Shifting Macroeconomic Tides: Investigating the Impact of Interest Rate Uncertainty on the Canadian Economy.

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March 26, 2024

Over the past fifteen years, in the wake of the seismic disruptions caused by the 2008 financial crisis and the COVID-19 pandemic, profound shifts in global monetary policy have led to elevated levels of interest rate uncertainty. This study utilizes a VAR – X Model to investigate the repercussions of interest rate uncertainty on the Canadian economy. Focusing on the 1985 to 2023 period, I use the quarterly volatility in daily returns for three-month Canadian treasury bills as a proxy for interest rate uncertainty. My findings suggest that increases in interest rate uncertainty have a negative effect on Gross Domestic Product, with more uncertain effects on capital accumulation, interest rate levels, and inflation.

Keywords: Interest Rates, Macroeconomic Fluctuations, Uncertainty, Canada

JEL Classifications: E44; E50

1 Introduction

“The Federal Reserve’s experiences over the past two decades make it clear that uncertainty is not just a pervasive feature of the monetary policy landscape, it is the defining characteristic of that landscape.” — Alan Greenspan 2004

In the midst of the shifting macroeconomic tides of the 21st century, a period marked by unprecedented events such as the 2008 financial crisis and the COVID-19 pandemic, there has been a substantial surge in academic interest in the economic dynamics of uncertainty. Most of the theoretical and empirical work focused on this topic primarily originates from the premise that uncertainty can exert a significant influence on real economic activity. This influence is predicated on the idea that heightened uncertainty may prompt firms to delay their investment decisions—a phenomenon known in the literature as the ”option value of waiting” channel (Leduc and Liu 2016). Despite previous efforts, given that the majority of research on this topic has been centered primarily on the United States, much remains to be explored in the realm of monetary policy uncertainty and its connections to broader economic dynamics.

Hence, a line of work focused on evaluating the impact of monetary policy uncertainty in the Canadian economy is yet to be established. Furthermore, Istrefi and Mouabbi (2016), the lone paper that provides some insight into the impact of interest rate uncertainty in Canada, relies solely on a survey-based proxy to measure uncertainty. This knowledge gap calls for a nuanced exploration into the impact of interest rate uncertainty within the Canadian context, which is the central focus of this paper. To address this gap, this paper is going to use the quarterly volatility in daily returns for three-month Canadian treasury bills as a proxy for interest rate uncertainty in order to evaluate the impact of interest rate uncertainty on gross domestic product, fixed capital formation, inflation, as well as short-term interest rates. The rest of the paper is organized as follows. Section 2 reviews the background on interest rate uncertainty in terms of the driving forces that have led to the current high-uncertainty environment. Section 3 is divided into three subsections as follows: Section 3.1 discusses the impact of uncertainty in the economy, followed by a discussion on uncertainty indicators in Section 3.2, and a discussion on uncertainty transmission channels in Section 3.3. Section 4 presents the conceptual framework of my research, whereas Section 5 provides an exposition of the sources from which empirical evidence for the study is derived. Section 6 offers an in-depth analysis of my findings, and Section 7 concludes.

2 Background

Prior to the COVID-19 pandemic, Canada, in tandem with other developed economies such as the United States, Japan, and Germany, was in a relatively low-interest rate environment, with short-term and long-term interest rates all being kept within the 1 percent to 3 percent range during the period 2012 to 2020 (see Figure 1 in the Appendix). However, with the onset of the COVID-19 pandemic, Canada quickly found itself exposed to a series of supply and demand shocks, which reverberated through its economy in overlapping waves. Ultimately, the convergence of supply chain bottlenecks, labor shortages, health-related restrictions, and government deficits, coupled with the Bank of Canada's adoption of a near-zero interest rate monetary policy approach, contributed to the emergence of persistent and heightened levels of inflation. As the COVID-19 pandemic gradually came under control, a remarkable policy reversal took place, with massive interest rate hikes being implemented as part of an overarching strategy to reign on inflationary pressures. This juxtaposition of rapid interest rate reductions followed by unprecedented increases has ushered in an era of heightened interest rate uncertainty.

The current environment has the potential to create disruptions and friction within the economic framework. The uncertainty surrounding the trajectory of interest rates is particularly impactful given the prolonged period of historically low rates. Businesses and households, having adapted to an environment of cheap credit, now face the challenge of adjusting to a new era of increasing interest rates. This abrupt change introduces an element of unpredictability, as economic agents must re-calibrate their expectations and strategies in response to evolving interest rate dynamics. Consequently, exploring the impact of interest rate uncertainty investment on the Canadian economy becomes a critical avenue of research.

