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The Effect of Quantitative Easing on the Financial Market in Canada

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By

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Abstract

This empirical study examines the effects of quantitative easing (QE) on the Canadian financial market. Specifically, the study focuses on the Bank of Canada's Government of Canada Bond Purchase Program (GBPP), conducted during COVID-19 between 2020 and 2022. I use two analytical methods, e.g., event study and time series analysis, to quantify the impact of the Bank of Canada's large asset purchases on the 10-year government bond yield's term premium. The results indicate that the Bank of Canada's $260 billion asset purchases in 2020 would reduce the 10-year term premium by 34 basis points, which suggests the significant impact of quantitative easing on the term premium. Furthermore, the study finds that QE has a portfolio balance effect by reducing the yields on other non-government assets. The findings of this study constitute a significant contribution to the current discourse regarding the use of QE as a monetary policy tool and have implications for future policy decisions related to monetary policy in the Canadian economy.

Keywords: QE, Monetary Policy, Asset Purchases, Bank of Canada, Canadian Financial Market.

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1. Introduction

At the beginning of 2020, when the economy was heavily affected by the COVID-19 disruptions and the unemployment rate was more than double in the second quarter of 2020, the Bank of Canada (BoC) undertook several steps to ease the strain on the financial system. Since conventional policy rates were restricted by the effective lower bound (ELB), extending the balance sheet of the central bank by purchasing large-scale assets can offer effective stimulus under the ELB (Reza et al. 2015). In March 2020, the BoC stated that the Government of Canada Bond Purchase Program (GBPP) was a part of quantitative easing (QE); and under this program, $5 billion worth of government bonds were purchased weekly in the secondary market to ease monetary conditions through the central bank's reserves (Bank of Canada, 2022). Bernanke et al. (2004) defined quantitative easing as a strategy that increases the central bank's balance sheet by raising the money supply (particularly bank reserves) on the economy. This strategy of the BoC was to increase the balance sheet by acquiring both government and non-government assets through central bank reserves, especially long-term government bonds. By acquiring such financial assets from the private sector, the objective was to raise the money supply in the economy and lower the term premium through long-term yields.[a] Also, QE increases nominal expenditure and ensure the target inflation in the economy. In a few months (January–July 2020), the assets held by the BoC increased by more than four times.[b] By February 2021, the BoC had acquired around $577 billion in assets, of which the majority were government bonds.

The Bank of Canada adopted QE late when other central banks in advanced economies implemented QE earlier. When the policy rate, the traditional policy instrument for managing aggregate demand, reaches its lower bound, central banks may resort to unconventional

[a] Term Premium refers to the difference between long-term bond and short-term bond yields.
[b] In January 2020, the total assets were $119 billion, and in July 2020, the total assets were $543 billion.

monetary policy to provide extra monetary impulses. Large-scale asset purchases may stimulate overall economic demand through several mechanisms (Joyce et al. 2011). During QE, interest rates on long-term securities were lowered by two major effects: the signaling effect and the portfolio rebalancing effect (Fortin, 2022). When the central bank buys assets, it conveys to the market that it is committed to maintaining short-term interest rates low for an extended period, a phenomenon known as the signaling effect. By pledging to purchase longer-term assets, the central bank decreases the term premium contained in longer-term bond yields, a phenomenon known as the portfolio effect that occurs when short-term and long-term securities are imperfect substitutes (Fortin, 2022). Through this mechanism, the yield on government bonds falls, the yield on private securities also drops, and asset values rise, resulting in a lower cost of financing for the economy as a whole.

This study is motivated to assess the effects of this unconventional policy (QE) on the financial market. I will concentrate on the consequences of the BoC's purchases of long-term government bonds and not explicitly analyze the implications of the other asset purchases by the bank. The objective is to examine how QE affects government bond markets and how it impacts the value of other financial assets through the portfolio balance channel. However, it is difficult to determine the specific contribution of the BoC's asset purchases as other policy measures and domestic and international economic developments may influence the financial market. The existing literature has noticed the immediate effect of quantitative easing through event study and time series analysis. Therefore, following the existing studies, I conducted an event study and time series analysis to assess the QE's success and effects on the Canadian economy. At first, using event-study analysis, I examine the immediate response of government and non-government bond yields to the QE-related announcements of the BoC. Later, I conduct an OLS

estimation of the pre-QE time series to predict the out-of-sample effect of QE on the economy. Both methods show that the BoC's large-scale asset purchases decrease the term premium (the difference between a 10-year government bond and 3-month T-bill yields). The event study observes a 6 basis point drop in the term premium, whereas the time series estimation suggests a drop of 6.2 basis points in the term premium when the BoC purchases 5- to 10-year government bonds in 2020. Also, the results of the event study show that QE is successful in decreasing not only the aggregate longer-term government bond yields by 28 basis points but also the yields of other longer-term bond yields by 66 basis points, even though the assets were not included in the GBPP. These findings suggest a significant portfolio balance effect.

The rest of the paper is organized as follows: Section 2 reviews the prior empirical studies on QE implementations, explaining the primary channels via which QE asset purchases affect the financial market. Next, Section 3 details the impacts of QE on the BoC's balance sheet. Afterward, in Section 4, this paper explains two methods that I use to do my research. Section 5 discusses the empirical findings and related channels through which the BoC's QE worked. Finally, in Section 6, I conclude with the measures and challenges of unconventional monetary policy and the prospects for ELB monetary policymaking.

