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Macroeconomic Determinants of Corporate Credit Spreads: Evidence from Canada

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Abstract

How important are macroeconomic factors relative to financial factors in explaining the variation in corporate credit spreads in the Canadian bond market? The answer to this question is of great significance in managing the risk associated with fixed-income securities and also in preventing the negative consequences that widening of spread has on real activity. I find that although the macroeconomic determinants both in their levels and volatilities have significant effects on credit spread, their contribution in explaining the variations in spreads is actually quite small. Much of the variation in spreads are attributed to the unobserved bond-specific heterogeneity, which reaffirms the existence of a - credit spread puzzle.

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1 Introduction

Since the financial crisis of 2007-2009, the analysis of credit spreads and how they behave with different economic scenarios has gained significant momentum. Following suit of the U.S. and the EU, Canada's bond market has been expanding in size. Moreover, the inflation targeting interest rate remaining low in Canada (0.25%) encourages Canadian investors to divert their investments from low-yielding government bonds to higher-yielding investment grade, high yield, or global bonds. In the past decade, total outstanding Canadian dollar-denominated corporate bonds have increased by almost 70% (see Figure:A-1). In addition, the new issuance of domestic corporate bonds in Canada is also on the rise since 2010 (see Figure:A-2). This domestic bond market growth greatly influences the composition of portfolios held by financial institutions, firms, trusts, and private investors. An increase in new issuance and the amount outstanding of risky corporate bonds are also associated with higher risk and thus call for better risk management to prevent the negative consequences wider credit spreads can have on real activity. This chapter explores the determinants of credit spreads and analyzes the relative importance of various macroeconomic and financial factors in explaining the variation of corporate credit spreads in the Canadian bond market.

A corporate bond's credit spread is the additional yield a (risky) corporate bond pays over a (riskless) government bond with matching maturity. It is a widely used measure of a company's cost of borrowing and creditworthiness. The spread reflects the premium an investor demands to invest in risky security. An increase in spread limits a borrower's ability to obtain further funding, which negatively affects the value of its assets and curbs its growth. This reduction in a firm's value through the financial accelerator channel further cuts the firm's borrowing potential, resulting in an even wider spread. Moreover, credit spreads are forward-looking and thus contain important information about investors' perception of future risk. The high information content of bond spreads acts as a leading indicator in providing early warnings of changes in real activity (Gilchrist and Zakrajšek (2012); Bleaney et al. (2016)).

Therefore, it is crucial to identify the driving factors behind movements in credit spreads, which can help policymakers better understand the risks associated with fixed-income securities and stabilize the economy in a risky event by providing appropriate policies. Previous studies attempt to identify the determinants of corporate bond credit spreads both from theoretical and empirical perspectives. Theoretical models have adopted two separate approaches to model credit risk: structural approach and reduced-form approach. Despite challenges associated with the implementation, these models have been able to identify variables such as the risk-free rate, slope of the yield curve, equity return and volatility, and recovery rate as important determinants of credit spreads.[1] However, the predicted spreads generated by the structural models do not match with empirical data. Collin-Dufresn et al. (2001) show that most of the determinants proposed by the structural models have very limited explanatory power. A theoretical study by Tang and Yan (2006) incorporates factors containing macroeconomic influence such as cash flow beta instead of firm value in their model. The default probabilities and credit spreads generated by this model perform better than the traditional structural models in matching the data.

Huang and Huang (2012) show that for higher rated bonds, the credit spreads predicted by the structural models are significantly below the actual numbers giving rise to the so-called - credit spread puzzle. The limitations in the empirical application of the theoretical models prompted the empirical literature to identify the determinants of credit spreads beyond those proposed by the theoretical models. The empirical literature suggests that incorporating a set of macroeconomic factors in addition to the theoretical determinants can explain a significant proportion of the variation in credit spreads. The determinants identified by the empirical literature ranges from bond- and firm-level variables like individual bond characteristics, liquidity risk, equity volatility, issuer credit rating to macroeconomic factors like monetary policy, taxation, and inflation (Collin-Dufresn et al. (2001); Elton et al. (2001); Campbell and Taksler (2003); Avramov et al. (2006); Duffie et al. (2007); Cenesizoglu and Essid (2012)). But even after including determinants additional to the theoretical determinants,

[1] Structural models (Black and Scholes (1973); Merton (1974); Black and Cox (1976); Longstaff and Schwartz (1995)) assume that corporate bond defaults when the company value falls below a threshold level. These models are based on the contingent claim hypothesis that assumes a firm's liabilities as a contingent claim to its assets. Thus, the firm value becomes the only source of uncertainty in these models. Although structural models provide better insights into the determinants of credit spreads, they are difficult to implement as firm value is not directly observable. On the other hand, the reduced-form models attempt to model the probability of default instead of firm value. The reduced form models specify default as a random event governed by some exogenous hazard rate that follows a Poisson distribution (Jarrow et al. (1997)). However, these models are better suited to price derivatives as they are heavily reliant on default intensity and lack economic interpretation.

the empirical literature has not been able to explain a significant portion (75%) of the variation in the spreads. Collin-Dufresn et al. (2001) finds that the returns of the S&P 500 have significant explanatory power to explain the spreads for U.S. corporate bonds. But they find that even after incorporating the returns with the determinants suggested by the theoretical literature, their model can explain only about a quarter of the variance in the spreads of U.S. corporate bonds as measured by the adjusted R squared. Elton et al. (2001) find significant improvement in explaining the variations in spreads (R^2 equal to 0.32 for industrial bonds and 0.58 for financial bonds) after including tax effects in their model. Thus, a lot of the variation in the corporate bond credit spreads remains unexplained. Some studies try to explain the gap between observed credit spreads, and the estimated credit spreads from the existing empirical models with credit risk and liquidity risk (Perraudin and Taylor (2003); Driessen (2005)). Amato and Remolona (2003), however, suggest that this gap attributes to the diversification risk. Gilchrist and Zakrajšek (2012) try to explain the puzzle in the context of 'excess bond premium'. The literature is yet to reach a conclusive solution to this puzzle.

My research is also partly motivated by this credit spread puzzle in the context of the Canadian bond market. Majority of the studies in the literature use data on U.S. corporate bonds. Despite being highly integrated with the U.S. market, the Canadian bond market has some distinctive features that make it well suited to examine the determinants of spreads of Canadian corporate bonds. Compared to the U.S., the bond market in Canada is much smaller, less liquid, and a tiny fraction of total debt issuance are high-yield bonds.[2] In the final quarter of 2019, bonds and debentures accounted for about 61.7% of the total borrowing by the financial sector and 22.3% (approximately $0.3 trillion CAD) for non-financial firms in Canada. In the U.S., bonds constituted about $5.7 trillion USD in liabilities by U.S. non-financial corporate sector in the same quarter.[3][4] Although the size of the corporate bond market in Canada is quite small, previous studies find corporate credit spreads to be important as a signal for economic activity in Canada (Leboeuf and Hyun (2018)). However,

[2]High-yield bonds are the bonds that pay higher interest rates than investment-grade bonds. The high-yield bonds have a lower credit rating (below BBB from S&P or below Baa3 from Moody's) than the investment-grade bonds. Due to their high probability of default, the high-yield bonds pay a higher interest rate to compensate the investors for the increased risk.

[3]Quarterly balance sheet and income statement by industry, Statistics Canada. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3310000701

[4]Balance sheet of Nonfinancial Corporate Business, Board of Governors of the Federal Reserve System (U.S.), Nonfinancial Corporate Business; Debt Securities; Liability, Level [NCBDBIQ027S], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/NCBDBIQ027S

not much work has been done on identifying the determinants of these spreads for the Canadian corporate sector. Analyzing the contribution of different risk components, Leboeuf et al. (2017) find default risk arising from falling oil prices explain the increase in spreads for the energy sector in Canada but the variations in spreads for other investment-grade firms remains largely unexplained. This chapter aims to contribute to the literature by identifying the individual determinants driving the corporate credit spreads and their relative contribution towards explaining the variation in spreads in the Canadian bond market.

I use quarterly panel data on option-adjusted spread (OAS) of individual bonds, denominated in Canadian dollars issued by Canadian nonfinancial corporations, to estimate a bond-level OLS regression and examine the impact of a list of macroeconomic variables along with some firm-specific and bond-specific controls.[5] I estimate the baseline regressions both by pooling the data as well as by incorporating bond fixed effects to account for potential bias that might arise from bond-specific heterogeneity. A variance decomposition analysis further shows which factor accounts for the most substantial variation in the spreads. To explore if the findings vary with default probabilities, I estimate the baseline regression (with bond F.E.) and perform the variance decomposition analysis for bonds with different rating classes separately.

The results show that macroeconomic factors significantly affect credit spreads in their levels and volatility. Although the exchange rate has the strongest effect on spreads in the level form, as far as the volatilities of the determinants are concerned, spreads are more sensitive to a volatile stock market. The findings associated with firm fundamentals show that firm liquidity and firm leverage have a moderate impact on the bond spreads, but firm size and profitability do not significantly affect the spreads. However, the effects of firm fundamentals substantially vary in magnitude, sign, and statistical significance across sub-samples of bonds with different ratings. While the bonds' maturity significantly affects spreads in the full sample, but across ratings, the effects are significant only for A rated bonds. A variance decomposition analysis shows that macroeconomic variables have a small contribution in explaining the variation in spreads across all rating classes. Interestingly, bond-specific fixed effects have a large contribution towards explaining the aggregate spreads. A critical finding from this analysis is that the major contributing factor in the spread variation is different for different rating classes. While macroeconomic factors contribute more to the variation of

[5] Sections 3.1 and 3.2 provide a detailed explanation OAS and the full list of firm-specific, bond-specific and macroeconomic variables included in the model.

spreads for higher rated bonds, the unobserved bond-specific characteristics become a more prominent contributor in the variation of spreads of the riskier bonds. The results are robust across different model specifications and also for different data frequencies.