3 Related Literature

Within this broader framework of understanding interest rate uncertainty's macroeconomic implications, several key themes have emerged as central focal points of research. The first significant theme revolves around identifying the most suitable proxies for measuring interest rate uncertainty, with survey-based, keyword frequency-based, and market volatility proxies being researched extensively. In addition to that, the second fundamental theme in this research area focuses on investigating the impact of interest rate uncertainty on the economy. Scholars have primarily concentrated on assessing the repercussions of interest rate uncertainty on various economic indicators such as investment, production, employment, and prices. The final major theme within the realm of research on this topic has to do with the primary channels through which monetary policy uncertainty influences the real economy. Various theoretical frameworks, such as the real option theory, the financial friction theory, and the precautionary saving theory, stand out as potential explanations for the transmission mechanisms

3.1 Impact of Uncertainty

While different researchers employ different methods when it comes to estimating interest rate uncertainty, most of them find very similar results when it comes to the impact that changes in interest rate uncertainty have on the real economy. Focusing on the United States, Qadan, Shuval, and David (2023), who use a VIX-style measure of forward-looking volatility about Treasury yields, find that greater levels of uncertainty about interest rates is linked to contractions in industrial output, retail trade, as well as elevated unemployment figures within the United States. These results are similar to the results of Bretscher et al. (2018) who find that for one standard deviation change in interest rate uncertainty in the United States results in a 52 billion drop in aggregate investment. Similarly, Istrefi and Mouabbi (2016), who use a survey-based proxy of interest rate uncertainty, also observe that shocks to interest rate uncertainty are recessionary as they increase unemployment, while also reducing production and prices.

3.2 Uncertainty Indicators

Just like it was mentioned earlier, another prominent theme in the research on interest rate uncertainty pertains to the identification of the most suitable proxy for measuring interest rate uncertainty. These proxies include subjective measures obtained through surveys, keyword frequency counts in newspapers, as well as volatility metrics derived from the stock market. Among these, the survey-based approach stands out as an increasingly preferred method for capturing uncertainty. One frequently employed survey-based proxy for uncertainty in the measure of disagreement among forecasters (Rich and Tracy 2010; Dovern et al. 2012). As noted by Istrefi and Mouabbi (2016), this approach is based on the notion that greater disagreement among forecasters correlates positively with heightened uncertainty.

Nevertheless, it is worth noting that some known limitations are associated with using disagreement among forecasters as a proxy for uncertainty. It has been argued that disagreement among forecasters may be more reflective of differences in opinion among forecasters rather than a true measure of uncertainty (Diether et al. 2002). Lahiri and Sheng (2010) provide further support to this point and note that the reliability of disagreement among forecasters as a proxy for uncertainty is dependent on the stability of the forecasting environment which can compromise the quality of the forecast and therefore introduce bias. In order to address the challenges of the survey-based proxies, Istrefi and Mouabbi (2016), in alignment with the approach introduced by D'Amico and Orphanides (2014) as well as Lahiri and Shang (2010), introduce a new subjective ex-ante interest rate uncertainty proxy that accounts for two components, disagreement among forecasters and the perceived variability of future aggregate shocks.

Another interest rate uncertainty proxy that has been used is the use of keyword frequency counts. Husted, Lucas, Rogers, and Sun (2017) introduce a novel approach to gauge monetary policy uncertainty (MPU) by tracking the frequency of newspaper articles related to interest rates. They utilize databases like ProQuest Newsstand and historical archives to construct this MPU index by examining major newspapers for keywords that can be linked to monetary policy uncertainty. It is worth noting that, while survey-based and keyword count measures offer valuable insights into uncertainty, they are limited in the sense that these measures are reliant on the opinions of a limited pool of market participants, potentially inadequately representing the broader population (Chang and Feunou 2014).

An alternative approach that is used to address these challenges is the use of the volatility of option prices to evaluate interest rate uncertainty (Bauer et al, 2021). More specifically, most papers employ implied volatility, generated from the prices of options related to interest rate futures (Neely 2005; Bauer et al. 2021). Other papers such as Kaminska and Roberts-Sklar (2018) also use realized volatility, which is computed by assessing intraday price movements of interest rate futures. It is worth noting, however, that most papers are primarily focused on computing market-based interest rate uncertainty metrics for regions outside Canada. The only paper that considers implied and realized volatility under a Canadian context comes from Chang and Feunou (2014) whose measures of volatility are formulated based on futures contracts associated with the three-month bankers' acceptance rate (BAX) and options linked to BAX (OBX).

3.3 Uncertainty Transmission Channels

As mentioned earlier, previous research has indicated that increases in monetary policy uncertainty usually tend to result in declines in investment, employment, and real GDP (Istrefi and Mouabbi 2016; Jiang, Xu and Li 2022). However, the specific channel through which monetary policy uncertainty impacts the real economy is not as clear cut. Robust theoretical approaches, such as the real option theory, financial friction theory, and precautionary saving theory, have been established to understand this impact. The real option theory suggests that economic agents factor in macroeconomic uncertainties when making investment decisions (Davig and Hakkio, 2010). Within this conceptual framework, periods of heightened uncertainty make the entities in the private sector – encompassing both households and corporations – increasingly risk-averse, thereby prompting them to defer investment activities (Panousi and Dimitris, 2012). At the same time, a more uncertain market translates to more valuable call options, which results in most firms adopting a ”wait-and-watch” approach (Bernanke, 1983). As a result of that, this leads to even lower investment levels, thereby further intensifying the effect of monetary policy uncertainty on real activity (Bloom, 2009).

