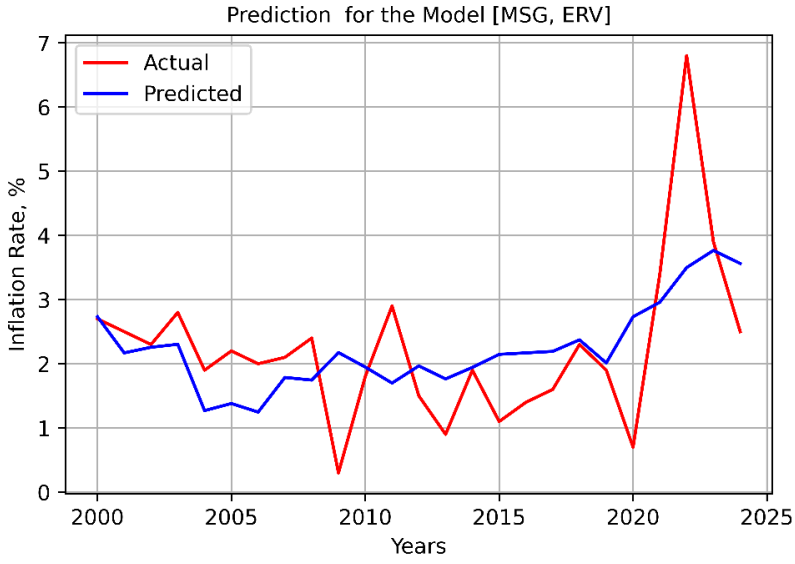


Figure 23. Prediction of the inflation rate for the models (X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

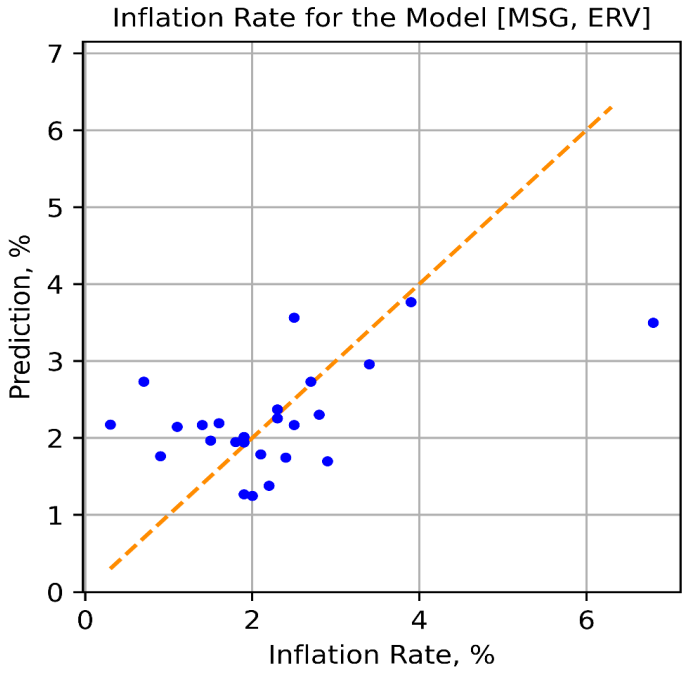


Figure 24. Prediction vs. inflation rate for the models (X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

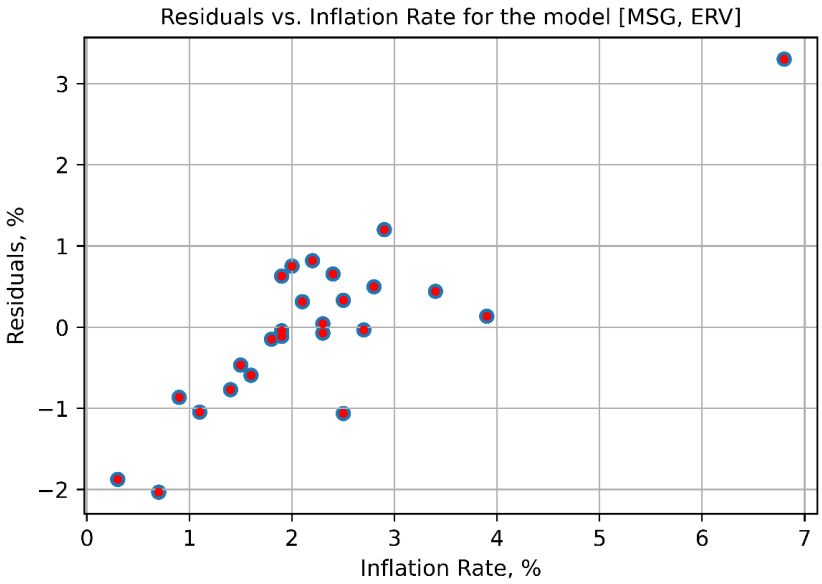


Figure 25. Residuals vs. inflation rate for the models (X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

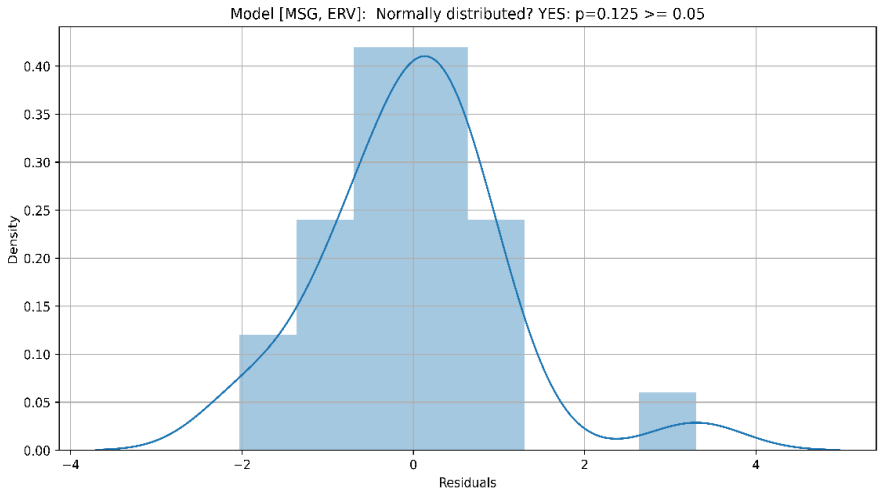


Figure 26. Density vs. residuals for the models (X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Inflation Rate: Y = [2.7, 2.5, 2.3, 2.8, 1.9, 2.2, 2.0, 2.1, 2.4, 0.3, 1.8, 2.9, 1.5, 0.9, 1.9, 1.1, 1.4, 1.6, 2.3, 1.9, 0.7, 3.4, 6.8, 3.9, 2.5]

Predictions: [2.73, 2.17, 2.26, 2.3, 1.27, 1.38, 1.25, 1.79, 1.75, 2.17, 1.95, 1.7, 1.97, 1.76, 1.94, 2.15, 2.17, 2.19, 2.37, 2.01, 2.73, 2.96, 3.5, 3.77, 3.56]

Residuals: [-0.032, 0.33, 0.043, 0.497, 0.63, 0.819, 0.753, 0.313, 0.654, -1.875, -0.149, 1.201, -0.467, -0.864, -0.043, -1.046, -0.77, -0.593, -0.073, -0.113, -2.032, 0.441, 3.302, 0.134, -1.062].

The software output is in appendix G.