The findings of this chapter contribute to the literature in multiple ways. This chapter analyzes different determinants of corporate credit spreads and their relative contribution towards explaining the variations in the spreads using the Option Adjusted Spreads data for Canadian non-financial corporations. The findings show that when the economy performs well, i.e., when the GDP growth and the stock returns are high, the spreads decline, but at the same time, if the economy or the stock market is more volatile, the spreads rise. In addition, increased uncertainty about economic policies can increase spreads in the future. These findings will help policymakers determine the overall impact targeted policies can have on investors' perceptions and risk appetite. Another significant contribution of this chapter is that it highlights the importance of unobserved firm-specific (embedded in bond-specific F.E.) characteristics in explaining the variations in the spreads. Without controlling for these characteristics, the model can explain only a small fraction of the total variation (R^2=0.17) in spreads. When pricing risk, it is important to carefully consider the time-invariant heterogeneity between firms, e.g., corporate governance, managerial attributes, a firm's compensation structure, etc. Moreover, the lack of portfolio diversification opportunities in the Canadian corporate bond market may prevent investors from diversifying risks and increase the cost of borrowing by firms.

The chapter is organized as follows: Section 2 provides a theoretical model on credit spread, Section 3 provides description of data and econometric methodology, Sections 4, 5, and 6 summarize the regression results across different specifications and data frequencies, and Section 7 concludes.

2 A theoretical model on credit spread

One of the first structural models of credit spreads is the Merton model. The Merton model is based on the Black-Scholes-Merton option pricing theory. The simplest form of the model assumes that the firm does not pay dividends, has only one liability claim (a zero-coupon bond), and the financial markets are perfect.

Suppose that the firm's only debt liability is a zero-coupon bond with a face value of F with the bond maturing at time T. At maturity T, if the firm value V_T is so low that the firm is unable to pay the principal amount, then the equity holders receive nothing, and the firm is bankrupt. Alternatively, suppose the firm's value at time T is sufficiently large enough to pay back the principal of the bond. In that case, the equity holders receive the remaining value net of payments to debt holders, i.e., the equity holders receive $V_T - F$. This payoff combination is the same as the payoff from holding a call option with firm value as the underlying asset and an exercise price of F, the face value of the debt. The value of equity at maturity is, therefore,

$$S_T = max(V_T - F, 0) \tag{1}$$

If the debt were risk-less, the debt holders would always receive the face value of the debt (F) regardless of the firm value (V_T). But because debt is risky, if the firm value is less than the face value ($V_T < F$), then the debt holders receive a payment that is less than the face value (F) by the amount $F - V_T$. However, if the firm value is higher than the face value of debt (i.e., if $V_T > F$), then the debt holders' receive a payment of F regardless of the firm value. So the value of the debt is

$$D_T = min(F, V_T) = F - max(F - V_T, 0) \tag{2}$$

This payoff is equivalent to buying a zero-coupon bond with a face value of F and selling a put option written on the firm value with an exercise price of F.

In the Merton model, the dynamics of firm value follows a Brownian motion which is given by the equation below:

$$\frac{dV}{V} = \mu dt + \sigma_V dW_t \tag{3}$$

where, μ is the mean rate of return on the value of assets of the firm, σ_V is the volatility of firm value, and W_t is a standard Weiner process.[6]

We know that the value of the firm equals the summation of the values of its debt and

[6] A Weiner process has the following properties; (i) The increments in W_t are unpredictable and uncorrelated with past increments, (ii) The increments $W_{t+s} - W_t$ are normally distributed with mean 0 and variance s; (iii) W_t is continuous in time t.

equity. Thus

$$V_T = D_T + S_T$$
$$or, D_T = V_T - max(V_T - F, 0) \quad (4)$$

So the value of the debt can also be expressed as the difference between the value of the firm and a call option written on the value of the firm with an exercise price of F.

Then the Black-Scholes-Merton option-pricing model for the European call option can be modified to value equity of the firm at a time period prior to T, (T-t). The value of the equity then becomes:

$$S_t = V_t N(d_1) - Fe^{-r(T-t)} N(d_2) \quad (5)$$

where, $N(d_1) = \frac{ln(\frac{V_t}{Fe^{-r(T-t)}})}{\sigma_V \sqrt{T-t}} + \frac{1}{2}\sigma_V \sqrt{T-t}$; $N(d_2) = \frac{ln(\frac{V_t}{Fe^{-r(T-t)}})}{\sigma_V \sqrt{T-t}} - \frac{1}{2}\sigma_V \sqrt{T-t}$

$N(d_i)$ = cumulative normal distribution evaluated at d_i; r = continuously compounded risk-free rate.

Now, a zero-coupon risky bond with face value 1 and maturity T will have the price $P(T) = D_t/F$. The credit spread on a defaultable/risky bond with maturity T can then be calculated as the difference between the yield of a defaultable zero-coupon bond (Y^d) and the yield of a risk-free zero-coupon bond (R_f) with maturity T,

$$CS = Y^d - R_f = -\frac{1}{T-t} ln(\frac{D_t}{Fe^{-r(T-t)}}) = -\frac{1}{T-t} ln(e^{r(T-t)} \frac{V_t}{F}(1 - N(d_1) + N(d_2)) \quad (6)$$

Equation 6 shows that, credit spread depends on the risk-free rate, the firm's asset value (V_t), and the volatility of firm value (σ_V).

3 Data and methodology

I construct a panel data set of individual bonds denominated in the Canadian dollar issued by Canadian non-financial corporations. The primary data source for the firm-specific and bond-specific variables is Bloomberg Professional, which provides comprehensive coverage of bond and firm fundamentals data. I am using the option-adjusted spread (OAS) of individual bonds as a measure of credit spreads, which I obtain from Bloomberg Professional. Firm fundamentals data are only available in quarterly frequency through Bloomberg, while spread data are available on a daily frequency. As the choice of frequency is constrained by data availability, I convert the daily spread data into a quarterly average. I retrieve data on macroeconomic variables from Statistics Canada (real GDP), Bank of Canada (policy rate/interest rate, inflation rate), FRED St.Louis (exchange rate), and Yahoo Finance (S&P/TSX Composite index). The sample period of the empirical study spans from 2012-Q1 till 2019-Q3.[7] All data are adjusted for seasonality. The final sample contains 336 bonds with 5224 bond-quarter observations. Table 1 provides a summary of the rating distribution of the bonds in the sample.

Table 1: Distribution of bonds

Rating	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	Total
Frequency	1	9	11	45	107	103	43	17	336

Due to the high volume and liquidity of the U.S. bond market, the majority of high-yield bonds by Canadian corporations are issued in the U.S. bond market. Since the focus of this chapter is to study Canadian bonds issued in local currency in the domestic market, my sample only includes investment-grade bonds issued in local currency (CAD). Table A-1 provides a summary of all variables, their definitions, and sources. Since I use a sample of investment-grade bonds, it is important to check to what extent the sample represents the risk profile of the corporate sector. Towards this, I compute the average OAS for each quarter from my sample data and compare the time series with the quarterly OAS of the S&P Canada investment-grade bond index. Figure A-3 plots the two series and displays high correlation (with correlation coefficient 0.84) between the two series.[8]

[7]Historical OAS data on Canadian dollar-denominated bonds are not available before 2012-Q1 through Bloomberg.

[8]The sample period starts from 2014 Q4 due to the unavailability of data for the S&P Canada investment-grade bond index series prior to 2014 Q4.

3.1 Option adjusted spread (OAS)

As a measure of credit spreads, I use the option-adjusted spread (OAS) of individual bonds. Option adjusted spread (OAS) calculates the yield difference between a bond and treasury security after accounting for embedded options. It is the spread that must be added to the yield of benchmark security (i.e., the yield of a zero-coupon bond) such that the discounted cash flows of a bond match the market price of the bond. Typically, credit spreads are calculated by taking the yield difference between a bond and a treasury security of matching duration. When bonds embed options in them, due to the possibility of being called early, it becomes difficult to identify the date of maturity of a bond (Gilchrist and Zakrajšek (2012)). Using OAS as a measure of spread adds advantage because it calculates the spread of a bond over an issuer's spot rate curve (i.e., the yield of a zero-coupon Treasury bond) after adjusting (removing) cash flows generated from embedded options. Thus, matching maturity remains no more a concern. Moreover, this allows to include a variety of corporate bonds in the sample conditional on their structure. In my sample, more than 60 percent of the bonds embed options in them. Hence, using OAS as a measure of spread is best suited for this analysis.

Table 2 presents the summary statistics for OAS (a measure of credit spread). The average spread of bonds included in my sample is approximately 166 basis points. Bonds with lower ratings are riskier, and therefore investors expect higher compensation to account for the increased risk. This is reflected in the higher value of spread for bonds with a lower rating.

Table 2: Summary statistics of OAS

	Full sample	**BBB**	**A**	**AA**
Average OAS	166.34 (bp)	192.38 (bp)	142.73 (bp)	98.10 (bp)
No of bonds	336	163	163	10

bp is basis points. This table displays the average OAS of bonds for the full sample as well as for different rating categories. The sample consists of investment-grade bonds issued in domestic currency by non-financial Canadian corporations.