2. Literature Review

Literature suggests that large-scale asset purchases (LSAPs) have substantial financial effects on the financial market. When any central bank initiates an LSAP, it often purchases longer-term government bonds and mortgage-backed securities. LSAPs intend to affect the yield curve, and this is accomplished by influencing the term premium (Gagnon et al. 2011). When the central bank's authority, ability to stimulate the economy during financial stress is constrained by the

zero lower bound on short-term nominal interest rates, for instance, as shown by Reifschneider and Williams (2000), conventional monetary policy might not be enough to stimulate the economy. The findings in Reifschneider and Williams (2000) justified the implementation of extra policy tools (QE) that benefited the economy in an extreme recession.

Yet, the existing literature lacks agreement on a single channel that QE primarily uses. The signaling channel is emphasized by Krishnamurthy and Vissing-Jorgensen (2011). On the other hand, Gagnon et al. (2011) and Joyce et al. (2011) derive different conclusions, arguing that portfolio rebalancing was the primary route via which QE in the United States and the United Kingdom lowered long-term rates. Furthermore, both the signaling and the portfolio balance channels are important in explaining the transmission of monetary policy and can influence spending and investment decisions. The signaling channel suggests that changes in interest rates convey information about the economy's future performance, while the portfolio balance channel posits that monetary policy affects the composition of investors' portfolios (Christensen and Rudebusch, 2012). Also, Christensen and Rudebusch (2012) discovered that the Fed's LSAPs mostly acted through a signaling channel, whereas the portfolio rebalancing channel was more essential in explaining the reduction in U.K. yields in response to the QE program. According to Joyce et al. (2011), the major source of the reduction in medium- to long-term gilt rates attributable to QE was the portfolio balance effect in the UK. They concluded that there was a significant increase in the value of most other assets during QE, indicating that QE had a much broader impact than previously expected.

Most of the QE-related studies use LSAP announcements to perform event studies to assess the effect of the programs. For instance, the works of Gagnon et al. (2011), Krishnamurthy and Vissing-Jorgensen (2011), Swanson (2011), Joyce et al. (2011), and Neely (2012) have shown

substantial impacts of LSAPs through event studies. The event analyses of LSAP announcements by Gagnon et al. (2011) demonstrate that after LSAPs, Treasury yields and yields on mortgage-backed securities (MBSs) decreased at a significant rate. Their research also stated that the drop in long-term interest rates reflects the reduction in risk premiums. Besides, they found more significant impacts on yields for agency debt and agency mortgage-backed securities. Another study done by Krishnamurthy and Vissing-Jorgensen (2011) used an event research technique to examine the first and second wave of federal purchases in the US. They predicted that further QE should affect MBS and corporate borrowing rates via signaling and the portfolio balance effect based on the MBS purchases. They find evidence that the interest rates dropped significantly in the first round of QE compared to other QEs due to the quantity of the purchase and market conditions. Furthermore, they failed to track the same effects on the second QE because the markets had already expected an impact before the second program was announced. Swanson (2011) supported their results in another study by finding that the second round of purchases had less of an effect on longer-term Treasury yields than the first round of purchases. The possible explanation given by Kandrac and Schlusche (2013) is that if the market knows the purchase price and the specific kinds of securities the Federal Reserve plans to buy, then the price impacts connected with the LSAP should be determined by the announcements.

In addition to the event study approach, other studies use time series regression, either VAR or OLS, to study the effects of QE. Kim et al. (2020) applied structural VAR methodology and demonstrated that large increases in the Federal Reserve's asset holdings have a considerable expansionary effect on the macroeconomy after the recessionary shock. Weale and Wieladek (2016) investigate the impact of LSAPs on the GDP and the Consumer Price Index (CPI) in the United Kingdom and the United States using the Bayesian VAR approach. They demonstrate

that asset purchases supported GDP following the financial crisis in the UK and the US. In addition, Gagnon et al. (2011) conducted OLS on pre-recession data and use out-of-sample analysis to quantify the effect of QE.

The literature on QE in the Canadian economy focuses mainly on the BoC's balance sheet and macroeconomic effects. For example, the study by Fortin (2022) of QE on the Canadian economy discussed how QE works in interest rate risks and public debt, and the government's potential losses in implementing QE. According to a different study by Zhang et al. (2021), the best policy mix for stabilizing the Canadian economy is extended monetary policy, where the central bank should implement conventional monetary policy first and then unconventional monetary policy (QE). On the other hand, my paper is one of the few attempts to capture the QE effects on the Canadian financial market. I conduct both an event study and an econometric model following Gagnon et al. (2011) to capture the effectiveness of QE through the term premium. Also, for transmission mechanism, I focus on portfolio balance channels.

3. Background

Canadian government bond purchases began in March 2020. The BoC has purchased government bonds, Treasury bills, and assets subject to resale agreements from financial institutions on the secondary market. By June 2020, the BoC's balance sheet had grown to over $520 billion, which was 20 percent of GDP. The BoC had $120 billion in assets before the pandemic; most of which were in the form of government bonds ($80 billion) and Treasury bills ($26 billion) to serve primary central bank operations. The magnitude of the increase over the QE period suggests that the BoC made a sizable number of acquisitions in 2020, even though the

percentage itself remained lower in terms of GDP than the most other central banks (Fortin, 2022).