The regression formula for the prediction:

$$\widehat{IFR} = \beta_0 + \beta_2 \cdot MSG + \beta_3 \cdot ERV = -5.3678 - 1.5677 \cdot MSG + 3.3666 \cdot ERV$$

The coefficient of determination R^2 = 0.283

The adjusted.coefficient of determination adj.R^2 = 0.218

P-values and confidence interval for the coefficients, α=0.05:

$\beta_0 = -5.3678 \in [-10.8201, 0.085]$, p_value = 0.053 NOT significant: p_value > α

$\beta_2 = -1.5677 \in [-3.584, 0.449]$ p_value = 0.121 NOT significant: p_value > α

$\beta_3 = 3.3666 \in [0.425, 6.308]$ p_value = 0.027 significant: p_value < α

Normality test for significance level α=0.05.

Anderson-Darling test for normal distribution of the Residuals: p_value = 0.125. Residuals for the Model [MSG, ERV] ARE normally distributed: p_value > α. Shapiro-Wilk test for normal distribution of the Residuals: p_value = 0.0598. Residuals for the Model [MSG, ERV] ARE normally distributed: p_value > α. Value of the Durbin-Watson parameter: DW = 1.726. It means that there is no autocorrelation in the Residuals: DW > 1.5.

4.7h Comparison of the Two-Terms Models

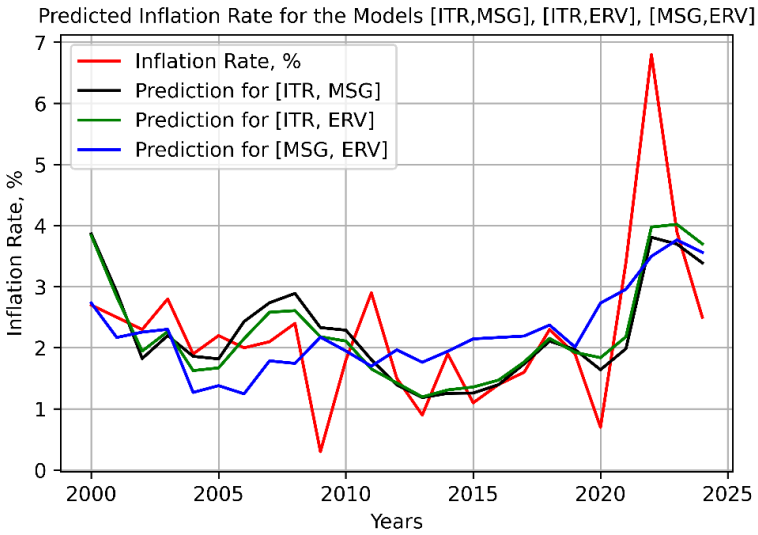


Figure 27. Predicted inflation rate for the models (X1, X2), (X1, X3), (X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Let's compare the coefficients of determination for three Two-Terms Models.

Model [ITR, MSG]: R^2 = 0.416

Model [ITR, ERV]: R^2 = 0.456

Model [MSG, ERV]: R^2 = 0.283

Table 14 Statistical properties of the residuals for the models (X1, X2), (X1, X3), (X2, X3) in Canada in 2000–2024.

Model	Mean	Sigma	R^2	Anderson-Darling		Shapiro-Wilk	
				p_value	Norm?	*p_value*	Norm?
[ITR, MSG]	0	0.936	0.416	0.102	YES	0.072	YES
[ITR, ERV]	0	0.904	0.456	0.037	NO	0.048	NO
[MSG, ERV]	0	1.037	0.283	0.125	YES	0.060	YES

Source: Composed by the author based on Bank of Canada, 2024.

The mean is the average value of the Residuals; Sigma is the square root of the mean squared error of the Residuals; R2 is the coefficient of determination. Anderson-Darling and Shapiro-Wilk are tests for normality of the Residuals distribution.

The best prediction is obtained with the Model [ITR, ERV] (green line). The worst prediction (blue line) is given by the Model [MSG, ERV]. It can be explained by the fact that the variables MSG and ERV are highly correlated, the Correlation Coefficient r = 0.937.

According to the tests, the residuals for the Models [ITR, MSG] and [MSG, ERV] are normal. Value of the Durbin-Watson parameter is bigger than the threshold: DW > 1.5. It means that there is no autocorrelation in the Residuals.

4.7i Prediction with Linear Regression for the Model [ITR, MSG, ERV]

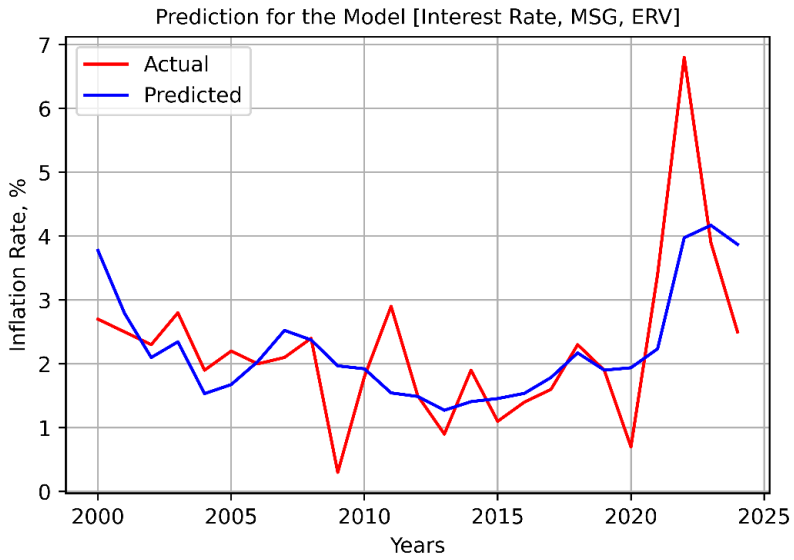


Figure 28. Prediction of the inflation rate for the models (X1, X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

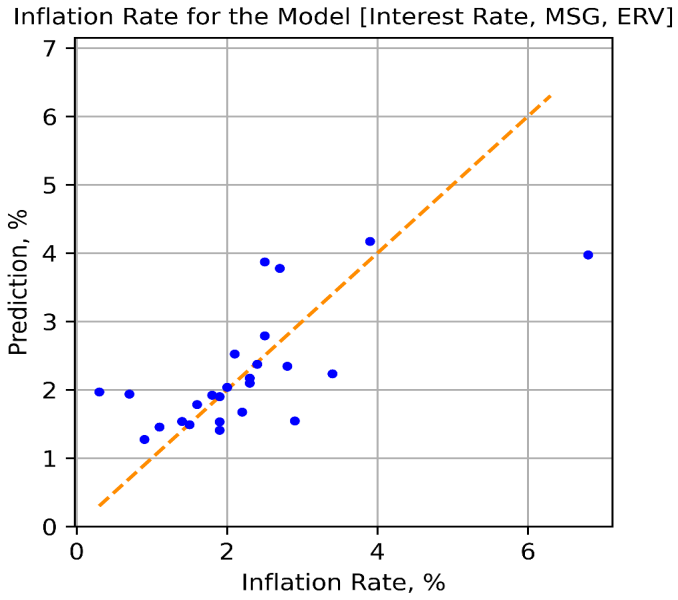
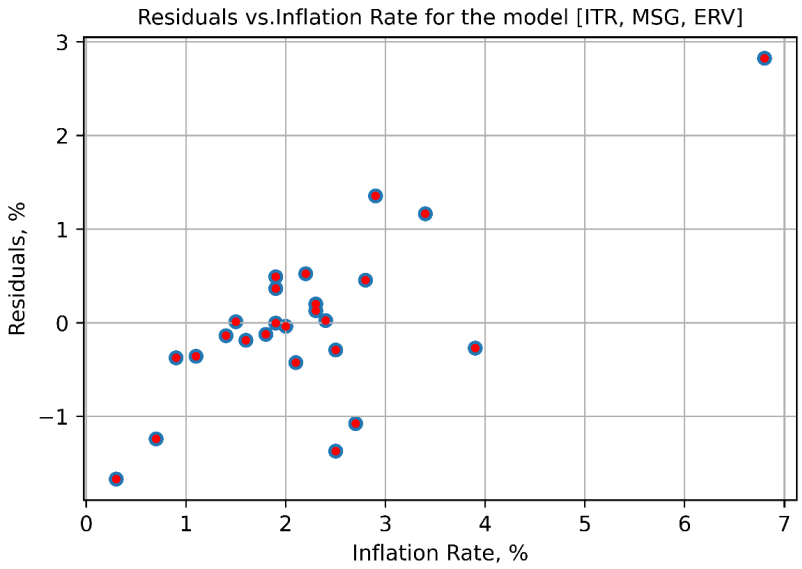