3.2 Explanatory variables

Below, I briefly describe the explanatory variables included in the empirical model distributing them in 3 categories:

Macroeconomic determinants: Previous studies have identified GDP growth rate (Tang and Yan (2010)) and inflation rate (Chun et al. (2014)) as macroeconomic determinants of credit spreads. In my analysis, in addition to the growth rate of real GDP, I include the CPI inflation rate to account for changes in the aggregate economy. Most of the previous studies (Longstaff and Schwartz (1995), Collin-Dufresn et al. (2001)) use the short-term or the long-term risk-free rate as a measure of interest rate. But in my analysis, I include the overnight interest rate as the Bank of Canada issues its monetary policy targeting this interest rate. Changes in the overnight rate influence the liquidity in the overall economy. Return data on the S&P TSX index enters the model as an explanatory variable to see how domestic stock market movements affect the corporate spreads. I also include the CAD/USD exchange rate as another macroeconomic determinant of credit spreads to see how external factors affect domestic corporations' credit conditions. I choose to include the bilateral exchange rate between the U.S. and Canada instead of the real effective exchange rate due to the high volume of trade (nearly half of total trade by Canada) between the two countries.

Firm-specific determinants: The firm-level determinants are primarily derived following Altman (2013). The variables include a measure on firm profitability (Earnings before interests and taxes (EBIT)/Asset)), liquidity (Working capital/Asset), leverage (Debt/Asset) and firm size (natural logarithm of total asset). Return on asset (EBIT/Asset) measures the effectiveness of a firm's assets before any tax or leverage considerations. Altman (2013) shows EBIT/Asset outperforms other profitability measures in predicting the financial distress of a firm. Working capital is the difference between current assets and current liabilities. Reduction in current assets relative to total assets is an indicator of a firm in financial distress, and Altman (2013) finds the Working capital/Asset ratio to be a better predictor of financial distress compared to other liquidity measures. The debt/Asset ratio measures how much of a firm's total assets are financed by borrowing. Too much debt can increase the risk of default by a firm. Previous empirical studies (e.g., Charalambakis and Garrett (2019)) find leverage ratio (Debt/Asset) to be a significant predictor of financial distress. Finally, firm size is also found to be a significant predictor of financial distress by Altman (2013).

Bond-specific determinants: For bond-specific determinants, I follow Cavallo and Valenzuela (2010) to include time to maturity of bonds and an interaction term between time to maturity and firm leverage. Firms with low levels of debt may face higher interest rate risk with longer maturity bonds because longer maturity bonds are more sensitive to interest rate changes in the future. Again, firms with high debt levels may face lower liquidity risk with longer maturity debt. The interaction term captures the possible correlation that can arise between firm leverage and term structure.

Table 3: Summary statistics of explanatory variables (2012 Q1 - 2019 Q3)

	Mean	Median	Std. Dev	CV	No of observations
Firm-specific					
Earnings before interests and taxes (EBIT)/Asset	2.005	1.760	1.627	81.147	5224
Debt/Asset	50.860	39.733	35.253	69.314	5224
Working capital/Asset	3.889	1.036	10.980	282.335	5224
Size	9.888	9.570	2.202	22.269	5224
Bond-specific					
Time to maturity	18.557	19.238	10.035	54.077	5224
Macroeconomic					
GDP growth rate	0.487	0.542	0.438	0.899	5224
Policy rate	0.997	0.997	0.425	0.426	5224
CAD-USD exchange rate	1.245	1.291	0.112	0.090	5224
Inflation rate	1.657	1.600	0.502	0.303	5224
Stock market index return	0.993	1.417	5.423	5.461	5224

Tables 3 and 4 summarize the descriptive statistics of the explanatory variables and the correlations among them. The firms included in the sample, on average, are highly levered. The distribution of their debt to asset ratios is also rightly skewed. The bonds included in the sample overall are long-maturity bonds with median maturity of 19 years. Most firm-level and bond-level variables have large variances as apparent from their coefficients of variation. Except for the moderate correlation between firm profitability (EBIT/Asset) and leverage (Debt/Asset), the majority of the firm-level variables do not share a substantial correlation with each other. In the set of macroeconomic variables, only inflation rate and the policy rate share a moderate correlation which is expected given that I use the overnight interest rate as a proxy which is a nominal measure and affected by inflation.

3.3 Econometric specification

The baseline specification I estimate is,

$$S_{i,t} = \alpha_0 + \alpha_1 F_{j,t-1} + \alpha_2 B_{i,t-1} + \alpha_3 M_{t-1} + \alpha_4 trend + \delta_i + \epsilon_{i,t} \tag{7}$$

Table 4: Correlation matrix

	Firm-specific determinants				
	EBIT/Asset	Debt/Asset	Working capital/Asset	Size	
EBIT/Asset	1.00				
Debt/Asset	0.45*	1.00			
Working capital/Asset	0.02	-0.25*	1.00		
Size	-0.3*	-0.26*	-0.03*	1.00	
	Macroeconomic determinants				
	GDP growth	Policy rate	Exchange rate	Inflation rate	Return
GDP growth rate	1.00				
Policy rate	-0.01	1.00			
CAD-USD exchange rate	-0.04*	-0.00	1.00		
Inflation rate	0.21*	0.56*	0.29*	1.00	
Stock market index return	-0.01	0.06*	-0.04*	-0.09*	1.00

This table displays the correlations among the firm-specific and macroeconomic variables used in the baseline analysis for the sample period between 2012 Q1 - 2019 Q3. * indicates significance at 5% level.

where, $S_{i,t}$ is the OAS (in basis points) of bond i in quarter t, $F_{j,t}$ is a vector of firm-specific variables for issuer j, $B_{i,t}$ are bond characteristics, M_t is a vector of macroeconomic determinants of credit spread, and $\epsilon_{i,t}$ is the error term. I also add a trend term (a linear term in time variable, quarter) to control any spurious relationship the time-varying variables share. To further control for unobserved time-invariant heterogeneity at the bond level, I include bond-specific fixed effects denoted by δ_i.[9] The regressors enter the regression with a lag to avoid any bias that might arise due to endogeneity stemming from simultaneity. The baseline specification does not include individual time dummies as the macro variables have no variation across bonds and only vary over time. I estimate the baseline regression using OLS for the whole sample as well as for different rating categories. Besides estimating the baseline specification, I provide a variance decomposition analysis to quantify the relative importance of various classes of determinants in explaining variations in the spreads. I also perform some robustness exercises, which I present in Section 5. Finally, in addition to analyzing the level effects of the macroeconomic determinants, in Section 6 I examine how the volatilities of some key macroeconomic variables affect the credit spreads.

[9] I use bond-specific fixed effects because my analysis is based on bond level spreads. Also, as bonds are nested in firms, controlling for bond-specific unobserved heterogeneity also controls the fixed-effects at the firm/issuer level.

4 Empirical results

Table 5 presents the OLS estimation results of the baseline model. Panel A reports the results from the baseline estimation of equation (7), and panel B reports results from pooled OLS estimation of the same equation, which additionally controls for bond ratings.

Both regressions produce similar coefficients for macroeconomic variables, which is expected as the macroeconomic variables do not vary across bonds. For bond- and firm-specific variables, the results vary between the two specifications. Although the Hausman test identifies OLS-FE estimation as the better fit for this model, I present the results from pooled OLS estimation to check how much the coefficients change due to the cross-sectional variation.

The coefficient of GDP growth rate is negative in both regressions, as expected from the counter-cyclical nature of credit spreads. High GDP growth indicates a well-performing economy which translates to higher asset value for firms and a narrower spread. The exchange rate coefficient is positive, which is consistent with the exchange rate risk faced by foreign investors. When exchange rates go up (the Canadian dollar depreciates), foreign investors face exchange rate risk on their expected cash flow from investment in Canadian bonds. This increased risk results in a higher yield paid by the debt issuers.

The interest rate/policy rate enters the regression with a positive coefficient. This positive coefficient implies that a corporate bond's yield is more sensitive to the interest rate increase than the yield of a risk-free bond. An increase in the overnight rate can increase the interest rate banks charge for commercial loans. Hence, it becomes difficult for firms to finance their investment through bank loans. Again, the opportunity cost for investors to invest in a bond also increases. Intuitively, this high nominal interest rate increases the risk premium of holding a corporate debt which widens the spreads. Again, the positive relationship can also stem from the correlation between the interest rate and the firm value (Collin-Dufresne and Goldstein 2001). If they are negatively correlated, then an increase in the interest rate decreases the value of the underlying assets for the firm, thereby widens the spreads.

There is a positive and significant relationship between inflation and corporate credit spreads; higher inflation leads to higher spreads. Higher inflation leads to lower expected cash flow in real terms from bond investment. Again, higher inflation also increases the nominal liabilities for firms by increasing wages and interest rates. Higher liabilities paired

Table 5: Determinants of OAS, 2012 Q1 - 2019 Q3

Dependent variable OAS	**Panel A (OLS FE)**	**Panel B (Pooled OLS)**
Macroeconomic factors		
GDP growth rate	-13.351**	-13.172**
	(-21.97)	(-10.58)
Policy rate	25.995**	24.245**
	(18.38)	(10.38)
CAD-USD Exchange rate	337.489**	320.430**
	(32.59)	(23.20)
Inflation rate	8.930**	9.374**
	(10.93)	(6.99)
Return	-0.918**	-0.905**
	(-25.06)	(-10.75)
Bond specific		
Time to maturity	-0.777*	3.200**
	(-2.53)	(32.28)
Time to maturity x Debt/Asset	0.013**	-0.007**
	(3.13)	(-5.30)
Firm specific		
EBIT/Asset	-0.085	1.563**
	(-0.19)	(3.80)
Debt/Asset	-0.535**	-0.044
	(-3.29)	(-1.02)
Working capital/Asset	0.692**	0.138*
	(5.29)	(2.38)
Size	-3.285	-1.176**
	(-0.80)	(-5.00)
Constant	1166.447**	1083.366**
	(27.51)	(31.44)
Rating dummies	No	Yes
Trend	Yes	Yes
No of observations	4537	4537
R^2	0.18	0.64

White-Hubar estimator corrects for heteroskedasticity and clustering. The t-statistics are reported in parenthesis. **, and * indicate significance at 1%, and 5% level respectively.

with low real cash flow increases the default risk by firms. This inflation risk induces issuers to increase the yield to compensate for the additional risk faced by investors.