Figure 1 illustrates monthly yields and overnight rate movements, particularly during the QE program. The overnight rate is an important monetary policy tool that influences borrowing costs and other economic activities. Before QE, the overnight rate was around 1.75% at the beginning

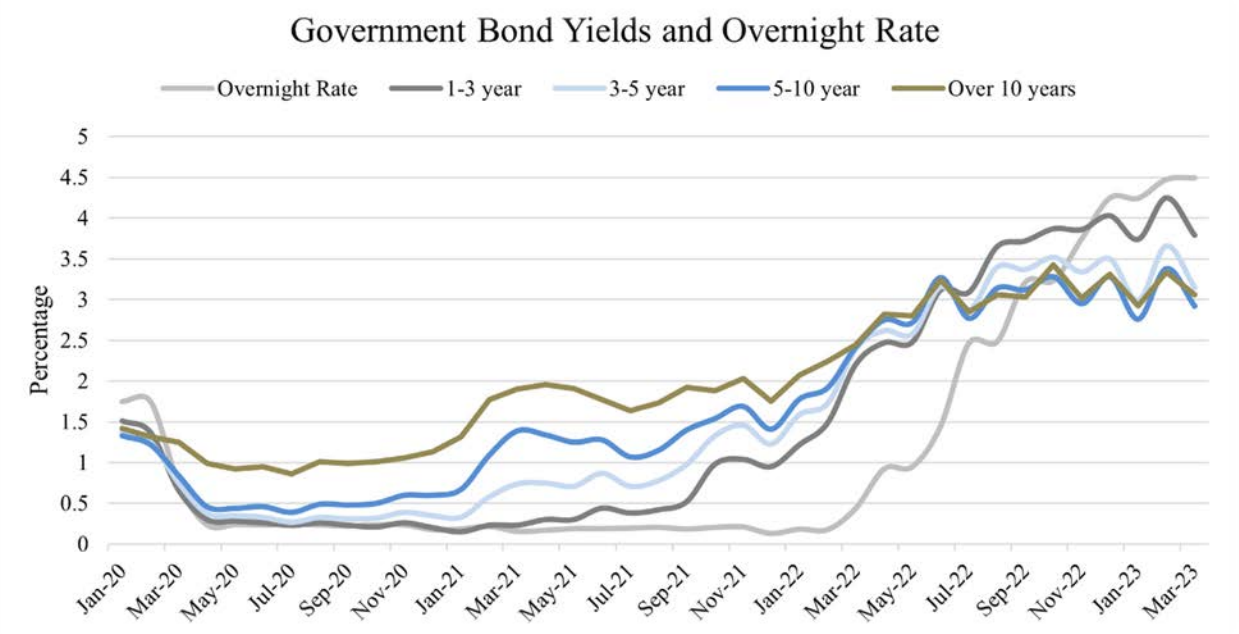

Figure 1: Government Bond Yields and Overnight Rate (Source: Bank of Canada)

of March 2020, and it became around 0.25% in April 2020. The BoC restrained this rate as the effective lower bound (ELB) for almost two years (2020-2022), and it got better after March 2022. According to Figure 1, the current overnight rate is around 4.5%, which is more than all other yields. Moreover, the government bond yields saw a significant drop after the announcement in March 2020 and remained close to each other (except over 10-year yields) during the first year of QE. Government bond yields started improving at the beginning of 2021.

Figure 2 shows the significant changes in the BoC's assets after QE. Before QE, in January 2020, the total assets of the BoC were around $119 billion, which increased to $543 billion by

July 2020. It shows that QE has increased the assets of the BoC by 356 percent in a few months (January–July 2020). During the initial period of QE, the BoC increased its assets through T-bills and securities purchased under resale agreements (repos). As of July 2020, the BoC's holdings of

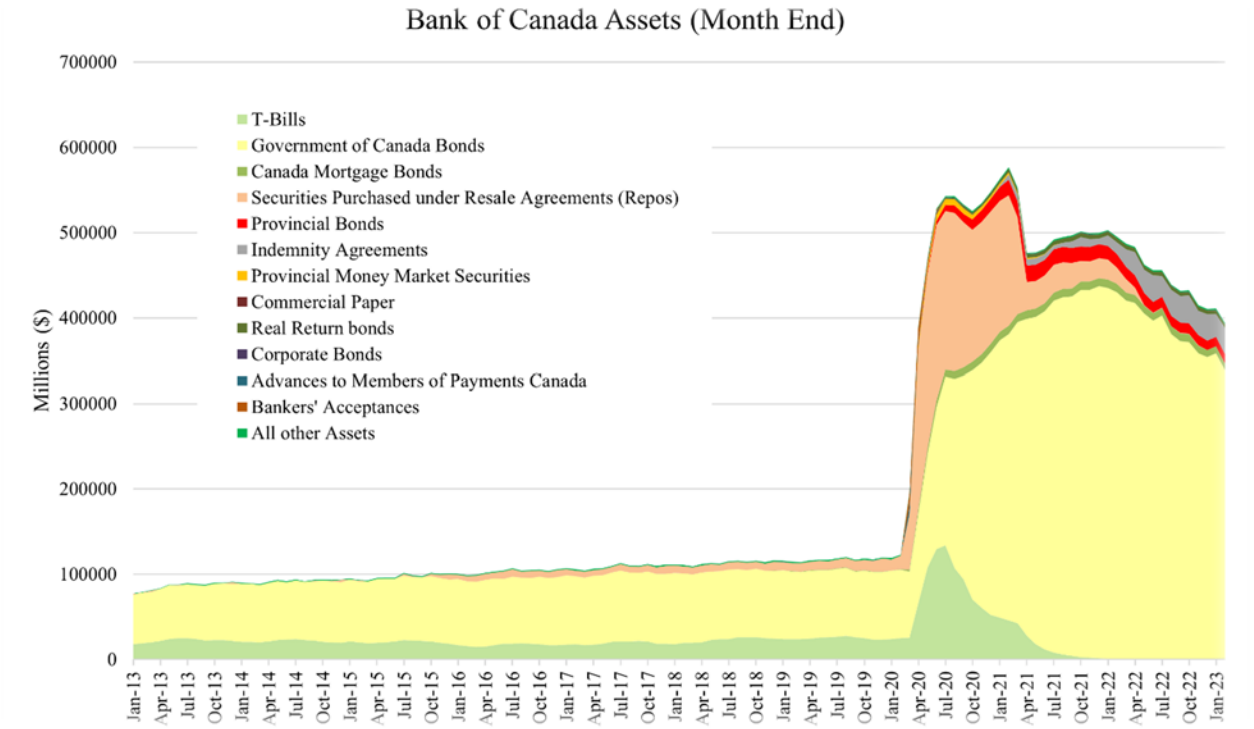

Figure 2: Bank of Canada's Assets (Monthly Data, Source: Bank of Canada)