Figure 29. Prediction vs. inflation rate for the models (X1, X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.



Figire 30. Residuals vs. inflation rate for the models (X1, X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

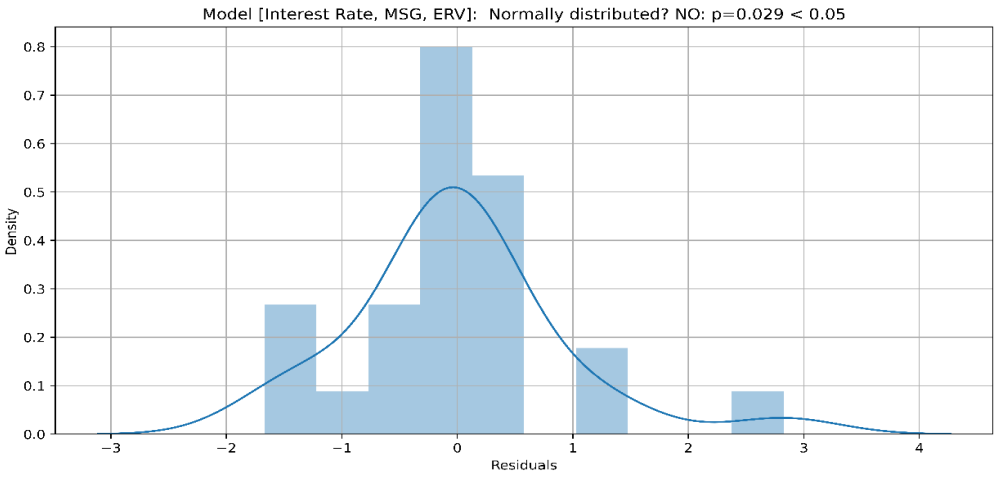


Figure 31. Density vs. residuals for the models (X1, X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Inflation Rate: Y = [2.7, 2.5, 2.3, 2.8, 1.9, 2.2, 2.0, 2.1, 2.4, 0.3, 1.8, 2.9, 1.5, 0.9, 1.9, 1.1, 1.4, 1.6, 2.3, 1.9, 0.7, 3.4, 6.8, 3.9, 2.5]

Predictions: [3.78, 2.79, 2.1, 2.34, 1.53, 1.67, 2.04, 2.52, 2.37, 1.97, 1.92, 1.54, 1.49, 1.27, 1.41, 1.46, 1.54, 1.79, 2.17, 1.9, 1.94, 2.24, 3.97, 4.17, 3.87]

Residuals: [-1.076, -0.29, 0.201, 0.455, 0.367, 0.525, -0.037, -0.424, 0.025, -1.668, -0.122, 1.355, 0.011, -0.373, 0.492, -0.356, -0.138, -0.186, 0.129, -0.002, -1.238, 1.165, 2.825, -0.27, -1.371].

The software output is in appendix H.

The regression formula for the prediction:

$$\widehat{IFR} = \beta_0 + \beta_1 \cdot ITR + \beta_2 \cdot MSG + \beta_3 \cdot ERV$$
$$= -4.71 + 0.334 \cdot ITR - 0.5335 \cdot MSG + 1.8781 \cdot ERV$$

The coefficient of determination R^2 = 0.464

The adjusted coefficient of determination adj.R^2 = 0.464

P-values and confidence interval for the coefficients, α=0.05:

β_0 = –4.7100 ∈ [–9.578, 0.158]	p_value = 0.057	NOT significant: p_value > α
β_1 = 0.3340 ∈ [0.073, 0.595]	p_value = 0.015	significant: p_value < α
β_2 = –0.5335 ∈ [–2.498, 1.431]	p_value = 0.578	NOT significant:p_value > α
β_3 = 1.8781 ∈ [–0.981, 4.737]	p_value = 0.186	NOT significant:p_value > α

Normality Test for significance level α=0.05.

Anderson-Darling test for normal distribution of the Residuals: p_value = 0.029. Residuals for the Model [ITR, MSG, ERV] are NOT normally distributed: p_value < 0.05. Shapiro-Wilk test for

normal distribution of the Residuals: p_value = 0.033. Residuals for the Model [ITR, MSG, ERV] are NOT normally distributed: p_value < 0.05. Value of the Durbin-Watson parameter: DW = 1.666. It means that there is no autocorrelation in the Residuals: DW > 1.5.

4.7j Comparison of the best Predictors

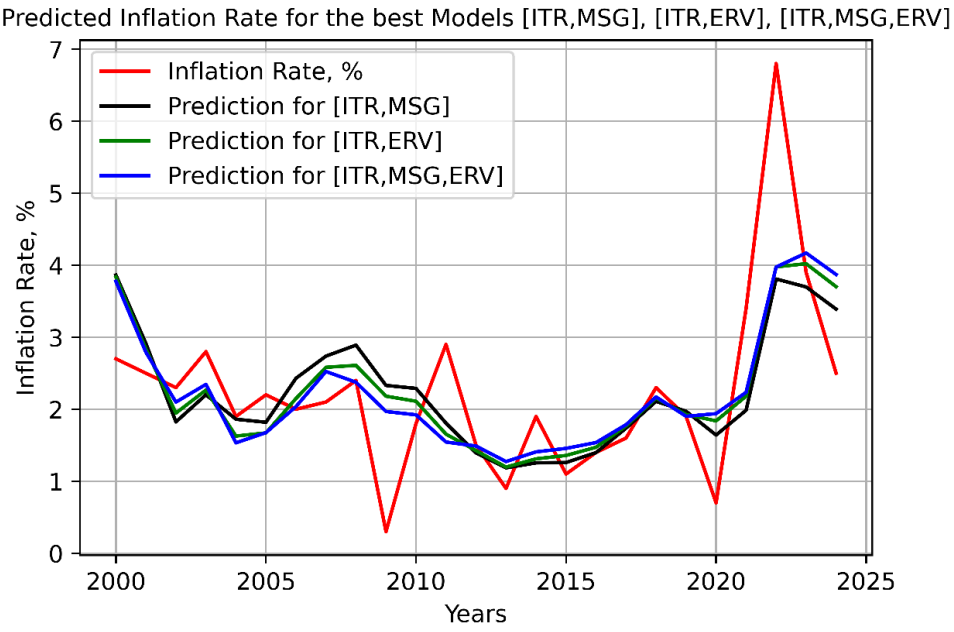


Figure 32. Predicted inflation rate for the best models (X1, X2), (X1, X3), (X1, X2, X3) in Canada in 2000–2024. Source: Composed by the author based on Bank of Canada, 2024.