The coefficient on the stock return is negative and significant. This finding is also consistent with the literature studying other bond markets that argues that a higher stock market index sends a positive signal to investors about the lower risk of default by firms due to rising stock prices. This positive signal leads to a reduction in the price of default risk, thereby shrinking the spread.

Bond maturity has a small and negative effect on credit spreads in the fixed-effect regressions. The interaction term that accounts for the non-linearity between bond maturity and the firm's debt structure enters with a positive coefficient in the fixed-effect regressions. This result is consistent with the rightly skewed debt distribution in the sample. As the majority of the firms in the sample are highly leveraged, thus, increased maturity gives the firms more time to pay back debt which eventually reduces default risk. Again, this reduction in risk is slightly smaller for firms with more debt, as reflected by the positive interaction term. In contrast, coefficients associated with bond maturity along with the interaction term enter with opposite signs in the pooled regressions.

Most of the coefficients are similar in their signs for firm-specific variables but vary in statistical significance across the two specifications. When I control for bond-specific fixed-effects, more leverage results in a lower compensation offered by firms, and this reduction in spreads is smaller for bonds with longer maturity. Although higher debt levels should increase the risk of default, one possible reason for the negative relationship can be attributed to the mean-reverting leverage ratio and investors' expectations about future firm leverage. Collin-Dufresne and Goldstein (2001) find that if the firms adjust their debt levels according to their firm value, then this generates a mean-reverting debt structure which can give rise to larger spreads for firms with low leverage. Again, expectations about a firm's future leverage have a significant role to play in determining the riskiness of investing in a bond (Flannery et al. (2012)). Hence, high leverage in the past quarter can influence investors' expectations to anticipate a reduction in firms' future debt holding, thereby expecting a lower compensation for risk in the current quarter. The coefficient of liquidity is positive and significant in both specifications. Finally, profitability and firm size do not have any statistically significant impact on the spreads. However, the signs of the coefficients are both consistent with theory. In the pooled regression, the coefficients associated with most firm-specific variables enter the model with similar signs as the FE regression with the exception of firm profitability.

Table 6 presents the results of the baseline regression estimated for different rating categories. All macroeconomic variables enter the regressions with the same sign as in the full sample. Except for the inflation rate, the coefficients for other macroeconomic variables are relatively larger in magnitude for bonds rated BBB. Hence, changes in the GDP growth, interest rate, the exchange rate, and the stock market return have a greater impact on bonds that rate between BBB- to BBB+. Although the coefficient associated with the stock index return is not statistically significant effect for AA rated bonds, it enters with the same sign as the other sub-samples. Bond maturity reduces spreads by a small amount only for A rated bonds.

The magnitude, sign, and statistical significance of coefficients for firm-specific control variables vary substantially across sub-samples of bonds with different ratings. EBIT/Asset ratio, which measures a firm's profitability, has no significant effect on the spreads of bonds rated BBB but surprisingly increases the spreads for A and AA rated bonds. Firm leverage has a statistically significant negative effect on the spreads of BBB rated bonds. Liquidity increases the spreads for AA and BBB rated bonds but has no significant effect on the spreads of A rated bonds. An increase in the firm size increases the spreads for AA rated bonds. The coefficient for firm size is not statistically significant at a 5% level for the other bonds.

Table 6: Determinants of OAS by rating category

Dependent Variable	**AA rated bonds**	**A rated bonds**	**BBB rated bonds**
OAS			
Macroeconomic factors			
GDP growth rate	-9.463**	-10.009**	-16.252**
	(-2.98)	(-20.28)	(-15.43)
Policy rate	16.837**	25.411**	27.076**
	(4.05)	(22.56)	(10.51)
CAD-USD Exchange rate	232.743**	286.884**	394.702**
	(11.06)	(35.57)	(22.91)
Inflation rate	22.293**	5.618**	12.710**
	(3.95)	(8.87)	(9.24)
Return	-0.155	-0.676**	-1.113**
	(-1.48)	(-22.17)	(-15.98)
Bond specific			
Time to maturity	-2.912	-0.614*	-0.981
	(-1.14)	(-1.88)	(-1.32)
Time to maturity x Debt/Asset	0.034	0.006	0.031*
	(0.71)	(1.52)	(1.70)
Firm specific			
EBIT/Asset	3.992**	1.953**	-0.449
	(2.86)	(3.14)	(-0.81)
Debt/Asset	0.402	-0.092	-1.125**
	(0.47)	(-0.54)	(-2.97)
Working capital/Asset	-0.199	0.532**	0.549**
	(-0.37)	(4.92)	(2.10)
Size	40.086	13.105**	-12.604*
	(1.62)	(4.00)	(-1.97)
Constant	508.782	855.231**	1450.162**
	(1.63)	(27.69)	(24.79)
R^2	0.05	0.08	0.28
Trend	Yes	Yes	Yes
No of observations	67	2239	2231

This table presents the OLS-FE estimation results of the baseline model for bonds under different rating category. White-Hubar robust standard error corrects for heteroskedasticity and clustering. The t-statistics are reported in parenthesis. **, and * indicate significance at 1%, and 5% level respectively. AA represent AA-, AA, and AA+ rated bonds. A represent A-, A, and A+ rated bonds. BBB represent BBB-, BBB, BBB+ rated bonds.

To analyze the relative contribution of different types of determinants, I perform a variance decomposition of OAS spread.[10] Figure 1 shows the variance contributions of only the time-variant determinants. The firm- and bond-specific determinants have very negligible contributions towards variation in the aggregate spread. However, the contribution of macroeconomic determinants on the aggregate spread is about 7%. The rating-wise decomposition shows that macroeconomic determinants contribute relatively more towards the variation in spreads of AA rated bonds compared to the riskier (A and BBB rated) ones. This implies that while economic theory applies better on the higher rated less risky bonds, idiosyncratic factors contribute more towards the more risky bonds.

In Figure A-4 I also include the contribution of the time trend and the bond-specific FE. The joint contributions of time-varying and time-invariant bond-specific factors amount to more than 22% of the total variation. The time trend is the second largest contributor in explaining variation in spreads for these bonds. One thing to note here is that the number of AA rated bonds is very small, and this creates a possibility of less reliable econometric inference for these bonds. For A and BBB rated bonds, unobserved heterogeneity across bonds explains a large amount of the variation in the spreads.

Since unobserved heterogeneity associated with bonds account for a lot of the variation in spreads, similar to findings in the previous literature, a large portion of the variation in spreads remains unaccounted for. Besides, the relative importance of the determinants in explaining spreads variation also depends on the riskiness of the bonds. As far as the macroeconomic determinants are concerned, they account for a small share of variance in the spreads of bonds (of any rating) issued by Canadian non-financial corporations. Consistent with previous empirical evidence on large and developed U.S. bond market (Collin-Dufresn et al. (2001); Duffie et al. (2007)), macroeconomic determinants do have a significant role in explaining the credit spreads in the context of a small market like Canada as well. Cavallo and Valenzuela (2010) apply a similar econometric analysis followed in this chapter on a smaller set of emerging market bonds and find firm-level fundamentals as the most prominent source of variation in the spreads.

[10] I use an ANOVA model to analyze the relative contributions. The contribution of each determinant X_i on the variance of Y is calculated as $\frac{PSS_{X_i}}{TSS_Y}$ where PSS is the partial sum of squares, and TSS is the total sum of squares. I use the marginal sum of squares to calculate the partial sum of squares, so the order in which the variables enter the model does not affect the variation they generate on the dependent variable.