Treasury bills had risen to $134 billion from $26 billion in March 2020, and its holdings of repos had risen to $186 billion from $65 billion (March 2020), even though the bank had purchased other securities at various maturities, e.g., long-term government bonds and provincial and corporate bonds. However, as of February 2023, the outstanding bonds are mainly government bonds, provincial bonds, and mortgage bonds, with zero T-bills and repos. In addition, according to the current allocations of assets on the BoC's balance sheet, around 90% of the BoC's holdings are bonds issued by the Canadian government. Though in the initial month (March 2020) of QE, the amount of total government bonds in the BoC's assets was $78 billion, it became $307

billion by the end of the year 2020, and by December 2021, it had reached its highest peak of $436 billion throughout the QE program.

Inflationary pressures have been developing since the middle of 2021 and into October 2021. Therefore, the BoC announced discontinuing QE (as of April 2022) in response to the robustness of the economic recovery until further notice. The BoC decided to acquire Canadian government bonds only to replace ones that had already matured. With a large drop in securities bought via resale agreements, the bank's total assets dropped to $497 billion at the time of this announcement. Now the assets of the BoC are shrinking. The assets that reached $577 billion in February 2021 have come to $394 billion in February 2023. It showed a 32% drop in assets over these two years. Although the BoC stopped making weekly purchases in October 2021 and had almost no Treasury bills outstanding, it did have 43% of the total bonds issued by the Canadian government at different maturities.

The liabilities of the BoC are presented in Figure 3. At the beginning of 2020, the total liabilities held by the BoC were $119 billion, where the Canadian government had reserves of $24 billion, notes in circulation of $89 billion, and only $250 million in settlement balances held by banking institutions. The BoC saw a significant increase in deposits since QE was implemented. Since March 2020, Canadian government deposits have shifted from $30 billion to $148 billion by July 2020. However, the settlement balance deposits held by financial institutions have experienced the most significant growth. It increased to its peak of $387 billion by February 2021, which was six times larger than March 2020. But it dropped to $201 billion

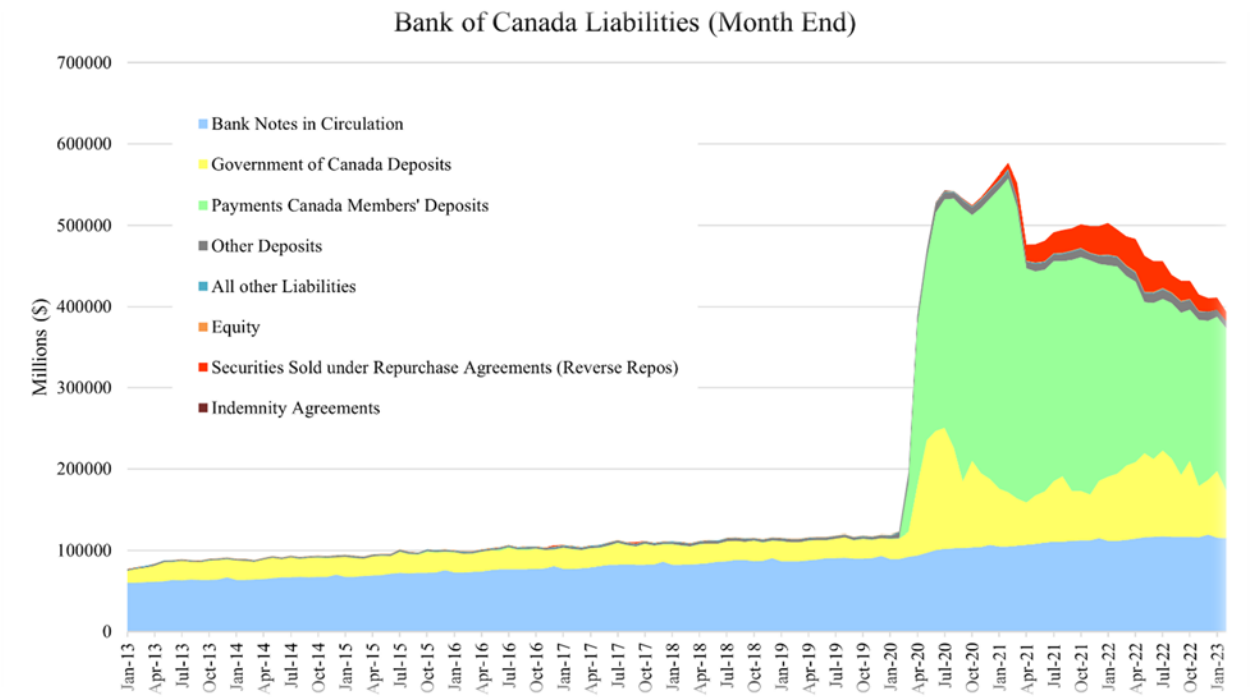

Figure 3: Bank of Canada's Liabilities (Monthly Data, Source: Bank of Canada)

by February 2023. As for the number of notes in circulation, it has gradually increased to $115 billion by February 2023, as most transactions are now conducted electronically.

