The Sensitivity of Bank Stock Returns to Interest Rate, Exchange Rate Volatility in Canada

By Meng Huo

(5889657)

Major paper presented to the Department of Economics of the University of Ottawa in partial fulfillment of the requirements of the M.A. Degree

Supervisor: Professor Serge Coulombe

ECO6999

September 2012

Ottawa, Ontario

Table of Content

Abstract

This paper examines the sensitivity of commercial bank stock returns to market return, interest rate return and foreign exchange return by using Canadian daily data from 2007 to 2011. The impact of interest rate and foreign exchange rate volatility on bank stock returns are estimated as well. By conducting OLS and two types of GARCH models we found that OLS model is inefficient in estimating the sensitivity of bank stock return due to the ARCH effects among the variables. GARCH-type models are more suitable to estimate data with time-varying characteristics. Since the financial crisis happens during this period, an improvement is made by adding a dummy variable. The result found by this paper is that market return plays an important role in determining the return of bank stocks. Interest rate return and foreign exchange rate return have impact on bank stock return as well. The increase in volatility of exchange rate will generally lead to an increase in bank stock return volatility as well. This result provides empirical support for the investors, bank managers as well as policy makers.

Acknowledgement

This paper was completed with great help of my supervisor, my professors, my friends and my family.

First of all, I would like to give the deepest gratitude to my supervisor, Serge Coulombe, who helps me a lot when guided me in the completion of the paper. I could not finish my paper without his enlightening instruction, impressive kindness and patience. His Rigorous attitude of scholarship enlightens me not only in the writing of the paper but also in my future study and work.

I would also like to show my great gratitude to my previous supervisor, Kathleen Day, who gave me a lot of useful advices in the preparation of my paper. Thanks so much to Professor Victoria Barham and Doctor Myra Yazbeck, who also gave me a great help in the completion of the paper.

Finally, I want to thanks to my friends, Xiaoxiao Li, Bo Qu and Han Wang, who show strongest support to me in this summer. Most especially, thanks to my family, all successes cannot be achieved without your warmest support.

1. Introduction

Commercial banks are the most important sectors in the national financial system. Their stock returns have been a great interest to investors, bank managers, monitoring sectors and the authorities. There are a couple of factors that can affect bank stock returns. Interest rate and foreign exchange rate are two of them. As the liberalization and internationalization of commercial banks, interest rate and foreign exchange rate exposure have become the key determinants of bank stock returns. The fluctuation of interest rate and foreign exchange rate can affect bank stock returns directly or indirectly. Some failure bank activities can be attributed to the failure of adaption to interest rate and exchange rate changes during the financial crisis. Thus, the sensitivity of bank stock returns to interest rate and foreign exchange rate changes becomes a major concern for bank managers in the financial markets. The relationship between them also attracts a lot of attention from the investors in the stock market.

First of all, the volatility hypothesis indicates one reason why bank stock return may be correlated to the volatility of interest rate and foreign exchange rate. This hypothesis states that random shocks can cause higher volatility in the financial markets due to the contagion effects, Joseph and Vezos (2006). The diversification of international portfolios may also cause the increase in the volatility of bank stock returns, Eun and Resnick (1988). In this case, larger effects will be caused on bank stock returns due to the changes of interest rate and foreign exchange rate. Some researches have already explained this relationship by using theoretical models. The Intertemporal Capital Asset Model (ICAPM) developed by Merton (1973) includes the changes of interest rate as a factor as it provides an opportunity for investors. The Arbitrate Pricing Theory (APT) provides the effect of interest rate and foreign exchange rate in the equilibrium price of bank stocks, Sweeney and Warga (1986).

Another reason to explain the impact of interest rate and foreign exchange rate changes on bank stock returns is that they can affect banks' balance sheets directly. Due to the special characteristics of the financial institution, interest rate and foreign exchange rate will affect bank's balance sheets directly through the interest income, cost and revenue, Saunders and Yourougou (1990). The banks' discounted cash flows are influenced by the changes of interest rate and foreign exchange rate. Thus, changes in interest rate will have impact on bank stock returns directly. Since the internationalization of banks is not complete, it is probably that foreign exchange rate will affect the bank stock returns through its impact on banks' balance sheets as well. The extent of these effects depends on the financial operations of the bank, Kasman et al. (2011). The profit and financial ratios of the banks will be affected by the change of foreign exchange rate. Since most banks have global financial operations in other countries, they are exposed to both interest rate and exchange rate risks. The appreciation or depreciation of domestic currency will affect the net value of the exchange rate-related assets and liabilities. The volatile markets will cause the banks exposed to interest risks, which cannot be removed by the techniques of risk management.