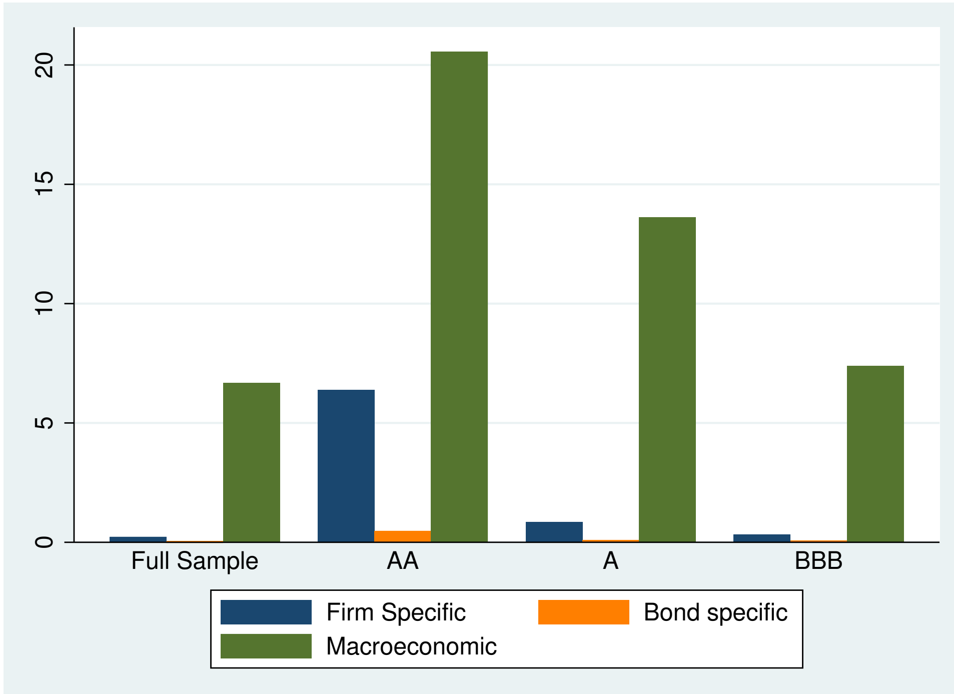

Figure 1: Variance decomposition of OAS spread

The variance decomposition analysis also points towards the existence of a ‘credit spread puzzle’ in a different way in the context of the Canadian corporate bond market. The finding that unobserved time-invariant bond FE explains most of the variations in the spreads creates an avenue for further research on exploring specific bond- or firm-specific characteristics that risk models can include. In this respect, the most closely relatable existing explanation for the Canadian bond market is concentration risk. As Amato and Remolona (2003) highlight, the returns distribution in the bond market is highly negatively skewed. The investors, therefore, need to have massively large portfolios in order to achieve full diversification, which is unattainable in the bond market. In the absence of such diversification, unexpected losses will be priced into credit spreads. The problem of diversification is more pronounced in the Canadian bond market. The bond and equity markets in Canada are very small compared to the respective global markets’ sizes. Moreover, the majority of the investment-grade bonds are issued by large utility companies (more than 67% in my sample) in Canada. The lack of diversification opportunities in the portfolio of investors in Canadian bonds increases the concentration and correlation risk. These risks feed into the pricing of bonds, which reflects in higher spreads. The bond FE included in the regressions captures this high concentration of utility firms in the sample. Findings in this chapter also indicate that the nature of the bond market and the economy may explain some variations in the borrowing cost.

5 Robustness check

I perform a variety of robustness checks to account for potential model misspecification or endogeneity arising from firm-specific variables. In the first specification, I control for firm-specific endogeneity and estimate the baseline regression by two-step dynamic panel GMM proposed by Arellano and Bond (1991). In this specification, I also include lagged spread as an explanatory variable to control for any missing information it might contain. In another specification, I replace the overnight rate with the risk-free interest rate and include term spread (the slope of the yield curve) as an additional explanatory variable to re-estimate the regressions. Finally, I re-estimate the baseline equation 7 for monthly frequency, including only the macroeconomic controls. In all of these specifications, I control for bond-level fixed effects.

5.1 Endogeneity

If there is any persistence in the spreads, then the baseline specification might give biased results due to endogeneity arising from the autocorrelation of spreads. To address this concern, I re-estimate the baseline regression using two-step dynamic panel GMM proposed by Arellano and Bond (1991). In this specification, I also include lagged spreads as an additional explanatory variable. Inclusion of lagged spreads allows controlling for any missing information that the lagged value of spreads might contain and reduce the possibility of an omitted variable bias. I also instrument all firm-specific variables with GMM-style instruments (all lags of the endogenous variables). Table 7 presents the results for GMM estimation.

The coefficients associated with the macroeconomic variables remain statistically significant with the same signs as the baseline results. The magnitude of these coefficients, however, slightly differs from those reported by the OLS estimation. Interestingly, the coefficients associated with the bond- and firm-specific determinants no longer remain statistically significant after controlling for endogeneity. This implies that the OLS estimates associated with firm-specific variables did suffer from endogeneity and likely produce biased estimates for firm-level variables in the OLS estimations.

Table 7: Determinants of OAS, 2012 Q1 - 2019 Q3 (GMM estimation)

Macroeconomic factors	
Lagged OAS	0.352**
	(6.14)
GDP growth rate	-15.415**
	(-7.83)
Policy rate	18.095**
	(4.04)
CAD-USD Exchange rate	242.069**
	(6.76)
Inflation rate	21.151**
	(11.74)
Return	-0.311**
	(-3.74)
Bond specific	
Time to maturity	0.577
	(0.49)
Time to maturity x Debt/Asset	-0.019
	(-1.07)
Firm specific	
EBIT/Asset	-0.553
	(-1.24)
Debt/Asset	-0.067
	(-0.16)
Working capital/Asset	0.383
	(1.60)
Size	-11.974
	(-1.21)
No of observations	4068
Sargan statistic of over identifying restrictions	335.28**

Windmeijer bias-corrected (WC) robust standard errors are used to construct the t statistics (reported in parenthesis). Instrumented EBIT/Asset, Debt/Asset, Working capital/Asset and Size. **, and * represent significance at 1%, and 5% level respectively.

5.2 Level and slope of the yield curve

As an additional robustness exercise, I replace the overnight rate with the risk-free interest rate (the 10-year benchmark bond yield) as a proxy for interest rate and include the slope of the yield curve or the term spread as an additional explanatory variable. The slope of the yield curve provides information about the financial market's expectation about the direction of future short-term interest rates. The level and slope of the yield curve are important determinants of the dynamics of the term structure of interest rate (Merton (1974)). A negative slope signals a weakening economy and reduction in firms' asset value, which, in turn, widens the spread. I construct the proxy for the term spread from the yield difference between 10- and 2- year benchmark bonds (Boss and Scheicher (2002)).

Table 8 shows the results with the above specifications included. For brevity, I only report the results from OLS-FE regressions for the full sample and the different rating categories. The results show a negative relationship between the slope of the yield curve and bond spreads. The negative relationship between the term spread and the bond spreads holds in the full sample and across different rating categories. A reduction in term spread signals weakening of the economy in the future and hence increases credit spreads. The positive association between the risk-free rate and the spreads implies that an increase in the 10-year benchmark bond yield induces a more than proportionate increase in the yields of corporate bonds compared to risk-free bonds. This finding is in contrast to the usual negative relationship between the risk-free rate and credit spreads, as found by notable theoretical studies like Merton (1974), Longstaff and Schwartz (1995), and Duffee (1998). This positive association can be attributed to the correlation coefficient between the risk-free interest rate and the firm value stated above. Morris et al. (1998) and Bevan and Garzarelli (2000) also find corporate spreads to be positively correlated to the risk-free rate.

The results also show a slightly more significant effect of GDP growth rate on the spreads. Compared to the baseline estimates, the coefficients associated with the other macroeconomic variables are smaller in magnitude for the entire sample and different rating categories. Most bond- and firm-specific variables enter the regression with similar signs and statistical significance with similar or relatively smaller magnitudes than the baseline regressions.

5.3 Data frequency

All the above exercises use data in quarterly frequency for a short sample period (2012 - 2019). Due to the short time length, there is a possibility that the baseline model does not have enough variations in the time series. To allow for more variations in the time series of the determinants, I use monthly data for the same time duration and run the baseline model without firm-specific and bond-specific controls. However, I include the bond-specific fixed effects to control the bonds' and their issuers' time-invariant characteristics. It should be safe to assume that the loss of the model's explanatory power due to not including firm-specific and bond-specific controls is limited because of the negligible contribution of

Table 8: Determinants of OAS, 2012 Q1 - 2019 Q3

Dependent variable OAS	**Full Sample**	**AA**	**A**	**BBB**
Macroeconomic factors				
GDP growth rate	-17.493**	-11.488**	-14.567**	-19.749**
	(-28.44)	(-4.12)	(-25.99)	(-19.07)
Term spread	-16.663**	-27.847*	-79.36**	-29.168**
	(-5.37)	(-2.30)	(-3.65)	(-5.10)
Risk free interest rate	8.50**	16.079*	5.164**	12.281**
	(5.68)	(2.38)	(3.98)	(4.43)
CAD-USD Exchange rate	275.112**	270.374**	203.214**	35712.82**
	(23.79)	(5.81)	(24.87)	(18.49)
Inflation rate	9.112**	15.982**	6.80**	11.79**
	(11.12)	(3.78)	(11.27)	(7.91)
Return	-0.884**	-0.037	-0.709**	-0.996**
	(-20.34)	(-0.31)	(-17.08)	(-12.49)
Bond specific				
Time to maturity	-0.797**	-2.231	-0.546	-1.199
	(-2.52)	(-1.27)	(-1.56)	(-1.64)
Time to maturity x Debt/Asset	0.013**	0.012	0.005	0.038*
	(2.99)	(0.36)	(1.11)	(2.09)
Firm specific				
EBIT/Asset	0.055	3.434	2.226**	-0.329
	(0.13)	(1.68)	(3.95)	(-0.67)
Debt/Asset	-0.474**	1.236	0.038	-1.255**
	(-2.75)	(2.18)	(0.21)	(-3.27)
Working capital/Asset	0.598**	0.575	0.406**	0.522*
	(4.21)	(0.89)	(3.39)	(2.01)
Size	-2.65	23.404	13.701**	-10.136
	(-0.64)	(0.75)	(4.11)	(-1.57)
Constant	1122.474**	495.479	709.017**	1547.259**
	(18.56)	(1.32)	(18.44)	(16.10)

White-Hubar estimator is used to correct for heteroskedasticity and clustering. The t-scores are reported in parenthesis. **, and * indicate significance at 1%, and 5% level respectively.

the firm-specific and bond-specific determinants found from the GMM and the variance decomposition exercises presented above. I include one additional macroeconomic control, oil price growth, in this model. As most bond issuing firms in the sample belong to the energy sector, they are likely to be significantly affected by oil price movements. As a proxy for oil price growth, I use the monthly growth rate of the seasonally adjusted data on West Texas Intermediate crude oil price. Table A-2 shows that all macroeconomic determinants except the stock market return retain their expected signs. Spreads reduce when oil price grows because, with the increased oil price, investors feel confident about future earnings of the bond issuing firms due to lower default risk. However, stock market return enters the regression with a positive sign, unlike the findings with quarterly data. One probable reason for this can be the perception of the bond investors. If the average stock returns are persistently higher in the past quarter, the investors feel more confident to substitute away from bonds and invest in the stock market. However, a higher return in the past month may not convince investors to buy more stocks by selling bonds.[11]

I also perform the variance decomposition analysis using the monthly data. Figure A-5 presents the visual illustration of the variance decomposition for monthly OAS. Similar to quarterly data, bond-specific FE dominates in explaining much of the variations in the spreads. Macroeconomic determinants continue to contribute more towards explaining variations in the spreads for higher rated bonds.