To sum up, QE's implementation has increased the balance sheet of the BoC by almost five times from 2020 to 2021. Different changes have been seen on both the asset and liability sides. Figures 2 and 3 suggest that the BoC undertook different purchase approaches (T-bills, repos, government bonds, commercial paper, reverse repos) throughout QE to simulate the financial market. However, the volume of government bonds is consistent and constitutes more than 80% of the BoC's assets from 2021. On the other hand, settlement deposits held by the government and the financial institutes form a majority of the BoC's liabilities.

4. Methodology

This research has focused on the impacts of unconventional monetary instruments in the financial market. The success of this unconventional policy, QE, could be measured by the behavior in financial markets, particularly government and non-government bond yields. To quantify the whole impact of QE purchases, I conduct event-study and time-series econometric analysis following Gagnon et al. (2011).

4.1 Event Study

An event study is a statistical analysis method used to measure the impact of a specific event on markets, for example, financial market. The significant occurrences that are analyzed in an event study could be anything that has substantial influence on the market, e.g., policy announcements, regulatory changes, or any other event that could have an impact on interest rates and the value of an asset (Krishnamurthy and Vissing-Jorgensen, 2011). An event study observes a few days before and after those specific occurrences. Krishnamurthy and Vissing-Jorgensen (2011), Swanson (2011), and Gagnon et al. (2011) all adopted the event study model. They mentioned some important assumptions for conducting event studies. First, it is assumed that the event is unexpected; then, no other variables than the event under study have an effect on the values; and markets are efficient.

Similarly, this paper estimates the impacts of QE using the event-study analysis of the BoC key announcements. Following the assumptions that Gagnon et al. (2011) had implied for event study, this paper's assumptions for event study are as follows: All announcements regarding QE affected the yields in the event sets; QE expectations have not been affected by anything other than these announcements; the measures response is in windows wide enough to capture the

effects but not so wide that the yields may affect through the arrival of other events; and the market is efficient at absorbing information that affects yields while holding everything else constant.

To be consistent with literature, this paper initially follows the reaction of interest rates by employing a one-day window around the announcements (Gagnon et al. 2011), starting the changes of the closing level on the day of the announcement with the closing level on the day before the announcement. Later, this paper also accounts for the two-day window by observing the changes between two days prior to the event and the event date. While a one-day window is often examined in event studies to avoid the cross-referencing of measured responses with irrelevant data, a wider window (a two-day window) is relevant here since it is possible that the event information has been anticipated by the market earlier. For example, Bernanke et al. (2004) looked at events related to the purchase of longer-term Treasury securities over a wider window. They found that the yields on such securities decreased considerably when the market anticipated a future decrease in the net supply of those securities. Therefore, I observe a two-day window to estimate the effects of an event where it is assumed that the event information has been anticipated by the market earlier than the occurrence of the event. A wider window, e.g., a three-day or four-day window, than a two-day window may contaminate the market with other information rather than QE. However, it is worth mentioning that there are other effects that may not be captured by one-day and two-day windows. For example, QE's adjustments might absorb monetary policy shocks more slowly because of the uniqueness of the QE and the mechanisms through which it works, e.g., purchasing different maturity bonds at different periods.

For the event study, I consider two-year to ten-year government yields and other financial variables, e.g., provincial and municipal bond yields; collateralized bond yields; investment-

grade corporate bond yields; and high-yield corporate bond yields. Here, two-year, five-year, seven-year and ten-year government bond yields show whether QE successfully leads to a reduction in government bond yields; provincial and municipal bonds will identify the effect of QE on local government bond yields; and corporate bond yields will determine the portfolio rebalancing effects on assets due to the key announcements. I also consider term premium, which is the difference between ten-year government bond and three-month Treasury bill yields, to observe the effects of the BoC's GBPP on term premium.

In this paper, I estimate the effects of key official announcements that each revealed significant data on GBPP. "Key Event Sets" are determined by the six significant official announcements of the GBPP program. The list of these six announcements is as follows:

1. 27th March 2020, the day when the BoC announced to launch QE by purchasing government of Canada securities in the secondary market. Purchases began with a minimum of $5 billion per week across the yield curve and will be continued until the economic recovery is well underway.
2. 15th April 2020, besides government bonds, the BoC announced to purchase provincial, ($50 billion) mortgage and corporate bonds ($10 billion).
3. 23rd April 2020, for managing the ongoing program, the BoC announced to assign asset manager to purchase provincial and eligible corporate bonds in the secondary market on behalf of the Bank.
4. 26th May 2020, as a part of the program, the bank started buying real return bonds (RRBs) up to $700 million from the secondary market.
5. 20th July 2020, for the purpose of supporting core funding markets and fostering the well-functioning of the Government of Canada securities market, the BoC announced the introduction of securities repo operations (SROs) in the program. It was intended to temporarily boost the source of Government of Canada nominal bonds and Treasury bills, to support liquidity in the securities financing market.

6. 15th October 2020, as the overall financial market conditions had improved through the QE program, the BoC announced that it would decline its functions in government bond purchases by shifting its purchases to mortgage bonds, and term repo operations.

4.2 Time Series Study

This paper also adopts the statistical model that Gagnon et al. (2011) have suggested in their paper to examine the effect of the central bank's asset purchases on the ten-year government bond's term premium. They used the US pre-Great Recession data to run OLS regression to study the effect of QE on the 10-year term premium. They estimated the effect of the changes of public bond supply on term premium; and conducted out-of-sample analysis to quantify the effect of QE during the Great Recession on term premium. Following Gagnon et al. (2011), I conducted a similar study using Canadian data. I use monthly data from January 2009 to December 2019 encompassing the data sample that ends before the initial announcement of QE in March 2020. The datasets are collected from Statistics Canada, the BoC database, the OECD, S&P Dow Jones Indices and Koyfin database. Afterwards, I quantify the effects of QE during COVID-19 through out-of-sample analysis.