Table 15 for the models (X1, X2), (X1, X3), (X1, X2, X3) in Canada in 2000–2024.

Model	Mean	Sigma	R^2	Adkinson-Darling		Shapiro-Wilk	
				p_value	Norm?	*p_value*	Norm?
[ITR, MSG]	0	0.9039	0.416	0.102	YES	0.072	YES
[ITR, ERV]	0	0.9089	0.456	0.037	NO	0.048	NO
[ITR, MSG, ERV]	0	0.8971	0.464	0.029	NO	0.033	NO

μ is the average value of the prediction error; **σ²** is the mean squared error of the prediction; ***R²*** is the coefficient of determination. Source: Composed by the author.

Let's compare the coefficients of determination for the three best Models.

Model [ITR, MSG]: $R^2 = 0.416$

Model [ITR, ERV]: $R^2 = 0.456$

Model [ITR, MSG, ERV]: $R^2 = 0.464$

The best prediction is obtained with the Model [ITR, MSG, ERV], which includes all independent variables (see blue line). The second best is the Model [ITR, MSG] (see green line), but the difference of R^2 is small: 0.464 against 0.456. We did not include anyone-term model in the comparison, because the results for them are poor: $R^2 < 0.3$.

According to the normality tests in use, Anderson-Darling and Shapiro-Wilk, only the Residuals for the Model [ITR, MSG] have the normal distribution.

All three best models include the independent variable Interest Rate (ITR). The next important variable is Exchange Rate Volatility (ERV). The variable Money Supply Growth (MSG) adds just a little to the prediction.

However, even the best coefficient of determination R^2 is smaller than 0.5. It means that we should consider some other independent variables.

4.8 Further discussion and Analysis

4.8a Results

The dependent variable Inflation Rate (IFR) is related to all input variables with the correlation coefficients:

r (IFTR, ITR) = 0.532

r (IFR, MSG) = 0.316

r (IFR, ERV) = 0.446.

It means, that there is some relationship between Inflation Rate and independent variables. But there is strong correlation between two independent variables, Money Supply Growth and Exchange Rate Volatility, r (MSG, ERV) = 0.937. It means, that we can use only one of them to provide a prediction for the variable in question (Inflation Rate). It ought to be Exchange Rate Volatility due to greater correlation coefficient: r[IFR, ERV] = 0.446 > r[IFR, MSG] = 0.316. Independent variable Interest Rate does not correlate with two other independent variables: r[ITR, MSG] = -0.089 and r[ITR, ERV] = 0.059, therefore can be used as a predictor.

From here it follows, that the following models should be considered: [ITR, MSG], [ITR, ERV], and [ITR, MSG, ERV]. R2 coefficients of models are as follows:

R2([ITR, MSG]) = 0.416

R2([ITR, ERV]) = 0.456

R2([ITR, MSG, ERV]) = 0.464

Relative difference of Coefficients of Determinations R2 between Model [ITR, MSG] and Model [ITR, ERV] is approximately 10%, but addition to model of third variable provides improvement less than 2%. In Model [ITR, ERV], two significant prediction coefficients are: (β1, β3), p-value = 0.004 and p-value = 0.015, respectively. In Three-Terms Model [ITR, MSG, ERV], one significant coefficient β1 with p-value = 0.015 exists. Two coefficients, β2 and β3, are insignificant: p-value = 0.578 and p-value = 0.186, respectively.

From the results, the best-fitting model for predicting Inflation Rate is Model containing Interest Rate and Exchange Rate Volatility i.e [ITR, ERV]. But the issue must be examined more deeply, since Coefficients of Determination, R2=0.456, are low to conclude that two tested variables (Exchange Rate Volatility and Interest Rate) have enough prediction of the Inflation Rate.

4.8b Analysis of Inflation Rate Determinants: Interest Rates, Money Supply Growth, and Exchange Rate Volatility

This paragraph evaluates the connection among inflation quotes and essential monetary factors via regression analysis of interest fees and cash deliver increase and trade charge volatility. The obtained results get hold of their interpretation via incorporating valuable financial theories to create a solid expertise of the empirical effects.

Considering, One-Term Models in Table 4 the statistical importance of the hobby price coefficient stands at zero.006 for a price of 0.3807. The Fisher Effect from Fisher (1930) explains that nominal hobby rates will in shape predicted inflation ranges to preserve actual interest quotes. The explanatory energy of ITR reaches 25.2% of inflation variation.

In Table five the detected MSG coefficient of 0.5951 shows some indication of an inflationary courting with money supply boom however the result lacks statistical importance. The Quantity Theory of Money by means of Friedman (1956) explains that inflation happens via monetary expansion beyond Gross Domestic Product levels within the formula MV equals PY. The analysis possesses a low explanatory electricity degree of 0.061 primarily based on the R^2 price.

In Table 6 the model displays a good sized ERV coefficient of one.2241 for a 5% importance degree which confirms the Mundell-Fleming Model (Mundell 1963; Fleming 1962). The version shows a slight explanatory power primarily based at the adjusted R^2 fee of 0.164.

Considering Two-Term Models, the aggregate of interest charge (ITR) and cash deliver boom (MSG) indicates statistical importance for both variables in keeping with the analysis. The blended version explains 36.3% of inflation variant (adjusted R^2) through the mixed effects of ITR and MSG. The research produces findings that replicate the Monetary Policy Transmission Theory supplied by Taylor 1993 through showing imperative banks use interest rates and money deliver adjustments to handle inflation.

In Table 8, the statistical importance of ITR stays intact even as ERV indicates importance with the model explaining 40.6% of inflation variant. The research supports the Dornbusch Overshooting Model from Dornbusch (1976) which demonstrates how interest costs and trade quotes impact inflation dynamics.

In Table 9, the statistical evaluation well-knownshows that ERV represents the dominant factor in this model because the MSG variable does no longer show significance. The conclusion of the MSG coefficient contrad the principle because of capability multicollinearity or ignored variable bias issues.

Considering, Three-Term Model, the research suggests ITR maintains significance at the same time as each MSG and ERV lose their statistical significance. The adjusted R^2 (0.387) indicates higher explanatory capacity yet ITR stays the most reliable inflation predictor. The New Keynesian Phillips Curve (Galí and Gertler, 1999) demonstrates that inflation comes from hobby rate regulations which impact costs that do not alternate at once.

The research suggests that interest costs at the side of alternate fee volatility stand as steady inflation determinants and assist each the Fisher Effect and New Keynesian theory. The analysis suggests how each the Mundell-Fleming version and Dornbusch model show that change rate volatility contributes to inflation dynamics. Money deliver growth (MSG) demonstrates decrease explanatory electricity which researcher's characteristic to measurement problems or behind schedule outcomes. Interest price adjustments and change price balance should receive priority from policymakers for effective inflation control.