6 Macroeconomic uncertainty

In addition to looking into the level effects of macroeconomic determinants on credit spreads, I also examine how the volatilities of some of these determinants affect the spreads. Higher volatility implies higher uncertainty, and higher uncertainty is expected to increase firms' default risk, thereby widening the spreads. In this specification, I include the second moments of macroeconomic variables (a proxy for uncertainty) as an additional explanatory variable to examine how the volatilities of the macroeconomic variables affect the spreads besides their level effects. I apply a Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model to construct the proxies for macroeconomic uncertainty. Previous literature (Byrne and Davis (2005); Driver et al. (2005);Baum et al. (2006)) apply this method of obtaining proxy of uncertainty from the conditional variance of macroeconomic variable. Baum and Wan (2010) follows the same methodology to show the impact of macroeconomic uncertainty on CDS spreads using U.S firm-level data.

I construct three measures of macroeconomic uncertainty. The first proxy construction uses the conditional variance of GDP, representing the overall uncertainty of the economy. The second measure captures the financial market uncertainty from the conditional variance of the quarterly index of S&P/TSX return. The third measure is a proxy for external uncertainty, for which I use the conditional volatility of the CAD/U.S exchange rate. I construct all proxies of uncertainty by fitting a lower order (1,1) GARCH model. Table

[11] Adding more lags of the stock return shows that the negative relationship between the credit spreads and stock return shows up in the third lag.

A-3 provides the details of the GARCH specifications. Finally, I include a measure of policy uncertainty to examine how corporate bond spreads respond to uncertainty around economic policy. I use the national economic policy uncertainty (EPU) index for Canada by Baker et al. (2016) as a measure of policy uncertainty.[12]

Table 9: Determinants of OAS, 2012 Q1 - 2019 Q3

Dependent variable	**Macroeconomic Uncertainty**			
OAS (in basis points)	**GDP growth**	**Stock market return**	**Exchange rate**	**Policy**
Macroeconomic factors				
GDP growth rate	-14.789**	-14.046**	-12.468**	-13.953**
	(-12.80)	(-11.93)	(-12.36)	(-12.86)
Policy rate	25.722**	7.955**	25.203**	24.127**
	(-10.42)	(2.11)	(10.09)	(9.33)
CAD-USD Exchange rate	314.777**	249.583**	311.927**	313.948**
	(15.10)	(13.18)	(14.71)	(16.25)
Inflation rate	12.534**	9.506**	9.203**	9.257**
	(9.03)	(6.94)	(7.98)	(7.73)
Return	-0.840**	-1.509**	-0.767**	-1.042**
	(-15.24)	(-9.07)	(-17.10)	(-14.97)
Uncertainty	367211.900**	4616.354 **	4325.525 **	-0.064**
	(15.76)	(4.51)	(13.00)	(-6.97)
η	0.07**	0.10**	0.04**	-0.09**
	(0.004)	(0.023)	(0.003)	(0.014)
Bond specific				
Time to maturity	-0.819**	-0.753**	-0.787**	-0.752**
	(-2.38)	(-2.32)	(-2.27)	(-2.07)
Time to maturity x Debt/Asset	0.014**	0.014**	0.015**	0.014**
	(2.53)	(2.57)	(2.58)	(2.44)
Firm specific				
EBIT/Asset	-0.241	-0.003	0.130	-0.211
	(-0.24)	(0.00)	(0.13)	(-0.21)
Debt/Asset	-0.540**	-0.549**	-0.517**	-0.495**
	(-2.48)	(-2.36)	(-2.35)	(-2.39)
Working capital/Asset	0.667**	0.714**	0.589**	0.702**
	(2.72)	(2.75)	(2.29)	(2.97)
Size	-2.187	-2.732	-2.910	-3.396
	(-0.23)	(-0.28)	(-0.30)	(-0.36)

White-Hubar estimator corrects for heteroskedasticity and clustering. The t-scores are reported in parenthesis. **, and * indicate significance at 1%, and 5% level respectively. η is the elasticity of spreads with respect to changes in uncertainty and its standard error is reported in the parenthesis below.

Table 9 reports the results for the baseline regression with macroeconomic uncertainty entering as an additional determinant. All regressions for four different uncertainty proxies generate similar results. The original relationship between the spreads and the macroeconomic variables in their level forms continues to hold. The coefficients associated with the

[12] For Canada, Baker et al. (2016) construct an index based on newspaper articles regarding policy uncertainty. The newspapers included in the index calculation are The Gazette, The Vancouver Sun, The Toronto Star, The Ottawa Citizen, and The Globe and Mail, including articles from the Canadian Newswire. The authors search for terms like ‘uncertainty’, ‘economy’ along with policy-relevant terms such as ‘policy’, ‘tax’, ‘spending’, ‘regulation’, ‘central bank’, ‘budget’, and ‘deficit’.

bond- and firm-specific controls also retain similar signs and magnitudes. An increase in any form of uncertainty except policy uncertainty increases the spreads. η reports the elasticity of spreads with respect to each uncertainty proxy. A 10% increase in the conditional volatility of the macroeconomic variables brings about a 0.4% - 1% increase in the corporate credit spreads depending on the choice of proxy for uncertainty. Stock market volatility affects the spreads more than all other types of uncertainty. One standard deviation (0.002) increase in the stock market volatility increases the spreads by about 8 basis points. The second largest effect comes from the overall macroeconomic uncertainty measured by the conditional volatility of GDP growth. One standard deviation increase in the overall uncertainty increases the spreads by 5 basis points. The external sector uncertainty, on the other hand, increases the spreads by the least amount. Unlike other types of uncertainty, policy uncertainty, with an elasticity of 0.09% reduces spreads in the next quarter. One possible explanation for this finding is the lag between the declaration of policies and their implementation. Policies typically take a long time to take effect, which can influence investors' perceptions. Again, more uncertainty about the policy may not necessarily mean policies detrimental to investment. Including multiple lags of policy uncertainty shows, higher policy uncertainty increases spreads after about three quarters.

Table 10 shows the effect of different macroeconomic uncertainty on the spreads of bonds with different rating categories. The higher rated bonds are mostly responsive to policy uncertainty. A 10% increase in the policy uncertainty reduces the spreads for these bonds by about 0.8%. The second most dominating factor for these bonds is the overall economic uncertainty. On the other hand, for lower rated bonds, uncertainty associated with the stock market has the largest effect. A 10% increase in the stock market uncertainty increases the spreads for these bonds by 1.8%. The effect of exchange rate uncertainty is the same across bonds with different ratings. These findings imply that bonds with higher ratings are more affected by changes in the overall economy, while bonds with lower ratings (riskier) are more affected by stock market activities.

7 Conclusion

Previous studies have identified the importance of corporate credit spreads in predicting future changes in real economic activity for the Canadian economy. On the other hand, the

Table 10: Determinants of OAS by Rating, 2012 Q1 - 2019 Q3

Dependent variable OAS (in basis points)		Macroeconomic uncertainty		
A and above	**GDP growth**	**Stock market return**	**Exchange rate**	**Policy**
Uncertainty	335164.200**	1688.070	4448.501**	-0.048**
	(12.87)	(1.89)	(10.87)	(-9.45)
η	0.07**	0.05*	0.05**	-0.08**
	(0.006)	(0.024)	(0.004)	(0.018)
BBB	**GDP growth**	**Stock market return**	**Exchange rate**	**Policy**
	378224.800**	9193.143**	6922.307**	-0.0700**
	(10.72)	(5.41)	(11.89)	(-3.09)
η	0.06**	0.18**	0.05**	-0.087**
	(0.006)	(0.034)	(0.004)	(0.028)

White-Hubar estimator is used to correct for heteroskedasticity and clustering. The t-scores are reported in parenthesis. **, and * indicate significance at 1%,and 5% level respectively. η is the elasticity of spreads with respect to changes in uncertainty and its standard error is reported in the parenthesis below.

corporate sector faces various risks that are affected by the macroeconomic condition of the economy. Therefore, to fully understand the feedback effect, it is crucial to identify how the macroeconomic variables affect the credit spreads. This chapter attempts to determine the importance of various macro and financial factors in explaining credit spreads for bonds issued by non-financial Canadian corporations. The results show that macroeconomic variables significantly affect the spreads across all rating categories, and the effects of bond- and firm-specific determinants vary across ratings. Variance decomposition analysis shows that unobserved heterogeneity associated with bonds accounts for the bulk of the total variation in spreads, and only a small percentage of the total variation in spreads is attributable to macroeconomic factors. The relative importance of different determinants in explaining the variation of spreads also varies across different rating classes. The effects of macro determinants are robust to different specifications of the model. Besides the level effects, the volatilities of different macroeconomic variables affect the spreads by a small percentage. The overall findings of this chapter reinforce the existence of 'the credit spread puzzle' in the context of the Canadian corporate sector.

References

Altman, E. I.: 2013, Predicting financial distress of companies: revisiting the z-score and zeta® models, *Handbook of research methods and applications in empirical finance*, Edward Elgar Publishing.