Another primary channel through which monetary policy uncertainty affects investment and output is the financial friction channel. In line with this theoretical framework, an increase in macroeconomic uncertainty contributes to a rise in credit spread (Higgins, 2023). This heightened credit spread subsequently leads to a reduction in lending and a decline in investment levels. In addition to that, the elevated risk and uncertainty in the economic environment result in larger losses from bankruptcies, which ultimately forces households to make more significant cuts in consumption (Gilchrist et al. 2014). What is more, banks deleverage when uncertainty rises, and this deleveraging disrupts financial markets and curtails credit availability to firms, thereby dampening investment even further (Istiak and Serletis, 2020).

What is more, in addition to the real option channel and the financial friction channel, researchers have also identified the precautionary savings channel as a possible channel through which monetary policy uncertainty can impact the real economy. According to this theory, individuals, amidst uncertainty, tend to adopt a conservative approach when it comes to their consumption decisions. This cautious behavior manifests in an uptick in extra savings, commonly referred to as ”precautionary saving” (Lugilde, Bande, and Riveiro 2017). However, on the flip side, this prudential approach to consumption bears an adverse consequence for the economy as it significantly reduces current consumption, ultimately resulting in a contraction of real GDP (Luo, Wang, and Zhang 2022).

Given the existing body of work, my research contributes to the ongoing discourse on interest rate dynamics by providing a market-based proxy of interest rate uncertainty that is free of the biases present in existing methodologies. What is more, the distinct focus on the impact of interest rate uncertainty on the Canadian economic environment further enhances the depth and applicability of the study while also bearing significant implications for informed policy-making.

4 Conceptual Framework

Given the theoretical framework which underscores the relationship between monetary policy uncertainty and macroeconomic variables, I now turn to the model framework that I have developed to investigate the relationship between monetary policy uncertainty and the economy. To capture the dynamic interactions among interest rate uncertainty and key macroeconomic variables, the Vector Autoregressive Model (VAR - X), first introduced by Pesaran, Shin, and Smith (2001), emerged as a suitable choice. The VAR - X model allows for the simultaneous estimation of the interdependencies among multiple variables over time, offering insights into the dynamic adjustments of the economy to changes in interest rate uncertainty. More importantly, the VAR-X model explicitly accounts for the exogenous variables, which is crucial for a study that is focused on evaluating exogenous variables such as interest rate uncertainty, oil price uncertainty, and economic price uncertainty. This approach has also been used by Ghosh, Sahu, and Chattopadhyay (2020) who employ a VAR-X model to evaluate the impact of economic uncertainty on inflation expectations in India, as well as Lanzilotta et al. (2023) who also propose a VAR-X model to capture the impact of uncertainty on key macroeconomic variables in Uruguay.

For the endogenous variables in this model, I picked the Real Gross Domestic Product (GDP), Business Gross Fixed Capital Formation (GFCF), Consumer Price Index (CPI), as well as 3-month Interest Rates (IR). On the other hand, for my exogenous variable, given the fact that survey-based measures and keyword count measures are constrained by their reliance on the opinions of a limited group of market participants, as well as the fact that realized and implied volatility of interest rates typically require extensive data on highly liquid derivatives, I sought to use a market-based measure of interest rate uncertainty that is free of the biases of survey-based measures. My choice was primarily based on the results from Arnold and Vrugt (2010) who – while using an implied volatility proxy for interest rate uncertainty – document that Treasury bond volatility for all maturities is primarily determined by monetary policy uncertainty. Given this result, I opted to use the volatility of daily returns for 3-month treasury bonds as my proxy for interest rate uncertainty. To calculate TBV, I first calculated the daily price of a 90-day treasury bond:

$$P_t = 100 \times (1 - \frac{d_t \times r}{360})$$

In this formula, r represents the time-to-maturity of the bond in days, whereas dt represents the estimated discount yield of the three-month treasury bonds at any given day. After computing the daily price of the three-month treasury bonds, I then calculated the day-over-day holding period return (HPR) using the formula:

$$HPR_t = \frac{(P_t - P_{t-1})}{P_{t-1}}$$

After calculating the day-over-day HPR, I then calculated TBV for every quarter as:

$$TBV = \sqrt{\sum_{n=1}^{90} (HPR - \overline{HPR}\}^2}$$

As depicted in Figure 2 in the Appendix, this interest rate uncertainty measure closely mirrors significant disruptions in the Canadian economy. We can easily observe significant spikes in the Term-Based Volatility (TBV) Q4 1979 and Q2 1980, a period marked by elevated interest rates and stringent monetary policy in the United States. This era, known as the Volcker disinflation era, had ripple effects on Canada, leading to increased uncertainty. Additionally, TBV values in Q1 and Q2 1991 (0.0135 and 0.00797) align with the early 1990s recession, while elevated TBV values in Q3 and Q4 2008 (0.0358 and 0.0426) correspond to the global financial crisis that resulted from the U.S. housing market collapse, therefore confirming the measure's efficacy in capturing periods of heightened uncertainty in the Canadian economy. We could also argue that another indicator of the TBV's ability to capture monetary policy uncertainty is difference in average TBV before and after Canada adopted a 2 percent inflation-targeting regime in February 1991. More specifically, from Q2 1961 until Q1 1991, the average TBV stood at approximately 0.0149. This value is almost 54 percent bigger than the average TBV after February 1991, which stands at around 0.0096.

What is more, if we were to compare TBV with other measures of interest rate uncertainty, we observe a relatively close match. Figure 3 presents both the survey-based measure of interest rate uncertainty used by Istrefi and Mouabbi (2016), who evaluate uncertainty by using the disagreements among forecasters. The figure also includes TBV from Q1 1994 to Q1 2018. Evidently, most of the time, these two measure move in the same direction, therefore once again confirming the validity of TBV as a good proxy for interest rate uncertainty in Canada.

In addition to TBV, I also decided to use Economic Policy Uncertainty (EPU) and Oil Price Uncertainty (OPU) as my exogenous variables. After selecting my endogenous and exogenous variables, I decided to investigate the following four VAR – X models:

$$\begin{pmatrix} \Delta GDP_t \\ \Delta GFCF_t \\ \Delta IR_t \\ \Delta CPI_t \end{pmatrix} = A_0 + A_1 \cdot \begin{bmatrix} \Delta GDP_{t-1} \\ \Delta GFCF_{t-1} \\ \Delta IR_{t-1} \\ \Delta CPI_{t-1} \end{bmatrix} + A_2 \cdot TBV_t + \epsilon_t \tag{1}$$

$$\begin{pmatrix} \Delta GDP_t \\ \Delta GFCF_t \\ \Delta IR_t \\ \Delta CPI_t \end{pmatrix} = A_0 + A_1 \cdot \begin{bmatrix} \Delta GDP_{t-1} \\ \Delta GFCF_{t-1} \\ \Delta IR_{t-1} \\ \Delta CPI_{t-1} \end{bmatrix} + A_2 \cdot TBV_{t-1} + \epsilon_t \tag{2}$$

$$\begin{pmatrix} \Delta GDP_t \\ \Delta GFCF_t \\ \Delta IR_t \\ \Delta CPI_t \end{pmatrix} = A_0 + A_1 \cdot \begin{bmatrix} \Delta GDP_{t-1} \\ \Delta GFCF_{t-1} \\ \Delta IR_{t-1} \\ \Delta CPI_{t-1} \end{bmatrix} + A_2 \cdot TBV_t + A_3 \cdot EPU_t + A_4 \cdot OPU_t + \epsilon_t \tag{3}$$

$$\begin{pmatrix} \Delta GDP_t \\ \Delta GFCF_t \\ \Delta IR_t \\ \Delta CPI_t \end{pmatrix} = A_0 + A_1 \cdot \begin{bmatrix} \Delta GDP_{t-1} \\ \Delta GFCF_{t-1} \\ \Delta IR_{t-1} \\ \Delta CPI_{t-1} \end{bmatrix} + A_2 \cdot TBV_{t-1} + A_3 \cdot EPU_{t-1} + A_4 \cdot OPU_{t-1} + \epsilon_t \tag{4}$$

Before we proceed further, it is crucial to emphasize that for GDP, the regressed variable represents the difference between the logarithms of two consecutive values of GDP. The same applies to GFCF, but not IR and CPI. Evidently, the first two models only contain TBV as an exogenous variable, with the Model 2 having TBV lagged by one period. The reasoning behind picking these two models has to do with the fact that there are potential inertia effects on the variables of interest. In addition to that, an inadequately chosen lag structure can commonly result in serial correlation of the error term. It is important to emphasize that the data that was used for the first two models, Model 1a and Model 2a, was available from Q2 1961 up to Q3 2023. However, as I was also interested in evaluating the impact of other exogenous variables such as oil price uncertainty and economic policy uncertainty for which data was only available after Q2 1985, I opted to re-evaluate Model 1 and Model 2, but within a more restricted timeframe.