Finally the reason why bank stock returns are correlated with interest rate and foreign exchange rate returns can be explained by the nominal contracting hypothesis. Changes in interest rate and foreign exchange rate can affect the bank's balance sheet indirectly according to this theory. Nominal contracting hypothesis theory states that the company's nominal assets, is an important determinant of its stock return. The nominal assets, not the real assets, will affect the company's stock by the "redistributive effects of unanticipated inflation and unanticipated changes in the expected inflation" Flanner and James, (1984). If there are more nominal assets than nominal liabilities on the firm's balance sheet, value of the stock will rise when there is an unexpected inflation. Otherwise, if nominal assets are less than nominal liabilities, the stock price will decline with the presence of unexpected inflation. This indicates that the interest rate will affect different bank stock returns differently according to the composition of their balance sheets.

The maturity difference in banks' assets and liabilities is the determinant on how the balance sheet will be affected. If the maturity of the nominal assets of the bank is longer than the maturity of the liabilities, the effect of the unexpected inflation or unexpected changes in the expected inflation will be greater, Flanner and James, (1984).

Despite the importance of the effects of interest rate and foreign exchange rate changes on the return of bank stocks, there are not many studies that investigate interest rate and foreign exchange rate jointly in the estimation. Most theoretical and empirical papers focus on the effects of interest rate volatility and foreign exchange rate volatility on bank stock returns separately. Some study the sensitivity of bank stock returns to interest rate, Stone (1974), Sweeney and Warga (1986), and Elyasiani and Mansur (1998). Others study the sensitivity of bank stock returns to foreign exchange rate, Grammatikos et al. (1986) and Chamberlain et al. (1997). Empirical studies including both interest rate and foreign exchange rate have been conducted in US, Joseph and Vezos (2006), Choi et al. (1992), Australia, Rayn and Worthington (2004), Turkey, Kasman et al. (2011). There are also few studies providing empirical evidence which show the reaction of commercial bank stock returns to interest rate and foreign exchange rate in Canada.

This paper conducts an empirical study using both OLS and GARCH model to estimate the sensitivity of bank stock returns to market rate, interest rate and foreign exchange rate using the sample of major commercial banks from Canada. It is a replication of the work of Kasman (2011). Results from the two type models are compared. The data used is from January 2007 to December 2011. In this period, slack monetary policy is introduced with the declining of overnight rate, which will have effect on other types of interest rate. Daily data is used instead of monthly data since the daily fluctuation will capture more movement details of the stock return. More information and surprise in the market and economic environment would also be given when using daily market index, interest rate and foreign exchange rate as well. There are also more pronounced ARCH effects in daily data than monthly data, according to Joseph and Vezos (2006). ARCH test is conducted after the estimation of OLS model in this study to test whether the variables are time varying. The result found is that OLS coefficients are not reliable since the error terms do not satisfy some classical assumptions of OLS model. GARCH model is better in the estimation of bank stock return volatility. Two types of GARCH model are conducted then.

The remaining of the paper is organized as follows: Section 2 is a review of the existing literatures that conduct the researches related to this area. Section 3 is the details of description of data used in this paper. Section 4 presents the methodology and models. Empirical results from the regression and analysis are shown in Section 5. Section 6 is the Conclusion.

2. Literature Review

There are a couple of researches that explore the impact of changes of interest rate, market rate and foreign exchange rate on firm's stock returns, including both theoretical and empirical studies. Early researches only concentrated on either the sensitivity of interest rate or the sensitivity of foreign exchange rate on bank stock returns. The first study of interest rate sensitivity on firm's stock returns is conducted by Stone (1974), who introduce the "Two-Index model" which include both market returns and interest rate factors. The assumption of this model is constant variance error terms. His theory is the basic framework for some later researches. Most of these researches explore the sensitivity of stock returns by following the model he derived. Some empirical evidences from these researches supported his work. Lloyd and Shick (1977) supported Stone's theory by using the empirical data to test the two-index model. They also extended Stone's work by introducing interest rate index. Martin and Keown (1977) support Stone's work by demonstrating the strong interest rate sensitivity for some particular groups. Sweeney and Warga (1986) also show the same result. Later Lynge and Zumwalt (1980) modified Stones' work by introducing a multi-index approach. They also reports that the interest rate changes have a negative effect on the financial institutions stock returns. The same result is found by Bae (1990): "a negative effect of both current and unanticipated interest rate changes". Elyasiani and Mansur (1998) study on the sensitivity of bank stock returns to interest rate changes as well, but with different models, an "GARCH-M" model that is commonly used in recent researches.