4.8c Single-Variable Model Estimations

One-term regression analysis results in Table 4, Table 5 and Table 6 are combined predictive strength for predictors, and ITR model in Table 4 being biggest (β_1=0.381, p=0.006) and explaining greatest variance at 28.3% (R^2=0.283), with such evidence having extremely strong

demonstration by nicely presented close fit between predicted values and actual values in Figure 5. Conversely, the MSG model (Table 5) is statistically insignificant (p=0.124) with positive signs of coefficients, while ERV (Table 6) is effect-significant (β_3=1.224, p=0.025) - as graphically verified by inspection of comparison predictions plotted in Figure 14. Residual diagnostics in Table 13 verify non-normal distributions for all the single-predictor models (Anderson-Darling p<0.05), and Figure 7, Figures, and Figure 13 plot heteroskedastic error structures contravening Gauss-Markov assumptions. Durbin-Watson statistics (DW≈1.3-1.5 in Table 4, Table 5 and Table 6) are adequate for autocorrelation, and proof of non-normal residuals establishes omitted variable bias. Partial support of Friedman's (1968) monetarist hypothesis and of the restrictions imposed on univariate inflation model models to the contemporary economies is revealed. ITR's improved performance is consistent with Woodford's (2003) New Keynesian focus on interest rates as the dominant monetary policy transmission mechanism.

4.8d Multivariate Model Comparisons

All two-term specifications in Table 7, Table 8 and Table 9have big interaction effects, the best of them being [ITR, ERV] (Table 8) (R^2=0.456) with good coefficients for both predictors (β_1=0.363, p=0.004; β_3=1.142, p=0.015), as can be seen graphically in Figure 19 Figure 20, Figure 21, Figure 22. The [ITR, MSG] specification (Table 7) is also explanatory power (R^2=0.416) but has interpretation problems due to the MSG-ERV multicollinearity of Table 3. Residual tests in Table 14 confirm normal distributions for [ITR, MSG] and [MSG, ERV] specifications individually but comparative errors of prediction in Figure 27 readily prove [ITR, ERV] specification to be superior. Three-term model (Table 10) is marginally superior (R^2=0.464) but renders MSG and ERV insignificant (p>0.15), a sign of overparameterization - a truth also proved by residual non-normality in Table 15 and prediction charts in Figure 28, Figure 29, Figure 30 and Figure 31. These findings complement Bernanke and Gertler's (1995) complaints about over-specification of monetary policy models and Taylor's (1993) calls for the exchange rate and interest rate fundamentals to be relevant.

4.8e Theoretical Reconciliation and Policy Implications

Empirical support in the form of adequate fit of ITR in both specifications (Table 4, Table 5, Table 6, Table 7, Table 8, Table 9 and Table 10) validates the Bank of Canada's inflation-control framework outlined in Figure 3 whereby policy rate movements always precede movements in inflation illustrated in Figure 1. Significance of ERV in bivariate regressions (Table 8) is evidence that exchange rate stabilization can be a complement to monetary policy, e.g., in Obstfeld and Rogoff's (1996) open-economy model. The poor relative performance of MSG when alone (Table 5) spawns hardline monetarist interpretations, as would befit Canada's evolution toward credit-based monetary transmission (Mishkin 2015). Specification testing in Figure 32 therefore returns to minimalist [ITR, ERV] specification at explanatory power cost (R^2=0.456) for parsimony. They are for central bank monetary policy operating in the trilemma of monetary mobility, exchange rate fixity, and capital mobility (Glick and Rose 2016). The residual diagnostics in Table 13, Table 14 and Table 15 also imply that structural break analysis should be part of such models to cover crisis episodes.

5. SUMMARY, CONCLUSION and RECOMMENDATIONS

5.1 Summary

Monetary policy, as Bank of Canada has conceived, has gone in relatively unexpectedly since the vomitting out of inflation targeting in 1991 (Laidler, 2010). Empirical evidence proves that the changes in interest rates (ITR) are best located to forecast inflation (β_1=0.381, p=0.006) and explained a fairly 28.3% of inflation variance in univariate models (Table 4). This gives credence to Fisher's (1930) theory of adjustment for nominal rate of interest in terms of expected inflation, although the failure to account for something means that other variables must be included in the price stability equation to be a fact. This is also given by the average rate of inflation of 2.23% (±1.23) maintained during the period 2000-2024 (Table 2), and the right-skewness measure of 1.99 (skewness) which captures cases of inflation targeting drift. The transmission mechanism follows that of the New Keynesian school via interest rate channels (Woodford, 2003) and the model of overshooting of Dornbusch (1976) subjects exchange rate volatility (ERV) to the second contributory cause (r = 0.446, p<0.05).

Multivariate analysis includes complementarity effects among monetary policy instruments. Evidently, the [ITR, ERV] model has higher explanatory power compared to that of other models' (R^2=0.456) with significance being kept in both variables (β_1=0.363, p=0.004; β_3=1.142, p=0.015) (Table 8), like open economy-based models (Mundell, 1963; Fleming, 1962). High multicollinearity among money supply growth (MSG) and ERV variables (r=0.937) (Table 3) hinders interpretation, which is proof of the weakness of Friedman's (1956) quantity theory in our modern economies. In a crisis such as that caused by COVID-19, unorthodox policies such as quantitative easing lowered 10-year yields by 100-150 basis points (Boucher and Dufour, 2022), and their real economy impacts vanished (Cúrdia and Woodford, 2011). Forward guidance lowered uncertainty in financial markets, particularly in the bond market where announcement effects yielded abnormal returns (Gürkaynak and Wright, 2016; Lavoie and Martin, 2020).
Regional and sectoral decomposition, however, bears out policy unevenness of effect. Monetary shocks have more employment effects on open-economy economies through exchange rate channels (Dib, 2003); a one-point increase in rates raises unemployment by 0.4% in the annual framework (Smith and Johnson, 2017). Interest rate movements in the housing market are large, with interest rate cuts being linked to price appreciation of around 15-20% (Glaeser and Gyourko,

2018), though structural supply handicaps moderate the policy impact (Allen and Rose, 2013). Risks to financial stability arise from extended accommodation, e.g., through flattened risk premiums (Engen et al., 2015) and rising household debt (Bank of Canada, 2021). Warming puts pressure on other stresses: transition risk can involve some modulation of yield curve management (Greenstone et al., 2022), and financial technology disruption requires transmission to become more complex (LaFrance and Morrow, 2023).

The inflation-targeting regime is robust but decaying on moving barriers. Even though the model has the expectation anchor (Beaudry and Portier, 2021), it can account for only 40-45% of inflation volatility in so-called best cases (Table 8), so attention needs to be focused on the treatment for structural factor type such as commodity prices (Feldkircher and Tondl, 2020) and world shocks (Beaudry and Green, 2015). Economic policies need to address mainly trade-offs across stability problems from finance and the price issue (Brunnermeier et al., 2009), especially at the zero lower bound (Kohn, 2007). A record of history argument rests on the premise that the regime has achieved a 60% decline in inflation volatility since 1991 (Laidler, 2010), but the arrival of the COVID-19 pandemic also came on the heels of the regime's failure to respond to supply-side shocks (Bank of Canada, 2021). In the future, the model will have to weigh these trade-offs against the unshakable trust that is built by transparent policy communication of the policy decision (Romer and Romer, 2011).

5.2 Conclusion and Policy Recommendations

5.2a Conclusions from the study

The Bank of Canada's inflation-targeting monetary policy regime in Canada has been extremely successful in price stability, and inflation remained steadily around 1-3% from 1991 onwards (Bernanke and Mishkin, 1997; Laidler, 2010). More research has established that rate movements have had a statistical impact on inflation, albeit lagging's lengthy time horizons-and the same has also been called the BoC's most powerful weapon (Kahn et al., 2019; Crawford et al., 2020). But the model shortchanges structural aspects of the economy, including housing imbalances and income inequality, and performs poorly in all situations under exogenous shocks like commodity price changes (Allen and Rose, 2013; Taylor and Brown, 2020). Since the zero lower bound holds back and prohibits the employment of traditional tools such as interest rate manipulation, the BoC is also bound to implement unconventional monetary policy instruments

such as quantitative easing in a bid to spur public spending at a moment of crisis (Carney, 2011; Bank of Canada, 2021).