Model 1b and Model 2b are identical in design to Model 1a and Model 2a, with the only difference being that Model 1b and Model 2b are estimated using data from the period Q2 1985 to Q3 2023. As for Model 3 and 4, they are identical in timeframe to Model 1b and Model 2b. However, in addition to TBV, these models also contain OPU and EPU as exogenous variables. I decided to evaluate these two models to investigate if adding other uncertainty measures such as OPU and EPU is going to lead to improvements to the model. It is also important to underscore that, methodologically, a VAR lag selection test was conducted to ascertain the optimal lag for all four models. Employing the Bayesian Information Criterion approach, it was discerned that a lag of 1 emerged as the optimal choice for each of the models that were described earlier.

5 Sources of Evidence

When it comes to the data used for this paper, the data for GDP, GFCF, and CPI was collected from the Statistics Canada database, whereas the data for IR was collected from the Federal Reserve of St. Louis (FRED) database. The OPU data was collected from the Oil Price Uncertainty Index created by Abiad and Qureshi (2023), whereas the EPU data was collected from the Economic Policy Uncertainty Index created by Baker, Bloom, and Davis (2016), with both these indexes being hosted in the Economic Policy Uncertainty website. In addition, in the computation of TBV, I use the "Bank of Canada, money market and other interest rates" series for 3-month treasury bonds extracted from the Government of Canada website. The data for GDP, GFCF, IR, and TBV are collected with a quarterly frequency, whereas CPI, EPU, and OPU data are only available monthly, so these variables were converted to a quarterly frequency by taking the three-month average of each index. For a comprehensive overview of the main summary statistics for the study variables, please refer to Table 1 in the Appendix.

6 Results

I will now explore whether interest rate uncertainty exhibits statistically significant effects on the endogenous variables of this study at the 10 percent significance level. Starting with TBV, at the 10 percent significance level, the evidence indicates a consistent negative impact of TBV on GDP across all models. Specifically, for Model 1a, my results show that a

1 standard deviation increase in TBV results in a 0.15 percent reduction in real GDP, or 3.3 billion CAD given Canada's real GDP in 2023. A similar impact is also observed in Model 2a, albeit with a slightly bigger magnitude at around 0.165 percent, or 3.63 billion CAD. Given the supposed effect of the real option channel, the financial friction channel, and the precautionary saving channel that were outlined in the literature review, the negative effect of TBV on GDP is in line with my expectations. However, it is important to emphasize that the impact of TBV is significantly smaller in magnitude for the models that span the 1985-2023 period, with GDP going down by 0.07 percent, 0.06 percent, 0.09 percent, and 0.08 percent for Model 1b, Model 2b, Model 3, and Model 4 respectively. It is also worth noting that, for the 1961 to 2023 period, Model 2a has the higher explanatory power. Given that the impact of interest rate uncertainty on the decision-making of producers takes time to permeate the economy, this result likely has to do with the presence of the lag on the exogenous variable TBV on Model 2a. As for the 1985 to 2023 period, Model 3 has the highest explanatory power, therefore indicating that, when taking into consideration other uncertainty indicators such as the EPU and OPU, there is not any explanatory gain from lagging the exogenous variables by one period.

When it comes to GFCF, similar to GDP, the evidence indicates a consistent negative impact of TBV on GFCF across most of the models. In Model 1a, findings illustrate that a one standard deviation increase in TBV translates to a 0.25 percent reduction in GFCF, equivalent to a decrease of 759 million CAD, considering Canada's GFCF in 2023. A comparable impact is echoed in Model 2a, albeit with a marginally larger magnitude at approximately 0.266 percent, or 835 million CAD. As for the models spanning the 1985-2023 period, the results show no statistically significant impact of TBV on GFCF for Model 1b, whereas Model 2b, Model 3, and Model 4 display a reduction in GFCF, with GFCF going down by 0.44 percent, 0.26 percent, and 0.59 percent, respectively. It is worth noting that, at a 10 percent significance level, Oil Price Uncertainty (OPU) and Economic Policy Uncertainty (EPU) also exert a statistically significant negative effect on GFCF, which is not entirely surprising considering Canada's heavy reliance on oil exports. When it comes to explanatory power, for the 1961 to 2023 period, just like the case of GDP, Model 2a has the higher explanatory power. As for the 1985 to 2023 period, Model 4 has the highest explanatory power, therefore indicating that, different from GDP, there is an explanatory gain from lagging the exogenous variables by one period. This difference could be explained by the fact that the uncertainty transmission channels take a longer time to impact GFCF compared to GDP, which constitutes of potentially more uncertainty-sensitive variables such as consumption.

While the impacts of TBV on GDP and GFCF are pronounced and statistically significant, the same level of clarity does not extend to its relationship with CPI and IR. Specifically concerning 3-month interest rates, only Model 2a, Model 1b, and Model 3 exhibited statistically significant impacts of TBV. However, the observed effects were divergent, therefore warranting further exploration in subsequent papers; while Model 2a revealed a negative impact of TBV on short-term interest rates, Model 1b and Model 3 indicated a positive effect. Moreover, the relationship between TBV and CPI appeared less definitive, as none of the models showed any statistically significant effect of TBV on CPI.