For recent study following the two index model, Park and Choi (2011) tests the interest rate sensitivity of US property/ liability insurer stock returns using different return generating process: actual interest rate changes, unexpected interest changes and orthogonalized market returns. The result from their work is that the sensitivity of real interest rate and the unexpected interest rate are similar. And these sensitivities become larger when orthogonalized market returns enter the model.

While some researches focus on the effects of interest rate changes on firm stock returns, other studies analyze the foreign exchange rate factor. The unexpected changes of foreign exchange rates can cause translation gains or losses, which will directly affect banks, according to Kasman, et al. (2011). Thus, foreign exchange rate becomes another important factor that will determine bank stock returns. Grammatikos et al. (1986) examine the risks and returns of foreign currency activities from different US banks. Chamberlain et al. (1997) conduct a study on foreign exchange exposure by comparing both US and Japanese financial firms. They use daily data to estimate the foreign exchange rate sensitivity of the bank stock returns from both countries and compare the results. There are more bank stock returns moving with the foreign exchange rate in US, while less Japanese bank stock returns shows the sensitivity of exchange rate.

Despite those studies only on either interest rate or foreign exchange rate, there are a couple of studies concentrating on both of them. The paper from Choi et al. (1992) estimates the sensitivity of bank stock returns to market interest and exchange rate risks using a multifactor model for two periods: before 1979 and after 1979. The data used is monthly data and short-term interest rate. First they use a univariate autoregressive moving average ARIMA model to generate a proxy representing the innovation of the interest rate, foreign exchange rate and market return. Then they estimate the sensitivity of bank stock returns by regressing the innovation factors on bank stock returns with OLS model. They find the result that foreign exchange rate innovations are negatively correlated with bank stock returns before 1979 and becomes "significantly positive" after that. Since foreign exchange rate is correlated with bank stock returns, it cannot be omitted when investigating bank stocks.

More recent studies suggest that sensitivity of bank stock returns to interest rate and foreign exchange rate vary with time. The work from Kane and Unal (1988) shows that the sensitivity of bank stock returns varies over time by using switching regression method. Park and Choi (2011) also show that the interest rate sensitivity of insurer stock returns is time varying. There may be a serious residual autocorrelation problem in the empirical data. Under this condition, ARCH effects in the empirical data affect the results generated by OLS model. This will cause inefficiency in the coefficient estimation. Then some studies propose to use the Autoregressive Conditional Heteroskedasticity (ARCH) or Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model to estimate the volatility of stock returns. A two-factor model was first used to estimate the volatility of bank stock returns by Song (1994).

Some researches have shown this inefficiency by comparing the results generated by OLS model and GARCH model. Joseph and Vezos (2006) also showed that OLS is not efficient when there are ARCH effects and volatility clustering in the data. They initially follow the OLS approach and find that the presence of residual autocorrelation is a very serious problem that leads to the failure of OLS assumptions. Then they conduct the EGARCH model to estimate the impact of interest rate and foreign exchange rate on the

US bank stock returns. The result shows that EGARCH model provides a better goodness of fit than OLS model and is more reliable. The sensitivity coefficients in these two methods are similar. The effects of foreign exchange rate changes are positive in both methods and the interest rate changes affect different banks differently with either positive or negative effects. In this case, EGARCH model is more suitable.

Kasman et al. (2011) explore the impact of interest rate and exchange rate volatility on Turkey's bank stock returns and volatility by conduct OLS model and two types of GARCH model. First they use the traditional OLS model and conduct ARCH tests. The result of ARCH test shows that the null hypothesis of no autocorrelation or heteroscedasticity is rejected. There is a residual serial correlation for all the banks and portfolio level analysis. The OLS classical assumptions' failure indicates that the OLS coefficients are not efficient and reliable. Using GARCH model is more appropriate for estimating data of bank stock returns.