Amato, J. D. and Remolona, E. M.: 2003, The credit spread puzzle, *BIS Quarterly Review, December* .

Arellano, M. and Bond, S.: 1991, Some tests of specification for panel data: Monte carlo evidence and an application to employment equations, *The Review of Economic Studies* **58**(2), 277–297.

Avramov, D., Jostova, G. and Philipov, A.: 2006, Corporate credit risk changes: common factors and firm-level fundamentals, *AFA 2005 Philadelphia Meetings*.

Baker, S. R., Bloom, N. and Davis, S. J.: 2016, Measuring economic policy uncertainty, *The quarterly journal of economics* **131**(4), 1593–1636.

Bangia, A., Diebold, F. X., Kronimus, A., Schagen, C. and Schuermann, T.: 2002, Ratings migration and the business cycle, with application to credit portfolio stress testing, *Journal of banking & finance* **26**(2-3), 445–474.

Baum, C. F., Caglayan, M., Ozkan, N. and Talavera, O.: 2006, The impact of macroeconomic uncertainty on non-financial firms' demand for liquidity, *Review of Financial Economics* **15**(4), 289–304.

Baum, C. F. and Wan, C.: 2010, Macroeconomic uncertainty and credit default swap spreads, *Applied Financial Economics* **20**(15), 1163–1171.

Bevan, A. and Garzarelli, F.: 2000, Corporate bond spreads and the business cycle: introducing gs-spread, *The Journal of Fixed Income* **9**(4), 8–18.

Black, F. and Cox, J. C.: 1976, Valuing corporate securities: Some effects of bond indenture provisions, *The Journal of Finance* **31**(2), 351–367.

Black, F. and Scholes, M.: 1973, The pricing of options and corporate liabilities, *Journal of political economy* **81**(3), 637–654.

Bleaney, M., Mizen, P. and Veleanu, V.: 2016, Bond spreads and economic activity in eight european economies, *The Economic Journal* **126**(598), 2257–2291.

Boss, M. and Scheicher, M.: 2002, The determinants of credit spread changes in the euro area, *Developments driving changes in market functioning* p. 181.

Byrne, J. P. and Davis, E. P.: 2005, Investment and uncertainty in the g7, *Review of World Economics* **141**(1), 1–32.

Campbell, J. Y. and Taksler, G. B.: 2003, Equity volatility and corporate bond yields, *The Journal of finance* **58**(6), 2321–2350.

Cavallo, E. A. and Valenzuela, P.: 2010, The determinants of corporate risk in emerging markets: an option-adjusted spread analysis, *International Journal of Finance & Economics* **15**(1), 59–74.

Cenesizoglu, T. and Essid, B.: 2012, The effect of monetary policy on credit spreads, *Journal of Financial Research* **35**(4), 581–613.

Charalambakis, E. C. and Garrett, I.: 2019, On corporate financial distress prediction: What can we learn from private firms in a developing economy? evidence from greece, *Review of Quantitative Finance and Accounting* **52**(2), 467–491.

Chun, O. M., Dionne, G. and François, P.: 2014, Credit spread changes within switching regimes, *Journal of Banking & Finance* **49**, 41–55.

Collin-Dufresn, P., Goldstein, R. S. and Martin, J. S.: 2001, The determinants of credit spread changes, *The Journal of Finance* **56**(6), 2177–2207.

Collin-Dufresne, P. and Goldstein, R. S.: 2001, Do credit spreads reflect stationary leverage ratios?, *The journal of finance* **56**(5), 1929–1957.

Cremers, M., Driessen, J., Maenhout, P. and Weinbaum, D.: 2008, Individual stock-option prices and credit spreads, *Journal of Banking & Finance* **32**(12), 2706–2715.

Driessen, J.: 2005, Is default event risk priced in corporate bonds?, *The Review of Financial Studies* **18**(1), 165–195.

Driver, C., Temple, P. and Urga, G.: 2005, Profitability, capacity, and uncertainty: a model of uk manufacturing investment, *Oxford Economic Papers* **57**(1), 120–141.

Duffee, G. R.: 1998, The relation between treasury yields and corporate bond yield spreads, *The Journal of Finance* **53**(6), 2225–2241.

Duffie, D., Saita, L. and Wang, K.: 2007, Multi-period corporate default prediction with stochastic covariates, *Journal of Financial Economics* **83**(3), 635–665.

Elton, E. J., Gruber, M. J., Agrawal, D. and Mann, C.: 2001, Explaining the rate spread on corporate bonds, *the journal of finance* **56**(1), 247–277.

Flannery, M. J., Nikolova, S. and Öztekin, Ö.: 2012, Leverage expectations and bond credit spreads, *Journal of Financial and Quantitative Analysis* pp. 689–714.

Gilchrist, S. and Zakrajšek, E.: 2012, Credit spreads and business cycle fluctuations, *American Economic Review* **102**(4), 1692–1720.

Huang, J.-Z. and Huang, M.: 2012, How much of the corporate-treasury yield spread is due to credit risk?, *The Review of Asset Pricing Studies* **2**(2), 153–202.

Jarrow, R. A., Lando, D. and Turnbull, S. M.: 1997, A markov model for the term structure of credit risk spreads, *The review of financial studies* **10**(2), 481–523.

Kang, J. and Pflueger, C. E.: 2015, Inflation risk in corporate bonds, *The Journal of Finance* **70**(1), 115–162.

Leboeuf, M. and Hyun, D.: 2018, Is the excess bond premium a leading indicator of canadian economic activity?, *Technical report*, Bank of Canada.

Leboeuf, M., Pinnington, J. et al.: 2017, *What Explains the Recent Increase in Canadian Corporate Bond Spreads?*, Bank of Canada= Banque du Canada.

Longstaff, F. A. and Schwartz, E. S.: 1995, A simple approach to valuing risky fixed and floating rate debt, *The Journal of Finance* **50**(3), 789–819.

Merton, R. C.: 1974, On the pricing of corporate debt: The risk structure of interest rates, *The Journal of finance* **29**(2), 449–470.

Morris, C., Neal, R., Rolph, D. et al.: 1998, Credit spreads and interest rates: A cointegration approach, *Technical report*, Federal Reserve Bank of Kansas City.

Nickell, S.: 1981, Biases in dynamic models with fixed effects, *Econometrica: Journal of the Econometric Society* pp. 1417–1426.

Perraudin, W. and Taylor, A. P.: 2003, Liquidity and bond market spreads, *EFA 2003 Annual Conference Paper*, number 879.

Tang, D. Y. and Yan, H.: 2006, Macroeconomic conditions, firm characteristics, and credit spreads, *Journal of Financial Services Research* **29**(3), 177–210.

Tang, D. Y. and Yan, H.: 2010, Market conditions, default risk and credit spreads, *Journal of Banking & Finance* **34**(4), 743–753.