In this analysis, I estimate the effect of QE by assessing the term premium for ten-year government bond yields over three-month Treasury bill yields. In particular, I estimate the pre-QE historical term premium's variability using data that captures the business cycle fluctuations, the uncertainty about economic fundamentals, and the net public-sector supply of longer-term dollar-denominated debt securities (Gagnon et al. 2011). I quantify the impact that shifts in the supply of longer-term debt held by public investors have on the term premium. Since QE, the BoC's government's asset purchases have reduced the availability of longer-term debt securities to public investors, so I can use the estimation from the pre-QE sample to forecast the effects of QE.

The ordinary least squares regression model consists of dependent or response variable (TP_t) and explanatory variables (X_t). The dependent variable, (TP_t), is the 10-year term premium, which is the gap between ten-year government yields and three-month T-Bills; and X_t is a set of explanatory variables. The explanatory variables are divided into three sets of variables. For cyclical factors, the unemployment gap and core CPI; for uncertainty, inflation disagreement and realized volatility; and for supply, government bonds held by the public, are considered explanatory variable sets. The regression model of the 10-year term premium on the explanatory factors is as follows:

$$TP_t = X_t\beta + \varepsilon_t$$

The descriptions of the dependent and explanatory variables are:

- *Term Premium (TP):* In this model, the dependent variable "Term Premium" is calculated by subtracting 10-year government bond and three months T-bills yields.
- *Unemployment Gap*: The unemployment gap is measured as the difference between the unemployment forecast and the unemployment rate. Here, the unemployment forecast is from the database by the OECD for the Canadian economy.
- *Core CPI:* Core CPI is measured from CPI data after deducting food and energy prices.
- *Inflation Disagreement:* Inflation disagreement is the gap between forecasted inflation and the CPI. The inflation forecast data has been collected from the OECD database.
- *Realized Volatility:* Realized volatility describes the actual movements in an asset's price or interest rate over a specific period. It measures the asset's standard deviation in daily returns over a period, such as a month or a year. As a proxy to the interest rate uncertainty, this paper incorporated the six-month realized daily volatility of the ten-year government bond yields. This data has been collected from the Koyfin database.
- *Government Bond Holdings by the Public:* In this variable, I estimate the securities held by the public (for more than one year), including private investors and others except the BoC's government bond holdings. Afterwards, it has been expressed as the percentage of GDP for capturing the net public sector supply of long-term debt to GDP ratio.

5. Results

5.1 Event Study

Tables 1 and 2 depict yield movements in the aforementioned key event sets. According to Tables 1 and 2, yields on government bonds and other financial instruments have changed significantly throughout the course of the key event sets. For the one-day window, I observe the yield movement from the day before the announcement to the day of the announcement. Moreover, in the two-day window, the movement of yield has been observed with two days before from the announcement date, assuming that the market predicts that event's information earlier than the announcement. For example, to observe the one-day window effect of the 10-year government bond yield on March 27, 2020, I subtract the 10-year government bond yield of March 26, 2020, from March 27, 2020's yield, which is negative 15 basis points. Similarly, to calculate two-day window effects, I deduct the 10-year government bond yield on 25th March 2020 from 27th March 2020, that is a negative 19 basis points.

According to Table 1, in one-day's response, the aggregate effects of key event sets which are for the period between March 27 and October 15, 2020, show 10-year, 7-year, 5-year, and 2-year government bond yields; and the term premium declined by 27, 20, 19, 21, 6 basis points, respectively. On other financial instruments mentioned in Table 2, provincial and municipal, collateralized and investment grade corporate bond yields fell by 28, 19, and 37 basis points, respectively in one-day response. Such yield drops in other financial instruments prove that the large amount of government bond purchases by the BoC have portfolio balance effects.

Key Event Sets' Date	Aggregate Govt. Bond Yield		10Y Govt. Bond Yield		7Y Govt. Bond Yield		5Y Govt. Bond Yield		2Y Govt. Bond Yield		Term Premium (10Y-3M T-bills)	
	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response
27-03-20	-14	-16	-15	-19	-13	-16	-14	-16	-15	-17	1	-2
15-04-20	-13	-15	-12	-11	-10	-12	-9	-12	-5	-8	-7	-3
23-04-20	-1	1	-2	-2	1	4	1	4	-1	1	-2	1
26-05-20	3	4	5	5	6	3	6	4	3	1	3	3
20-07-20	-2	-1	-2	-2	-2	0	-2	1	-2	1	-1	-1
15-10-20	-1	-1	-1	-1	-2	-2	-1	-1	-1	-2	0	-1
Aggregate Effects	-28	-28	-27	-30	-20	-23	-19	-20	-21	-24	-6	-3

Table 1: Event Study on Government Bond Yields and Term Premium (Basis Points)[c]
Sources: S&P Dow Jones Indices, StatsCan, and Bank of Canada

[c] All basis points are rounded to integers.

Key Event Sets' Date	Provincial & Municipal Bond Yield		Collateralized Bond Yield		Investment Grade Corporate Bond Yield		High Yield Corporate Bond Yield	
	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response
27-03-20	-12	-12	-9	-10	-18	-24	13	-33
15-04-20	-17	-19	-7	-8	-12	-16	-17	-26
23-04-20	-1	1	-2	6	-1	1	3	-12
26-05-20	5	8	2	1	-3	-4	12	12
20-07-20	-2	-1	-2	-1	-2	-1	-3	-4
15-10-20	-1	1	-1	-1	-1	-1	0	-3
Aggregate Effects	-28	-22	-19	-13	-37	-45	8	-66

Table 2: Event Study on Non-Government Bond Yields (Basis Points)[d]
Sources: S&P Dow Jones Indices, StatsCan, and Bank of Canada

[d] All basis points are rounded to integers.