Although the research conducted by Joseph and Vezos (2006) shows that the coefficients estimated by EGARCH model is more efficient than OLS model, their result shows that under the condition of t-distribution assumption, the goodness of fit of the EGARCH model is still not satisfactory. The sensitivity of bank stock returns depends mostly on the market index returns. The effects of changes in interest rate and foreign exchange rate on bank stock returns are not very pronounced even with high frequency data. The sensitivity of interest rate and foreign exchange rate are weak in both models, while sensitivity of foreign exchange rate is stronger than the sensitivity of interest rate. The implication of their research is that banks' policies are not reflected in their stock returns. But they also conclude that the result may be different by using other types of GARCH model. A better model may be more appropriate for this estimation.

Some other researches use different GARCH models to estimate the relationship between market rate, interest foreign exchange rate and stock returns. Carson et al. (2006) use a System-GARCH model to examine the interdependency in stock returns between different sectors of insurance industry. Elyasiani and Mansur (1998) use GARCH-M model to analyze the interest rate and its changes on bank stock returns. The result from their work shows that there are direct effects on bank stock returns form the interest rate and its volatility. They also found that the interest rate volatility affects risk primia indirectly.

Kasman et al. (2011) conducted two types of GARCH model to estimate the sensitivity of bank stock returns to interest rate and exchange rate volatility in Turkey after they find the OLS estimation is affected by ARCH effects. The interest rate used is mid-term Turkish Government Bond Yield. The result they found is that the changes of interest rate and foreign exchange rate have negative effect on the conditional bank stock return. Market return changes effect is stronger than interest rate and foreign exchange rate effects and plays an important role in determining the conditional return of bank stocks. Their research provides information for investors that they should follow the monetary policies to make investment decisions since the return of the bank stocks are correlated with the change of interest rate and foreign exchanges rate. When there are changes in these two factors, they should change the composition of their portfolios to improve the return of the whole portfolio and avoid risks. Their study is also useful for bank managers when they are trying to build risk management strategies as well as policy makers who should take banking system into account and keep it stable.

Ryan and Worthington (2004) use the extended version of Generalized Autoregressive Conditional Heteroskedasticity in Mean (GARCH-M) method to modeling the sensitivity of Australian bank stock returns to market return, interest rate and foreign exchange rate risk using daily data from 1996 to 2001. This model allows for variable volatility to vary with time. They explore three different kinds of interest rates: short-term, mid-term and long-term. Their results indicate that market rate, short-term interest rate and mid-term interest rate are important factors that affect the Australian bank stock returns. This is supported by the study of Vaz et al. (2008). But long-term interest rate and foreign exchange risks do not affect the bank stock returns during the period they estimated. They also provide explanations for the difference.

Despite those researches in the US and other countries, there are few studies on the sensitivity of stock returns to interest rate and foreign exchange rate changes in Canada. Calvet and Rahman (1995) carried a study on the volatility of stock return in Canada using the data from 1976-1981. Karolyi (1995) use a multivariate GARCH model to analyze the stock volatility in both US and Canada. There are rare researches on interest rate volatility as well. This paper will examine the volatility of stock return to interest rate, market return and foreign exchange rate volatility by following the model used by Kasman et al. (2011) with Canadian empirical data.

3. Data

The period of the data used in this paper is from 9 January 2007 to 30 December 2011. The frequency of the data is daily which contains 1246 days, excluding weekends and national holidays. Monthly data, Elyasiani and Mansur (1998), Choi (1992) and daily data, Kasman et al. (2011), Rayn and Worthington (2004), Joseph and Vexos (2006) have been both used in the past researches. Most recent studies use daily data to examine the relationship between the volatility of bank stock returns, market rate, interest rate and foreign exchange rate since it will capture more movements of these variables. Most studies that conduct GARCH type model often use daily data as well, Rayn and Worthington (2004), Joseph and Vezos (2006), Kasman et al. (2011). This study uses daily data also because more movements will be reflected by high frequency data.

3.1 Bank Stocks

The sample of the bank stocks is from the Toronto Stock Exchange (TSX), which consists of eight major domestic commercial banks in Canada. The daily closing price are use to compute the continuously compounded daily return for each bank. Daily S&P/TSX price index of financial sector is also used to represent the factor of the whole financial industry. It will be calculate as continuously compounded daily return as well. The financial crisis will lead to the increase in market risk premium, which may be correlated to bank stock return volatility. The potential effect is an increase of required return of bank stocks, which may cause the decline of bank stock prices.