7 Conclusion

This paper investigates the repercussions of interest rate uncertainty on the Canadian economy by introducing a market-based metric of interest rate uncertainty derived from the quarterly volatility in the holding period return for 3-month Canadian treasury bonds. Employing a VAR-X model, the investigation unveils a consistent, adverse, and statistically significant influence of heightened interest rate uncertainty on Canadian real Gross Domestic Product (GDP) and Gross Fixed Capital Formation (GFCF) across diverse empirical models. However, it is imperative to acknowledge that the existing research landscape predominantly focuses on the United States, necessitating further inquiry into the transmission channels of uncertainty within the Canadian context. Such understanding is pivotal for formulating effective strategies to mitigate future interest rate uncertainty shocks. Additionally, regarding the impact of interest rate uncertainty on interest rate levels, the conflicting results observed across different models of this paper underscore the need for further research to elucidate the relationship between these variables, particularly within the Canadian framework.

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Appendix

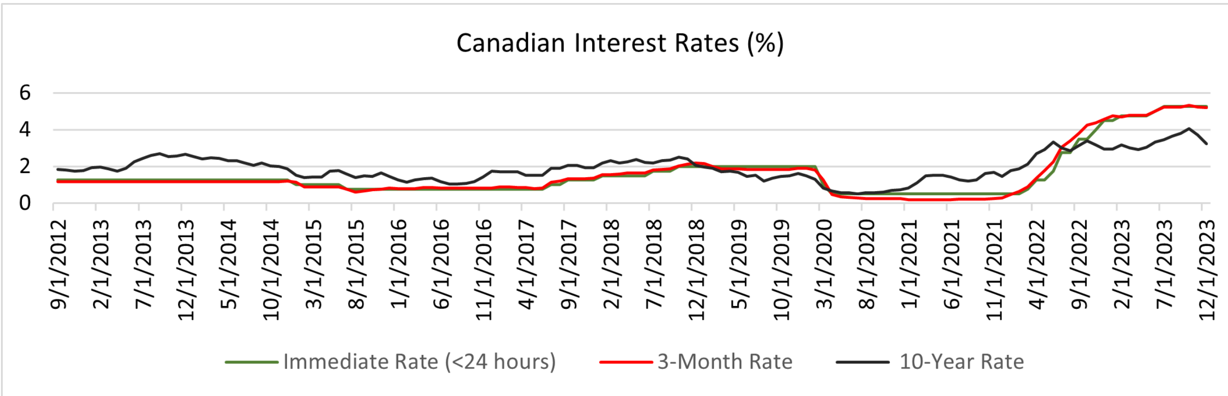

Figure 1: Canadian Interest Rates From 2012 to 2023.