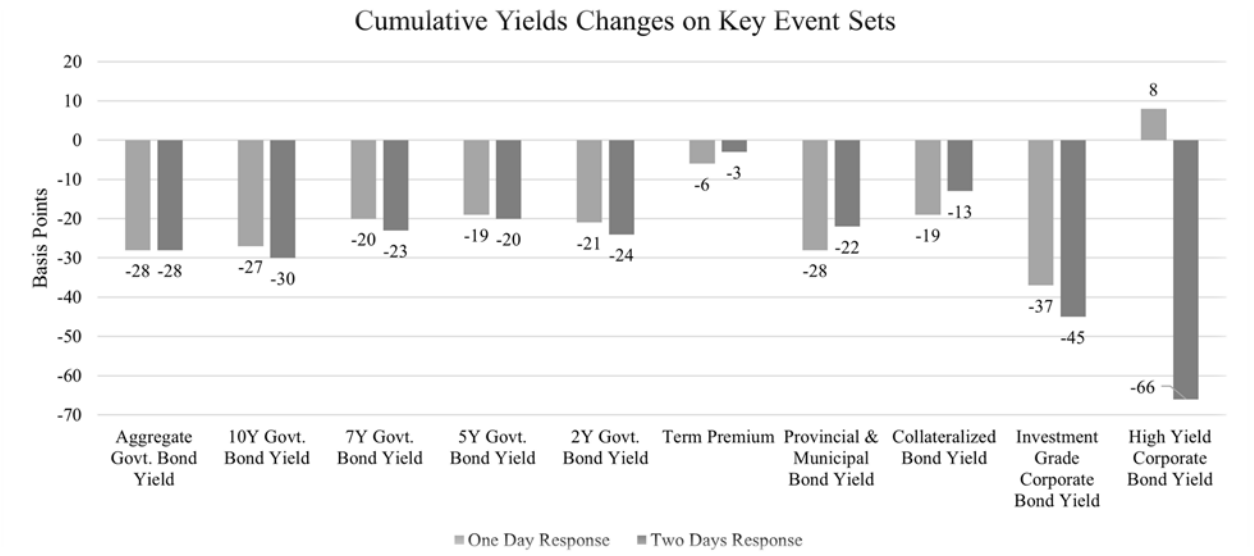

Figure 4: Cumulative Yields change on Key Event Sets
Source: S&P Dow Jones Indices, StatsCan, and Bank of Canada

Figure 4 further compares the aggregate effects of QE's key announcements between one-day and two-day window. As stated in Figure 4, at the two-day response, almost all yields except provincial and municipal, and collateralized yields have dropped in the range of 0 (in aggregate government bond yields) to 74 (in high-yield corporate bond yields) basis points compared to one-day response.[e] So, the key event-set announcements have more than a one-day window impact on the Canadian economy. The greater drops from one-day to two-day response in government bond yields are an indication that markets had previously assigned some likelihood to additional rises in the QE's operations. However, the larger drops in corporate bond yields from one-day to two-day response by 8 and 74 basis points in investment-grade and high-yield corporate bond yields confirm the existence of portfolio rebalancing effects in the financial market.[f] It appears that the event study needs a wider window (two-day) to capture the effect on

[e] 0 (28-28 = 0) and 74 (8-(-66) = 74) are calculated by subtracting the aggregate government bond yield from the one-day to two-day window.
[f] 8 is calculated by subtracting the investment-grade corporate bond yield from the one-day to two-day window (45-37 = 8).

the financial market; not more than a two-day window, e.g., a three-day or four-day window, as it may have the possibility of other information arriving in the market that may affect the yields.

Overall, I find that around the time of key QE announcements, the aggregate longer-term government yields dropped by 28 basis points. Besides, 10-year government bond yields decreased the utmost by 30 basis points at two-day response among all government bond yields. Though, the 6 basis points fall in term premium suggests that the yield gap between long-term and short-term government bonds was not large. Generally, this event effect is dependent on the event set and reaction window chosen.

5.2 Time Series Results

Details	Coefficient	Std. Error
Constant	-0. 756***	0.164
Cyclical Factors		
Unemployment Gap	0.00666	0.0583
Core CPI	0.0309**	0.0137
Uncertainty		
Inflation Disagreement	0.0517*	0.0284
Realized Volatility	1.098***	0.0151
Supply		
Public Debt Supply	0.0282***	0.00589
Adjusted R Squared	0.993	
Number of Observations	132	

*P<0.10, **P<0.05, ***P<0.01

Table 3: OLS Regression of Term Premium, January 2009–December 2019

On the other hand, Table 3 shows, a regression analysis of the ten-year term premium on the explanatory variables measure. According to the results in Table 3, most of the explanatory factors are statistically significant. Moreover, the coefficient signs of explanatory variables for term premium are supported by the literature. The estimated model shows that the increases of one percentage point in the unemployment gap, core CPI inflation, inflation disagreement, and

realized volatility raise the term premium by approximately 0.7, 3, 5, and 110 basis points, respectively. Also, for debt supply, the debt-to-GDP ratio is calculated dividing the longer-term government bonds held by the public (except the BoC's holdings) by GDP. Therefore, a one-percentage-point increase in public debt-to-GDP ratio raises the ten-year term premium by 2.8 basis points. Given that the increase in government debt held by the BoC implies a decrease in government debt held by the public, this result also implies that a one-percentage-point increase in the longer-term government bond held by the BoC will decrease the ten-year term premium by 2.8 basis points. Also, this debt-to-GDP ratio coefficient is statistically significant at the 1% level.