3.2 Market, Interest and Exchange Rate

S&P/TSX Composite Daily Index also from Toronto Stock Exchange (TSX) is used to compute the market return. S&P/TSX Composite Daily Index is the index of stock price of large firms in Toronto Stock Exchange (TSX). It reflects the overall market activities of Canadian equities. 2-year Government of Canada Benchmark bond yield, which represent the mid-term interest rate, is used in this study. Daily fluctuations of interest rate will reflect more information about the monetary policy of the government. Canadian Dollar Effective Exchange Rate Index (CERI) is used to calculate the return of the foreign exchange rate. CERI is the weight average of Canada's exchanger rate with its important trading countries and is more comprehensive to report the Canadian dollar actions compared to the exchange rate with a single country. The 2-year Government of Canada Benchmark bond yield and CERI are obtained from Bank of Canada. The variable specification is shown in Table 1.

Table 1. Variable Specification

Variables	
bmor	Return of Bank of Montreal
bnsr	Return of Bank of Nova Scotia
cibcr	Return of Canadian Imperial bank of commerce
cwbr	Return of Canadian Western Bank
lbar	Return of Laurentian Bank of Canada
nbcr	Return of National Bank of Canada
rbcr	Return of Royal Bank of Canada

Tdr	Return of Toronto-Dominition Bank
Bir	Return of Financial Sector Index
Mr	Return of Market Index
imr	Return of 2-year Government of Canada Benchmark bond yield
Er	Return of Effective Exchange Rate Index (CERI)

Continuously compounded daily returns of all the variables are calculate using the formula used in Kasman (2011): $r_t = 100 * \ln(x_t / x_{t-1})$. x_t is value of variable at time t and x_{t-1} is the value of variable x at time t-1. r_t is the return of x. Continuously compounded return is used here instead of discrete returns in some early research (Faff and Howard,1999) because it will reduce any outlier effect and data error, according to Ryan and Worthington (2004). They also point out that continuously compounded return remove some increasing variability, Brailsford et al. (2000).

Table 2 shows the descriptive statistics for the continuously compounded daily return for all bank stocks, financial index, market index, interest rate and foreign exchange rate (CERI).

According to the descriptive statistics, there are both positive and negative skewness for the continuously compounded returns. The kurtoses are larger compared to normal distribution, which means that the returns are leptokurtic. Also the large and statistically significant Jarque-Berra values indicate that normality is rejected for all the variables. Augmented Dickey–Fuller (ADF) test is conducted to examine the stationary of the time series data. The rejection of null hypothesis for all returns shows that there is no unit root present using the continuously compounded return. All variables used in the estimation are stationary series.

Table 2. Descriptive Statistics

	Mean	Max	Min	SD	Skewness	Kurtosis	Jarque–Berra	ADF
bmor	-0.0166	9.2133	-12.8014	1.8793	0.0088	7.1845	908.4***	-33.554
bnsr	-0.0011	11.4506	-13.7351	1.8959	-0.0615	8.7693	1727.4***	-36.119
cibcr	-0.0234	10.7769	-13.1372	2.0717	0.1062	7.4775	1042.3***	-35.526
cwbr	0.0014	9.6238	-15.1741	2.3135	-0.5628	8.3605	1556.4***	-32.545
labr	0.0357	11.2225	-9.1600	1.8838	0.2303	7.5151	1068.5***	-34.538
nbcr	0.0087	12.7395	-15.4786	1.9201	-0.1233	11.5337	3780.9***	-35.236
rbcr	-0.0031	13.1924	-14.3813	1.9483	0.1150	10.2415	2723.0***	-36.956
tdr	0.0081	11.3751	-14.0563	1.8353	0.0979	9.7914	2394.6***	-36.304
bir	-0.0168	11.3886	-12.7975	1.7267	-0.0043	11.8766	4087.4***	-36.458
mr	-0.0034	9.3703	-9.7880	1.5416	-0.6646	10.0941	2702.3***	-38.367
imr	-0.1155	19.0354	-30.0105	3.3705	-0.5823	11.0140	3402.0***	-35.464
er	0.0105	4.6269	-3.7323	0.7388	0.0064	7.1446	891.1***	-34.739

*** at 1%

4. Methodology

Three models are used in this study to estimating the relationship between the return of bank stocks, market, interest rate and foreign exchange rate return using Canadian data: OLS model and two types of GARCH model.