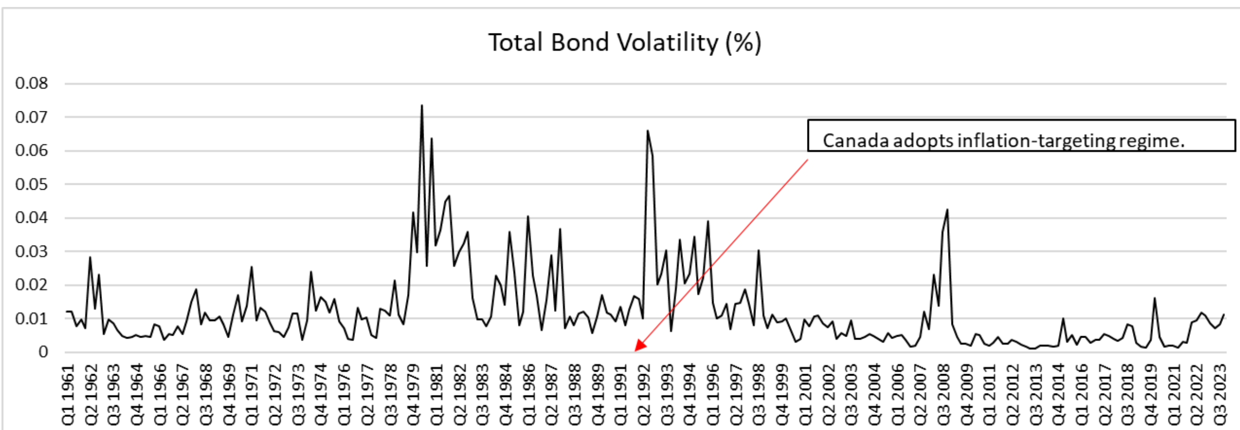

Figure 2: Total Bond Volatility Over Time

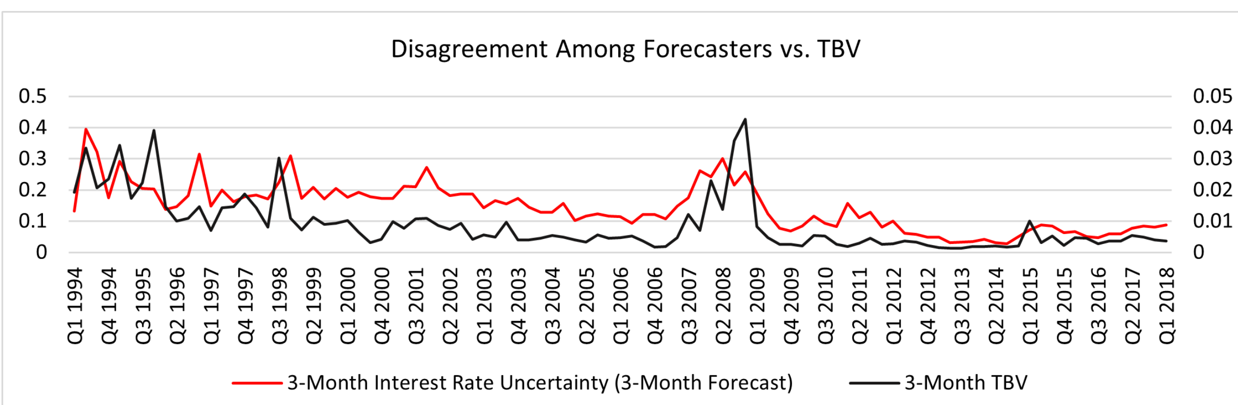

Figure 3: DAF and TBV Over Time

Table 1: Summary Statistics

Variables	**N**	**Mean**	**SD**	**Median**	**Min**	**Max**	**Freq**
GDP (10^6)	251	978935	451761	896231	293535	1891478	Quarterly
GFCF (2017 Dollars)	251	277345	150084	233962	65003	536777	Quarterly
IR (%)	251	5.7413	3.9973	5.0318	0.1834	20.7375	Quarterly
CPI (Δ%)	251	3.7852	3.0201	2.6806	-0.8643	12.696	Quarterly
TBV	251	0.0121	0.0115	0.0092	0.0013	0.0736	Quarterly
EPU	468	154	104	120	29	678	Monthly
OPU	420	99	82	75	4	500	Monthly

Table 2: VAR-X Results.

Dependent Variables	Explanatory Variables	Model 1a	Model 2a	Model 1b	Model 2b	Model 3	Model 4
Delta_GDP							
	Delta_GDP_1	-0.3013***	-0.3063***	-0.1501*	-0.1604*	-0.2137***	-0.2049**
		[0.0731]	[0.0731]	[0.0818]	[0.0826]	[0.0798]	[0.0857]
	Delta_GFCF_1	0.0683*	0.0617*	0.0957***	0.0943***	0.0857***	0.0851***
		[0.0360]	[0.0360]	[0.0186]	[0.0187]	[0.0179]	[0.0195]
	Delta_IR_1	-0.0422	-0.0227	-0.0481	-0.0249	-0.0493	-0.0205
		[0.0856]	[0.0856]	[0.0579]	[0.0578]	[0.0550]	[0.0575]
	Delta_CPI_1	0.0017	0.0022	-0.0179	-0.0187	-0.0312	-0.0321
		[0.0267]	[0.0267]	[0.0274]	[0.0275]	[0.0269]	[0.0286]
	TBV	-0.1528**		-0.0689**		-0.0920***	
		[0.0696]		[0.0347]		[0.0337]	
	TBV_1		-0.1653**		-0.0637*		-0.0758**
			[0.0699]		[0.0348]		[0.0359]
	EPU					-1.7819e-05***	-1.0737e-05*
						[4.7829e-06]	[5.5019e-06]
	OPU					-7.4224e-06	-2.0807e-07
						[5.2429e-06]	[5.6448e-06]
	Constant	0.0109***	0.0111***	0.0075***	0.0075***	0.0116***	0.0098***
		[0.0014]	[0.0014]	[0.0009]	[0.0009]	[0.0014]	[0.0016]
	R-squared	0.0826	0.1436	0.1918	0.1882	0.2804	0.2113
Delta_GFCF							
	Delta_GDP_1	-0.3228**	-0.3306**	0.7698**	0.6480*	0.5573	0.3028
		[0.1509]	[0.1510]	[0.3552]	[0.3475]	[0.3499]	[0.3455]
	Delta_GFCF_1	0.2372***	0.2266***	0.3360***	0.3217***	0.2919***	0.2283***
		[0.0743]	[0.0744]	[0.0809]	[0.0788]	[0.0787]	[0.0787]
	Delta_IR_1	-0.0058	0.0261	-0.1329	-0.0366	-0.1362	-0.0127
		[0.1766]	[0.1762]	[0.2514]	[0.2433]	[0.2413]	[0.2314]
	Delta_CPI_1	-0.0340	-0.0339	-0.0560	-0.0382	-0.0836	-0.0384
		[0.0551]	[0.0547]	[0.1192]	[0.1156]	[0.1183]	[0.1152]
	TBV	-0.2515*		-0.1544		-0.2569*	