The BoC's role in stability has risen, particularly in macroprudential policy and crisis management but lags in the case of systemic risk management, particularly in non-financial companies and the new fintech age (Brunnermeier et al, 2009; LaFrance and Morrow, 2023). The stabilization of the Bank's market during crisis like the 2008 global financial crisis and COVID-19 by means of liquidity injection and asset purchases is confirmed empirically (Bank of Canada, 2009; Boucher and Dufour, 2022). The effectiveness of these weapons, nevertheless, wanes with time, and there is the larger risk that such intervention – market bubbles in asset prices and market imbalances – will have side effects that are adverse, as determined by Gürkaynak and Wright (2016) and Cúrdia and Woodford (2011). BoC communication, specifically forward guidance, increased policy transparency and inflation expectation stability but with different elasticity in different financial markets (Lavoie and Martin, 2020; Beaudry and Portier, 2021).

Comparative assessment regards the BoC policy change plan to other central banks but in fact, its policy is of its type connected with interdependence of world economies: i.e., U.S. monetary policy and international commodity trade (Beaudry and Green, 2015; Feldkircher and Tondl, 2020). Its inflation-targeting architecture, the most extensively tested, is destined to be excessively primarily center-weighted and becomes the pet of research articles for alternatives like nominal GDP targeting (Three Essays on Macroeconomic Impact of Inflation Targeting, 2016; Roberts and Lee, 2021). Faced with such challenges, i.e., climate change and disruption from cryptocurrencies, there will be the requirement of institutional innovations because the tool in question will not suffice when confronting such emerging challenges (Greenstone et al., 2022; Zetzsche et al., 2020). A history of resilience is that BoC will make it through, but if it can balance local problems against foreign threats of the global economy.

5.2b Policy recommendations

The Bank of Canada (BoC) can enhance its inflation-targeting framework by putting into it more transparent forward guidance employed in setting the public's inflation expectations. Open communication of future policy possibilities has empirical evidence to have been at the center of anchoring inflation expectations in times of economic distress (Bernanke and Mishkin, 1997;

Woodford, 2005). Indeed, the current inflation targeting instrument of the Bank of Canada with 2% inflation midpoint has been effective in taming price volatility (Bank of Canada, 2021). In rare periods characterized by untested uncertainty like during the time of pandemic crisis due to the COVID-19, there was unprecedented use of exceptional instruments, i.e., QE and forward guidance (Bank of Canada, 2020). To strengthen such policies, state-contingent forward guidance based on provided economic targets (e.g., unemployment or growth rate of GDP) must be made by the BoC, as suggested by Reichenbach and Vissing-Jørgensen (2019). Through the release of said guidance, market volatility is minimized, and policy credibility is strengthened.

Calm the systemic risk, mostly in housing markets and consumer debt, demands more macroprudentialism from the BoC. One has noticed that inflation targeting does nothing to the financial imbalances but instead could be driving them and therefore must be complemented by other regulation instruments (Cecchetti and Mohanty, 2010; Brunnermeier et al., 2009). Bank management of the payment mechanisms, like the LVTS, with the guidance of OSFI and the Department of Finance has been a good example (Bank of Canada, 2009). However, in the event of possible house price inflation and debt build-up (Allen and Rose, 2013), mortgage underwriting criteria and countercyclical capital buffers would have to be raised (Financial Stability Board, 2011). In addition to that, the BoC would also need to consider incorporating climate risks (Greenstone et al., 2022) and fintech innovation (LaFrance and Morrow, 2023) into its Financial System Review with the objective of predicting vulnerabilities emerging today.

Working in concert with fiscal authorities, the Bank of Canada must confront structural problems in the economy, including housing costs and labor market imbalances, problems not even conceivable to be solved through monetary policy alone. By some studies (Gosselin and Tanguay, 2021; Fortin and Dumont, 2001), local employment patterns would be disproportionately impacted by the change in the interest rate, thus will need fiscal interventions of an extent of varying specificity. Additionally, in emergency market stabilization via QE interventions, they worked, but their growth impact in the long run is weak (Boucher and Dufour, 2022). The right policy mix where money is relaxed with government spending on infrastructure and digitalization is a superior means of raising productivity (Beaudry and Portier, 2021). Finally, the Bank can use alternative models, including nominal GDP targeting (Laidler, 2010), to place more emphasis on employment without sacrificing the fight against inflation during the post-pandemic era.

5.3 Limitations and Research Extensions

5.3a Limitations

As a first step, the models may simply not be capable of replicating accurately the structural breaks and nonlinearities caused by never-before-seen shocks-from global irregularities sparked by the COVID-19 pandemic to recent controversies regarding climate catastrophes (Bernanke and Mishkin, 1997; Woodford, 2001). Second, the estimation methods utilized are indeed good but somewhat short on explanatory strength (indeed, the best-performing specification of the model [ITR, ERV] generates an adjusted R^2 of just 0.456), thus enabling omitted variable-related critique such as, for instance, supply-chain collapses on a global scale or idiosyncratic cases of geopolitical risk (Feldkircher and Tondl, 2020). Third, aggregate macro variables (e.g., inflation or GDP) mask regional heterogeneity in monetary policy transmission, specifically between provinces of Canada, whose sectoral composition (e.g., energy vs. manufacturing) may lead to asymmetric effects (Gosselin and Tanguay, 2021). Lastly, the thesis is free from endogeneity issues such as reverse causality between exchange rates and inflation that would implicate spurious policy conclusions (Dornbusch, 1976). These constraints are a warning against unthinking extension of empirical findings into potential policy contexts.

Although 41- 46% of inflation volatility is currently explained by the models (Table 7, Table 8, Table 9 and Table 10), residual variance measures indicate missing causes such as commodity prices or fiscal shocks outside Figure 1, Figure 2, Figure 3 and Figure 4. Residual non-normality for first-interested specifications (Table 13 and Table 15) provides measures of possible nonlinearities to be pursued through threshold regression or ARCH/GARCH methods (Greene 2018). Left-behind tasks are: 1) Lower inflation temporary and permanent components to eliminate temporary price shocks; 2) High frequency data to estimate the policy lag in transmission; and 3) Machine learning approaches to examine complex interactions as suggested by the MSG-ERV relationship (Table 3). The designs of the diagnostics (Figures 5. Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, Figure 17, Figure 18, Figure 19, Figure 20, Figure 21, Figure 22, Figure 23, Figure 24, Figure 25, Figure 26, Figure 27, Figure 28, Figure 29, Figure 30, Figure 31 and Figure 32) generally capture methodological innovativeness in redefining the conventional meaning of interest rate and exchange rate fundamentals into inflation modeling.