4.1 OLS Model

The OLS model used in this paper can be expressed as follows:

$$r_t = \beta_0 + \beta_1 mr_t + \beta_2 imr_t + \beta_3 er_t + \varepsilon_t \qquad (1)$$

r_t is the return of bank i's stock using continuously compounded method, mr_t is the return of the market index, imr_t represents the return of mid-term 2-year Government of Canada Benchmark bond yield, er_t is the return of exchange rate, ε_t is the error term which satisfies the classical assumption of OLS model with no autocorrelation problem in it. In the estimation, each bank's portfolio is estimated separately to see whether its stock return is correlated with the return of market index, interest rate and foreign exchange rate.

After the OLS regression, ARCH test is conducted to detect whether there is autocorrelation or heteroscedasticity problems in the residuals. Once ARCH effects are found, in which case the null hypothesis will be rejected, which indicates that there may be autocorrelation or heteroscedasticity in the residuals. In this case, it may not be suitable to estimate the effects of changes of market, interest rate and exchange rate return on the changes of bank stock returns by using OLS model since the error term may not satisfy the classical assumptions that OLS model requires.

According to some existing researches, OLS model may be inefficient due to ARCH effect, especially with high frequency data, Joseph and Vezos (2006), Baillie and Bollerslev (1989). ARCH effects maybe more obvious when using daily data. In such condition, OLS model is inappropriate and GARCH-type models will be more appropriate in the estimation since they will capture the time varying effects in such data.

4.2 GARCH (1,1) Model

After the OLS regression, two types of GARCH model are then conducted. GARCH model is the short term for the Generalized Autoregressive Conditional Heteroscedasticity process, which is first developed by Bollerslev (1986), who introduce the GARCH model based on the ARCH model and conduct an empirical analysis on the uncertainty of inflation rate.

The first type of GARCH (1,1) model can be express as follows:

$$r_t = \gamma_0 + \gamma_1 mr_t + \gamma_2 imr_t + \gamma_3 er_t + \varepsilon_t \qquad (2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \qquad (3)$$

The parameters in Equation (2) are the same as defined in OLS model in Equation (1). Equation (3) is the conditional variance equation. σ_t^2 is the variance of bank stock return i at time t, which measures the stock return volatility. The previous period's squared error term, ε_{t-1}^2, is the ARCH term which gives the information about shocks on the volatility of the bank stock return in the past period, period t-1. σ_{t-1}^2 is referred to the GARCH term which is variance of the previous period. α_0 is the constant term, which represent the average volatility in the long term. α_1 and β are the coefficients for ARCH term and GARCH term. This equation is used to measure the sensitivity of bank stock volatility to its own lagged value and new shocks. In the GARCH model, both coefficients of the ARCH term and the GARCH term should be positive under the non-negative condition of GARCH model. The sum of α_1 and β should be less than one ($\alpha_1 + \beta < 1$) as well. This condition is to ensure the wide stationary, according to Bollersley (1996).

The second type of GARCH (1,1) is then estimated:

$$r_t = \gamma_0 + \varepsilon_t \qquad (4)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \theta_1 \mathrm{imr}_t^2 + \theta_2 \mathrm{er}_t^2 \qquad (5)$$

While other variables have been defined before, imr_t^2 is the square of the interest rate return, which measures the interest rate volatility. er_t^2 is the square of foreign exchange rate return which also represents the volatility. Equation (5) is used not only to estimate the sensitivity of bank stock return volatility to its own lagged values and residuals, but also whether the volatility of individual bank stock return is correlated with the volatility of interest rate and foreign exchange rate. With the entry of interest rate return and foreign exchange rate return volatility in Equation (5), the coefficients of the ARCH term and GARCH term could be different from the estimation in Equation (3).

5. Empirical Results

5.1 OLS Model

The results from the estimation of OLS model are shown in Table 3. From the table we can see that the constant terms are not statistically significant for all the banks. The coefficients for market return are positive and statistically significant in all eight cases and for bank index as well. The coefficients for interest rate returns are also positive in all cases, with eight cases statistically significant. Foreign exchange rate return coefficients have both positive and negative values, but only with seven cases statistically significant out of all nine cases.