Appendix

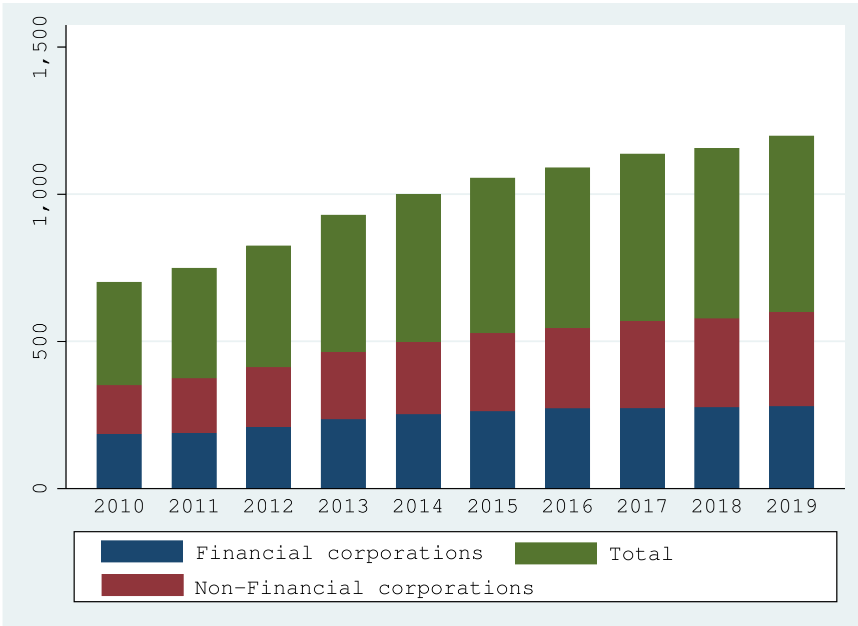

Figure A-1: Total bonds outstanding in Canadian Dollars

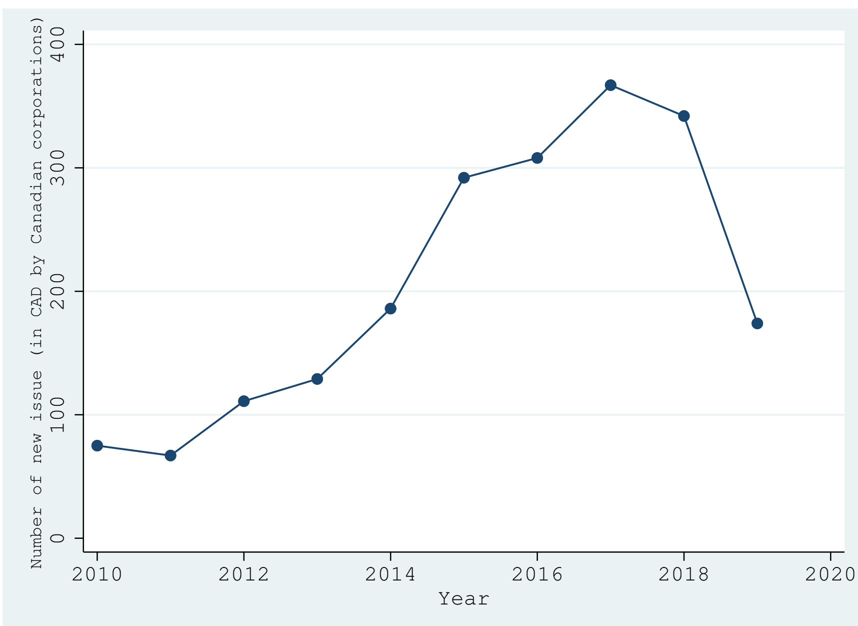

Figure A-2: Number of new issues in CAD by Canadian corporations

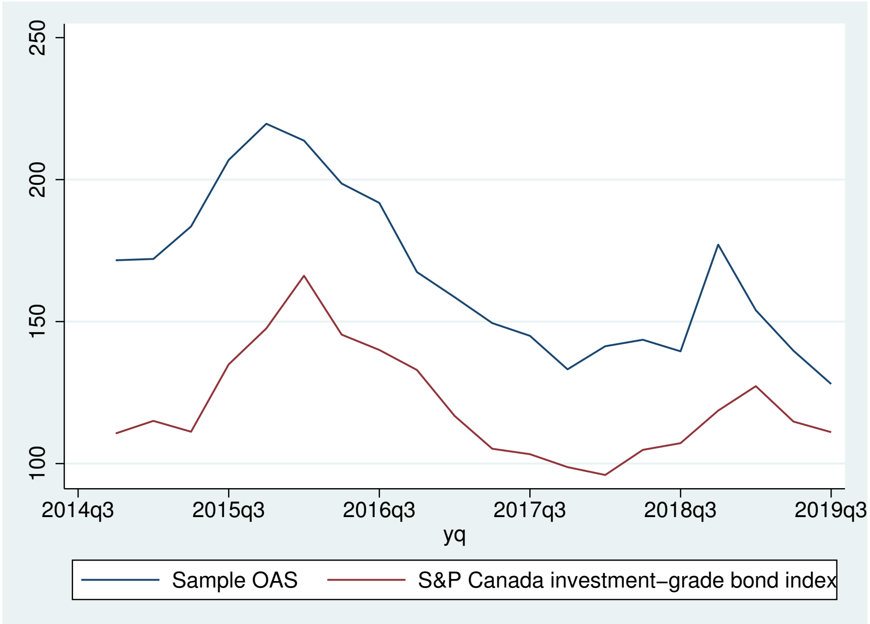

Figure A-3: Sample OAS, 2014 Q4 - 2019 Q3

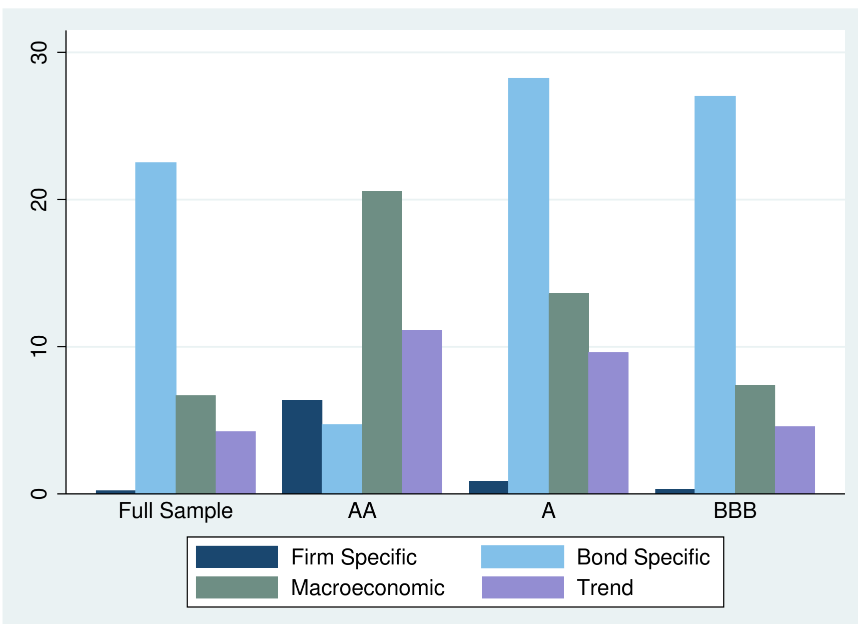

Figure A-4: Variance decomposition of OAS spread (including bond-specific FE and time trend)

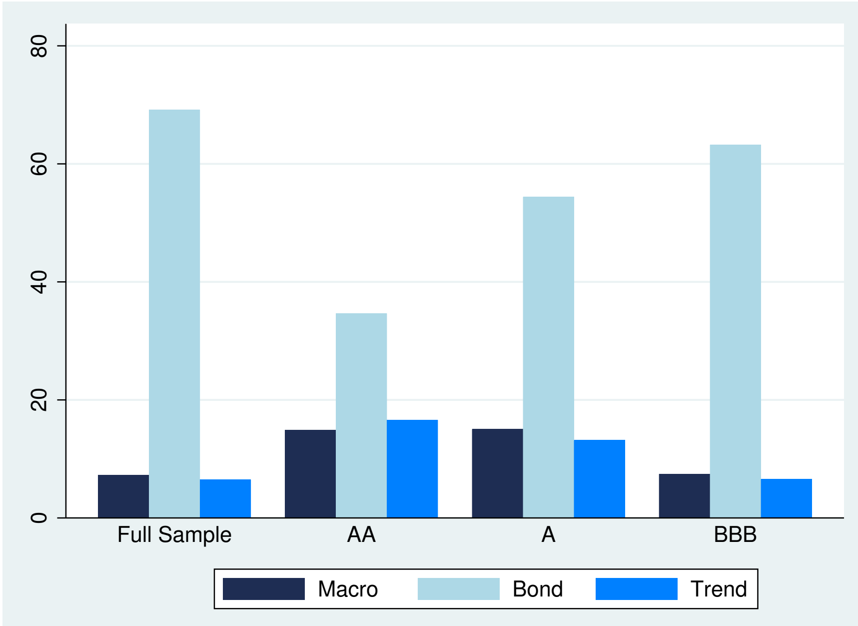

Figure A-5: Variance decomposition of OAS spread (monthly data)

Table A-1: Description of variables and sources

Variable name	Unit of measurement	Source
OAS	Basis points	Bloomberg
Macroeconomic		
GDP growth rate	Percent	Statistics Canada
GDP monthly (chained 2012 dollars)	Millions of CAD	Statistics Canada (CANSIM Table: 36100434)
Policy rate (Overnight money market financing rate)	Percent	Bank of Canada
Risk free interest rate (10 year benchmark bond yield)	Percent	Bank of Canada
Slope of the yield curve/ Term spread	Percent	Bank of Canada
CAD-USD exchange rate	Percent	FRED St. Louis
Inflation rate (CPI)	Percent	Statistics Canada
S&P/TSX return	Percent	Yahoo Finance
Oil price, West Texas Intermediate crude oil price	Dollars per barrel	FRED St. Louis
Economic policy uncertainty index (EPU)	Index	Economic Policy Uncertainty website. https://www.policyuncertainty.com/canada_monthly.html
Bond specific		
Time to maturity	Years	Bloomberg
Firm specific		
EBIT/Asset	Percent	Bloomberg
Debt/Asset	Percent	Bloomberg
Working capital/Asset	Percent	Bloomberg
Size	Millions of CAD (in natural logarithms)	Bloomberg

Table A-2: Determinants of OAS, January 2012 - October 2019 (Monthly data)

GDP growth	-1.472**
	(-3.26)
Policy rate	22.487**
	(15.30)
CAD-USD Exchange rate	392.698**
	(46.65)
Inflation rate	25.454**
	(11.88)
Return	0.162**
	(4.75)
Oil price growth	-0.046**
	(-3.86)
Constant	1101.282**
	(34.79)
No of observations	17,897
R^2	0.17

White-Hubar sandwich estimator corrects for heteroskedasticity and clustering. The t-scores are reported in parenthesis. **, and * indicate significance at 1%, and 5% level respectively.

Table A-3: GARCH proxies for macroeconomic uncertainty, 1990 Q3 - 2019 Q3

	GDP	**Stock index**	**Exchange rate**
Constant (mean)	-0.004	0.016**	1.162**
	(-1.19)	(2.33)	(2.59)
AR(1)	0.985**		0.991**
	(72.05)		(55.11)
ARCH(1)	0.384**	0.276**	0.307*
	(2.78)	(2.06)	(1.95)
ARCH(2)	0.375**		0.365**
	(2.78)		(3.47)
GARCH(1)	-0.902**	0.617**	-0.467*
	(-3.15)	(4.83)	(-2.09)
Constant(variance)	0*	0.001	0.001**
	(3.40)	(1.80)	(3.80)
Log-likelihood	441.822	141.076	221.97
No of observations	117	117	117

z- statistics are given in the parenthesis. The dependent variables are the detrended logarithms of GDP, S&P/TSX Stock returns and Exchange rate at quarterly frequency. 'mean' is conditional mean equation and 'variance' is conditional variance equation. **, and * indicate significance at 1%, and 5% level respectively.

Table A-4: Summary statistics for uncertainty proxies

	Mean	Standard deviation	No of observations
GDP	0.0000302	0.0000135	5224
Stock index	0.0039013	0.0017533	5224
Exchange rate	0.0015241	0.000969	5224
EPU	240.1616	67.68472	5224