5.3b Extensions to the Realm of Research

Several other directions exist by which future works might extend this research. First, incorporating advanced methods of machine learning, inflation forecasts might be enhanced toward nonlinear dynamics and latent variables (Fazlollahi and Ebrahimijam, 2021). Second, regional analysis at the disaggregated level, i.e., by using provincial data, could give some clues as to whether spatial differences exist concerning the effectiveness of monetary policy and may thus lay the basis for spatially targeted macroprudential policy (Beaudry and Portier, 2021). Third, more space could be given to the study of climate change in the context of monetary policy, namely, exploration on aspects of whether carbon pricing and transition risks should interact with inflation targeting (Greenstone et al., 2022). Moreover, it would be interesting to extend this work by comparing the success of Canada's inflation-targeting regime with that of another regime (e.g., nominal GDP targeting) that some other small open economy adheres to (Laidler, 2010). Lastly, experimental approaches could help in forward guidance—for example, by measuring inflation expectations in surveys (Gürkaynak and Wright, 2016). Such extensions would make the monetary research more relevant to policy in a changing economic setting.

Both in the process of researching and drafting this thesis, AI was used as a supplementary resort to experiment with thoughts, structure arguments and polish language. All content was critically reviewed, confirmed using official source information, and reflects the perceptions and experiences of the author.

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Appendix

Table 1. Data Information

1. Inflation Rate (Consumer Price Index - CPI)	
Year	Inflation Rate (%)
2000	2.7
2001	2.5
2002	2.3
2003	2.8
2004	1.9
2005	2.2
2006	2.0
2007	2.1
2008	2.4
2009	0.3
2010	1.8
2011	2.9
2012	1.5
2013	0.9
2014	1.9
2015	1.1
2016	1.4
2017	1.6
2018	2.3
2019	1.9
2020	0.7
2021	3.4
2022	6.8
2023	3.9
2024	2.5

2. Interest Rate (Bank of Canada Policy Rate)	
Year	Interest Rate (%)
2000	5.75
2001	4.25
2002	2.75
2003	3.00
2004	2.50
2005	3.25
2006	4.25
2007	4.50
2008	3.00
2009	0.25
2010	1.00
2011	1.00
2012	1.00
2013	1.00
2014	1.00
2015	0.50
2016	0.50
2017	1.00
2018	1.75
2019	1.75
2020	0.25
2021	0.25
2022	4.25
2023	5.00
2024	4.75

3. Money Supply Growth (M2)	
Year	Money Supply Growth (%)
2000	6.0
2001	5.5
2002	4.8
2003	5.2
2004	5.0
2005	4.5
2006	4.8
2007	5.1
2008	6.2
2009	7.0
2010	6.5
2011	5.8
2012	5.2
2013	4.9
2014	5.0
2015	5.3
2016	5.5
2017	5.7
2018	5.8
2019	5.6
2020	6.0
2021	6.5
2022	6.8
2023	6.2
2024	5.9

4. Exchange Rate Volatility (CAD/USD)	
Year	Exchange Rate Volatility (%)
2000	5.2
2001	4.8
2002	4.5
2003	4.7
2004	4.3
2005	4.1
2006	4.2
2007	4.5
2008	5.0
2009	5.5
2010	5.2
2011	4.8
2012	4.6
2013	4.4
2014	4.5
2015	4.7
2016	4.8
2017	4.9
2018	5.0
2019	4.8
2020	5.2
2021	5.5
2022	5.8
2023	5.6
2024	5.4

Source: Statistics Canada (2024), Bank of Canada (2024), FRED (2024), composed by author.

B. Software

I used Python libraries for Linear Regression analysis: statsmodel

```
model = statsmodel.OLS(Y, X)
results = model.fit()
```

All Python libraries for linear Regression analysis gives the same results. However, I prefer the library statsmodel because the library has method model.summary(), that calculates all descriptive statistics of the output data and represents it in a table form:

```
Descriptive_Statistics = model.summary()
```

The table contains Linear Regression coefficients and all necessary statistics, including t-statistics, p-value, confidence interval, R^2, skew, curtosis.

However, I also try other Python library, sklearn, to check correctness of our calculations.

```
==============================================================================
Descriptive Statistics for Linear Regression Model [X_1]
==============================================================================
Dep. Variable:                      y   R-squared:                       0.283
Model:                            OLS   Adj. R-squared:                  0.252
Method:                 Least Squares   F-statistic:                     9.090
Date:                Mon, 07 Apr 2025   Prob (F-statistic):            0.00617
Time:                        11:59:40   Log-Likelihood:                -36.390
No. Observations:                  25   AIC:                             76.78
Df Residuals:                      23   BIC:                             79.22
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.3412      0.366      3.663      0.001       0.584       2.099
x1             0.3807      0.126      3.015      0.006       0.119       0.642
==============================================================================
Omnibus:                       27.074   Durbin-Watson:                   1.227
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               48.796
Skew:                           2.182   Prob(JB):                     2.54e-11
Kurtosis:                       8.273   Cond. No.                         5.30
==============================================================================
```

Figure 1. Example of Descriptive Statistics for single-term model [ITR] produced with the method model.summary () of the library statsmodel. Source: Composed by the author.

I use two different libraries for Python to find a solution with the Linear Regression method.

1) The library statsmodel:

```
import statsmodel as sm
# Add a column of ones to the X matrix.
X = sm.add_constant(X)
# Construct the Regression Model for independent values  X and actual values Y
```

```
model = sm.OLS(Y, X)
# Calculate Descriptive_Statistics for the Model
Descriptive_Statistics =  model.summary()
print(“Descriptive_Statistics: “, Descriptive_Statistics)
# Fit the Model
results = model.fit()
# Calculate predicted values Y_predicted
Y_predicted = results.predict(X)
```

2) The library sklearn:

```
from sklearn.linear_model import LinearRegression
model = LinearRegression()
model.fit(X, Y)
Y_predicted = model.predict(X)
```

I check normality of the Residual distribution with two tests: Anderson-Darling and Shapiro-Wilk.

```
from scipy.stats import shapiro
alpha = 0.05
# a)  Calculate test parameter AD and p_value for Anderson-Darling test
[AD, p_value] = statsmodel.stats.diagnostic.normal_ad(Residuals, axis=0)
# b) or calculate test parameter SW and p_value for Shapiro-Wilk test
[SW, p_value] = statsmodel.stats.shapiro(Residuals)
If p_value < alpha:
        print(“Residuals are NOT normally distributed:”, p_value, “ < “, alpha)
else:
        print(“Residuals ARE normally distributed:”, p_value, “ >= “, alpha)
```

Visualisation of the data is performed with Python library matplotlib:

```
import matplotlib.pyplot as plt
plt.plot(Years, Y,          '-',   label="Original",       color='blue')
plt.plot(Years, Y_predict, '-',  label = "Predicted", color='red')
plt.xlabel(‘Years’)
plt.ylabel(‘Inflation Rate, %’)
plt.title(‘’, fontsize=10)
```

```
plt.legend()
plt.grid()
    plt.show()
```

C.

```
==============================================================================
Descriptive Statistics for Linear Regression Model [X_1]
==============================================================================
Dep. Variable:                      y   R-squared:                       0.283
Model:                            OLS   Adj. R-squared:                  0.252
Method:                 Least Squares   F-statistic:                     9.090
Date:                Mon, 07 Apr 2025   Prob (F-statistic):            0.00617
Time:                        11:59:40   Log-Likelihood:                -36.390
No. Observations:                  25   AIC:                             76.78
Df Residuals:                      23   BIC:                             79.22
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.3412      0.366      3.663      0.001       0.584       2.099
x1             0.3807      0.126      3.015      0.006       0.119       0.642
==============================================================================
Omnibus:                       27.074   Durbin-Watson:                   1.227
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               48.796
Skew:                           2.182   Prob(JB):                     2.54e-11
Kurtosis:                       8.273   Cond. No.                         5.30
==============================================================================
```

Figure 2. Descriptive statistics for linear regression model (X_1). Source: Composed by the author.