At the end of 2020, the BoC had increased its balance sheet by around $260 billion in asset purchases, which is 12 percent of total GDP. According to the estimation, the overall the BoC's asset purchases will lower the term premium by 34 basis points. Also, during this period, the BoC acquired around $43 billion in five- to ten-year equivalent bonds, which was nearly 2.2 percent of 2020's total GDP. So, the calculations in Table 3 suggest that these 5- to 10-year government bond purchases by the BoC will lower the term premium by 6.2 basis points.

5.3 Discussion of Results

According to the findings of the event study, a two-day response has confirmed more drops in bond yields, especially in 10-year government bond yields and corporate bond yields. The drop of corporate bond yields suggests the portfolio balance effect of QE. That is, after the large purchases of longer-term securities by the BoC, long-term securities become scarcer, which increases their prices and decreases their yields. But if the asset is hard to substitute, such purchases by the BoC will impact other assets in the financial market. For example, if the BoC purchases large amounts of 10-year government bonds from the financial market, the supply of

10-year government bonds will be low, and the public will spend more on other assets available in the market. Thus, the event study finds significant drops in corporate bond yields through portfolio rebalancing. Gagnon et al. (2011) and Reza et al. (2015) found substantial evidence for the significance on the portfolio rebalancing effect in the U.S. LSAPs in government bonds. In the UK, Joyce et al. (2014) observed that the Bank of England's asset purchases encouraged investors to reallocate their portfolios from government bonds towards corporate bonds through portfolio rebalancing.

In addition, comparing the results in the paper with the existing studies, my result is consistent with Gagnon et al. (2011) on the US financial market, where I find that the one percent unit increase in the debt-to-GDP ratio would lower the term premium by 2.8 basis points. The OLS results predict that the implication of QE of $43 billion 5-10 year government bond purchases in 2020 may decrease the overall government bond yield term premium by 6.2 basis points in the Canadian economy. The results from the event analysis's key announcements show that the term premium has decreased by 6 basis points at the one-day window, which is surprisingly close to where the results were derived using totally different data and methodology.

According to the calculations in Table A1, the longer-term government bond yields have increased overall throughout the QE programs (26-03-2020 to 12-04-2022). This outcome suggests that the programs had little long-term impact (Zhang et al. 2021). Also, these results can be supported by Reza et al. (2015), that QE may have less of an impact on the term premium in an open capital market economy (e.g., Canada) than it would be in a major and relatively closed country (e.g., the United States). Yet, the effects are observable by lowering other bond yields, e.g., corporate bonds, up to 355 basis points (Table A1) through portfolio rebalancing. Even though the QE has not had a longer effect on the Canadian economy as it has on other

economies, e.g., the USA and the UK; it is still visible and effective. Due to the infrastructure of the market and the robustness of the economy, the Canadian economy has seen an early recovery from financial distress.

6. Conclusion

In this paper, I followed Gagnon et al. (2011) and Joyce et al. (2011). This analysis focuses on one of the most important policy tools available at effective lower bound (ELB): the large-scale purchases of longer-term assets (QE) that the BoC has experienced since March 2020.

The Bank of Canada (BoC) implemented quantitative easing (QE) via the Government Bond Purchase Program (GBPP) in Q2 2020 to support inflation and GDP during economic distress caused by the pandemic. In this paper, I conduct an event study and OLS regression to quantify the effects of QE. I find that the GBPP reduced the net supply of long-duration assets, which decreased the term premium and had a significant impact on non-government bond yields, indicating its effectiveness in rebalancing financial markets. Although, the expansion of the BoC's balance sheet and the acquisition of a large number of securities in a short period posed operational obstacles, but the study found extended monetary policy (QE) effective when the ELB prevails.

In this paper I focus on the portfolio balance effect; however, other channels could have a role in reducing the term premium, e.g., the signaling channel. The BoC signaled to the market that interest rates would remain low by executing a future course of actions. The market participants expected the entire amount would be acquired by the BoC, which decreased the longer-term yields in later announcements. In addition to QE, the BoC initiated quantitative

tightening (QT) in April 2022. That is, BoC is no longer replacing maturing Government of Canada bonds on its balance sheet (Bank of Canada, 2022).

Even if the QE appears successful, it will be worthwhile to reflect on its structure and evaluate whether the strategy used was the most effective. As the economy progresses, other extended monetary policy studies, e.g., further QE and QT, could be incorporated to measure and supplement fiscal policy, especially in anticipation of potential future recovery paths.

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Appendices

Appendix A

Table A1: Summary of Event Study (Basis Points[g])
Sources: S&P Dow Jones Indices, StatsCan, and Bank of Canada

	Aggregate Govt. Bond Yield		10Y Govt. Bond Yield		7Y Govt. Bond Yield		5Y Govt. Bond Yield		2Y Govt. Bond Yield		Provincial & Municipal Bond Yield		Collateralized Bond Yield		Investment Grade Corporate Bond Yield		High Yield Corporate Bond Yield	
	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response	One Day Response	Two Day Response
Effects of Key Announcements	-28	-28	-27	-30	-20	-23	-19	-20	-21	-24	-28	-22	-19	-13	-37	-45	8	-66
Cumulative Changes (26-03-2020 to 12-04-2022)	104	220	176	361	171	354	174	362	173	355	111	234	156	320	30	72	-187	-355
SD of Daily Changes (26-03-2020 to 12-04-2022)	4	5	5	6	4	6	4	6	3	5	4	5	10	12	4	5	7	9

[g] All basis points are rounded to integers.

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