Table 2 – Continued from previous page

Dependent Variables	Explanatory Variables	Model 1a	Model 2a	Model 1b	Model 2b	Model 3	Model 4
		[0.1436]		[0.1508]		[0.1476]	
	TBV_1		-0.2662*		-0.4435***		-0.5946***
			[0.1443]		[0.1466]		[0.1444]
	EPU					-6.1821e-05***	-5.5066e-05**
						[2.0980e-05]	[2.2160e-05]
	OPU					-4.8402e-05**	-7.4537e-05***
						[2.2997e-05]	[2.2736e-05]
	Constant	0.0129***	0.0132***	0.0027	0.0064	0.0193***	0.0256***
		[0.0029]	[0.0014]	[0.0042]	[0.0041]	[0.0061]	[0.0066]
	R-squared	0.0603	0.0616	0.1918	0.2369	0.2653	0.3211
Delta_IR							
	Delta_GDP_1	0.0109	-0.0003	0.5320***	0.5146***	0.5674***	0.5051***
		[0.0517]	[0.0515]	[0.1064]	[0.1086]	[0.1091]	[0.1140]
	Delta_GFCF_1	0.0885***	0.0855***	0.0541**	0.0524**	0.0580**	0.0484*
		[0.0255]	[0.0254]	[0.0242]	[0.0246]	[0.0245]	[0.0260]
	Delta_IR_1	0.2307***	0.2309***	0.1199	0.1045	0.1207	0.1044
		[0.0605]	[0.0601]	[0.0753]	[0.0761]	[0.0752]	[0.0765]
	Delta_CPI_1	-0.0003	0.0201	-0.0684*	-0.0613*	-0.0582	-0.0544
		[0.0189]	[0.0186]	[0.0357]	[0.0362]	[0.0369]	[0.0380]
	TBV	0.0547		0.0872*		0.0959**	
		[0.0492]		[0.0451]		[0.0460]	
	TBV_1		-0.0981*		-0.0128		-0.0208
			[0.0492]		[0.0458]		[0.0477]
	EPU					9.5177e-06	3.8694e-07
						[6.5411e-06]	[7.3213e-06]
	OPU					2.7166e-07	-6.9037e-06
						[7.1702e-06]	[7.5115e-06]
	Constant	-0.0014	-0.0002	-0.0035***	-0.0025*	-0.0054***	0.0018
		[0.0010]	[0.0010]	[0.0012]	[0.00013]	[0.0019]	[0.0022]
	R-squared	0.1340	0.1436	0.2692	0.2490	0.2809	0.2539

Table 2 – Continued from previous page

Dependent Variables	Explanatory Variables	Model 1a	Model 2a	Model 1b	Model 2b	Model 3	Model 4
Delta_CPI							
	Delta_GDP_1	0.0414	0.0418	0.2158*	0.2213*	0.1877	0.2022
		[0.0439]	[0.0440]	[0.1166]	[0.1175]	[0.1195]	[0.1232]
	Delta_GFCF_1	0.0342	0.0352	0.0193	0.0199	0.0207	0.0172
		[0.0216]	[0.0217]	[0.0266]	[0.0266]	[0.0269]	[0.0281]
	Delta_IR_1	0.1320**	0.1289**	0.0615	0.0609	0.0605	0.0634
		[0.0514]	[0.0513]	[0.0825]	[0.0822]	[0.0824]	[0.0827]
	Delta_CPI_1	0.9642***	0.9648***	0.8867***	0.8854***	0.8715***	0.8738***
		[0.0160]	[0.0159]	[0.0391]	[0.0391]	[0.0404]	[0.0411]
	TBV	0.0258		-0.0068		-0.0030	
		[0.0418]		[0.0495]		[0.0504]	
	TBV_1		0.0225		0.0135		0.0116
			[0.0420]		[0.0496]		[0.0516]
	EPU					-6.5954e-06	-6.1691e-06
						[7.1640e-06]	[7.9141e-06]
	OPU					9.6991e-06	3.9451e-06
						[7.8530e-06]	[8.1196e-06]
	Constant	0.0005	0.0005	0.0012	0.0009	0.0116	0.0018
		[0.0008]	[0.0008]	[0.0014]	[0.0014]	[0.0021]	[0.0023]
	R-squared	0.9463	0.9463	0.7987	0.7988	0.8023	0.8002

Standard errors in brackets
***** p<0.01, ** p<0.05, * p<0.1**