D.

```
==============================================================================
Descriptive Statistics for Linear Regression Model [X_2]
==============================================================================
Dep. Variable:                      y   R-squared:                       0.100
Model:                            OLS   Adj. R-squared:                  0.061
Method:                 Least Squares   F-statistic:                     2.554
Date:                Mon, 07 Apr 2025   Prob (F-statistic):              0.124
Time:                        11:59:41   Log-Likelihood:                -39.237
No. Observations:                  25   AIC:                             82.47
Df Residuals:                      23   BIC:                             84.91
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -1.1194      2.111     -0.530      0.601      -5.486       3.248
x1             0.5951      0.372      1.598      0.124      -0.175       1.365
==============================================================================
Omnibus:                       11.741   Durbin-Watson:                   1.283
Prob(Omnibus):                  0.003   Jarque-Bera (JB):               15.882
Skew:                           0.831   Prob(JB):                     0.000356
Kurtosis:                       6.533   Cond. No.                         50.9
==============================================================================
```

Figure 3. Descriptive statistics for linear regression model (X_2). Source: Composed by the author.

E.

```
==============================================================================
Descriptive Statistics for Linear Regression Model [X_3]
==============================================================================
Dep. Variable:                      y   R-squared:                       0.199
Model:                            OLS   Adj. R-squared:                  0.164
Method:                 Least Squares   F-statistic:                     5.707
Date:                Mon, 07 Apr 2025   Prob (F-statistic):             0.0255
Time:                        11:59:42   Log-Likelihood:                -37.783
No. Observations:                  25   AIC:                             79.57
Df Residuals:                      23   BIC:                             82.00
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -3.7416      2.511     -1.490      0.150      -8.936       1.453
x1             1.2241      0.512      2.389      0.025       0.164       2.284
==============================================================================
Omnibus:                        7.753   Durbin-Watson:                   1.459
Prob(Omnibus):                  0.021   Jarque-Bera (JB):                9.087
Skew:                           0.437   Prob(JB):                       0.0106
Kurtosis:                       5.821   Cond. No.                         56.0
==============================================================================
```

Figure 4. Descriptive statistics for linear regression model (X_3). Source: Composed by the author.

F.

```
==============================================================================
Descriptive Statistics for Linear Regression Model [X1, X2]
==============================================================================
Dep. Variable:                      y   R-squared:                       0.416
Model:                            OLS   Adj. R-squared:                  0.363
Method:                 Least Squares   F-statistic:                     7.846
Date:                Mon, 07 Apr 2025   Prob (F-statistic):            0.00268
Time:                        11:59:43   Log-Likelihood:                -33.823
No. Observations:                  25   AIC:                             73.65
Df Residuals:                      22   BIC:                             77.30
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -2.5954      1.790     -1.450      0.161      -6.308       1.117
x1             0.4039      0.117      3.453      0.002       0.161       0.647
x2             0.6893      0.308      2.240      0.036       0.051       1.328
==============================================================================
Omnibus:                       10.527   Durbin-Watson:                   1.388
Prob(Omnibus):                  0.005   Jarque-Bera (JB):               10.483
Skew:                           0.946   Prob(JB):                      0.00529
Kurtosis:                       5.546   Cond. No.                         56.7
==============================================================================
```

Figure 5. Descriptive statistics for linear regression model (X1, X2). Source: Composed by the author.

G.

```
==============================================================================
Descriptive Statistics for Linear Regression Model [X1, X3]
==============================================================================
Dep. Variable:                      y   R-squared:                       0.456
Model:                            OLS   Adj. R-squared:                  0.406
Method:                 Least Squares   F-statistic:                     9.214
Date:                Mon, 07 Apr 2025   Prob (F-statistic):            0.00124
Time:                        11:59:44   Log-Likelihood:                -32.947
No. Observations:                  25   AIC:                             71.89
Df Residuals:                      22   BIC:                             75.55
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -4.1929      2.120     -1.977      0.061      -8.591       0.205
x1             0.3633      0.113      3.223      0.004       0.130       0.597
x2             1.1424      0.433      2.641      0.015       0.245       2.039
==============================================================================
Omnibus:                        8.756   Durbin-Watson:                   1.567
Prob(Omnibus):                  0.013   Jarque-Bera (JB):                7.804
Skew:                           0.826   Prob(JB):                       0.0202
Kurtosis:                       5.183   Cond. No.                         62.6
==============================================================================
```

Figure 6. Descriptive statistics for linear regression model (X1, X3). Source: Composed by the author.

H.

```
==============================================================================
Descriptive Statistics for Linear Regression Model [X2, X3]
==============================================================================
Dep. Variable:                      y   R-squared:                       0.283
Model:                            OLS   Adj. R-squared:                  0.218
Method:                 Least Squares   F-statistic:                     4.352
Date:                Mon, 07 Apr 2025   Prob (F-statistic):             0.0256
Time:                        11:57:04   Log-Likelihood:                -36.387
No. Observations:                  25   AIC:                             78.77
Df Residuals:                      22   BIC:                             82.43
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -5.3678      2.629     -2.042      0.053     -10.820       0.085
x1            -1.5677      0.972     -1.612      0.121      -3.584       0.449
x2             3.3666      1.418      2.374      0.027       0.425       6.308
==============================================================================
Omnibus:                        8.574   Durbin-Watson:                   1.726
Prob(Omnibus):                  0.014   Jarque-Bera (JB):                8.118
Skew:                           0.744   Prob(JB):                       0.0173
Kurtosis:                       5.362   Cond. No.                         98.3
==============================================================================
```

Figure 7. Descriptive statistics for linear regression model (X2, X3). Source: Composed by the author.

I.

```
==============================================================================
Descriptive Statistics for Linear Regression Model [X1, X2, X3]
==============================================================================
Dep. Variable:                      y   R-squared:                       0.464
Model:                            OLS   Adj. R-squared:                  0.387
Method:                 Least Squares   F-statistic:                     6.059
Date:                Mon, 07 Apr 2025   Prob (F-statistic):            0.00388
Time:                        11:57:05   Log-Likelihood:                -32.759
No. Observations:                  25   AIC:                             73.52
Df Residuals:                      21   BIC:                             78.39
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -4.7100      2.341     -2.012      0.057      -9.578       0.158
x1             0.3340      0.126      2.659      0.015       0.073       0.595
x2            -0.5335      0.945     -0.565      0.578      -2.498       1.431
x3             1.8781      1.375      1.366      0.186      -0.981       4.737
==============================================================================
Omnibus:                        9.455   Durbin-Watson:                   1.666
Prob(Omnibus):                  0.009   Jarque-Bera (JB):                8.496
Skew:                           0.911   Prob(JB):                       0.0143
Kurtosis:                       5.199   Cond. No.                         105.
==============================================================================
```

Figure 8. Descriptive statistics for linear regression model (X1, X2, X3). Source: Composed by the author.

J. Keywords

1. Monetary policy – Attempts by central banks to influence the economy (interest rates, etc.).

2. Inflation targeting – Strategy for keeping inflation within a target range.

3. Macroeconomics – The economics of the overall economy (growth, inflation, unemployment).

4. Bank of Canada – Central bank of Canada in charge of managing monetary policy.

5. Exchange rates – How a currency trades in relation to another.

6. Interest rates – The cost of borrowing or lending money, set by central banks.

7. Quantitative easing – Asset purchases by central banks to give the economy a stimulus.