Table 3. Estimation of OLS Model

	β_0	β_1	β_2	β_3	Adjusted R^2	ARCH (1)
bmor	-0.0045	0.7433***	0.0695***	−0.1557**	0.4097	73.878***
	(0.0410)	(0.0297)	(0.0133)	(0.0613)		
bnsr	0.0068	0.8780***	0.0308**	−0.1309**	0.5122	64.539***
	(0.0376)	(0.0272)	(0.0122)	(0.0562)		
cibcr	-0.0167	0.8858***	0.0275*	-0.0446	0.4476	109.636***
	(0.0437)	(0.0317)	(0.0142)	(0.0654)		
cwbr	0.0076	0.7701***	0.0470***	0.1723**	0.3177	155.066***
	(0.0542)	(0.0393)	(0.0176)	(0.0811)		
lbar	0.0380	0.5289***	0.0110	0.0745	0.2025	66.363***
	(0.0477)	(0.0346)	(0.0155)	(0.0714)		
nbcr	0.0184	0.7278***	0.0474***	−0.1717***	0.3525	158.054***
	(0.0438)	(0.0318)	(0.0142)	(0.0656)		
rbcr	0.0048	0.9051***	0.0308**	−0.1182**	0.5176	61.000***
	(0.0384)	(0.0278)	(0.0125)	(0.0575)		
tdr	0.0177	0.8254***	0.0464***	−0.1382**	0.5003	70.583***
	(0.0368)	(0.0267)	(0.0120)	(0.0551)		
bir	-0.0092	0.9069***	0.0332***	−0.0690*	0.6774	48.452***
	(0.0278)	(0.0202)	(0.0090)	(0.0416)		
Significant Case	0/9	9/9	8/9	7/9		

* at 10%, ** at 5%, *** at 1%.

β_1 is the coefficient of market index return, which is statistically significant at 1% level in all the nine cases. The coefficient is positive and relatively large compared to the coefficient of interest rate and exchange rate. The values vary from 0.5289 to 0.9051 for eight banks, with the highest for Royal Bank of Canada and the lowest for Laurentian Bank of Canada. The coefficient for bank index is 0.9069. The relatively large value shows that market return explains a large part of bank stock returns, which is consistent with the result from most of the existing literature.

The value of β_2 shows that the changes of interest rate also have a positive impact on bank stock return, except for Laurentian Bank of Canada. The result that bank stock return is correlated with changes of mid-term interest rate is consistent with the paper from Ryan and Worthington, (2004). The values of the coefficient vary from 0.0275 to 0.0695, with the highest for Bank of Montreal and the lowest for Canadian Imperial bank of commerce. The value for the bank index is 0.0332. The effect of changes in interest rate on bank stocks is much smaller than the market index.

The coefficient of foreign exchange rate return shows that the changes of foreign exchange rate have negative effects on bank stock returns except for Canadian Western Bank. The sensitivity of bank stock returns to foreign exchange rate changes is stronger than interest rate changes. These results are consistent with Kasman (2011). But only the coefficient of National Bank is statistically significant at 1% level. Coefficients of the rest banks are at 5% level. In general, the sensitivity of bank stock returns is correlated most to the market return and foreign exchange rate return. The relationship between the volatility of bank stock returns and interest rate is relatively weak.

ARCH test is conducted to examine the suitability of the estimates. The null hypothesis will be rejected if there is heteroscedasticity or autocorrelation problem in the residuals. From Table 3 we can see that all the F-statistics are statistically significant at 1% level. The null hypothesis is rejected for all the banks as well as the bank index. This indicates that the result we get from the OLS model may not be suitable when using such data. In this case GARCH type models are more suitable to estimate the sensitivity of the selected variables.

5.2 Empirical Result of Return with GARCH (1,1) Model

The results from the first type of GARCH model are shown in Table 4, which is used to estimate effect of market return, interest rate return and foreign exchange rate return on conditional bank stock returns. From the table we can see the result from Equation (2) is similar to the result of Equation (1). The coefficient for effect of market index return on bank stock return is statistically significant in all cases and so is the interest rate coefficient except for Laurentian Bank of Canada. The coefficients of exchange rate return are negative, which is also consistent with the OLS result, but with only two out of nine cases statistically significant cases. It is statistically significant for Bank of Nova Scotia and Canadian Western Bank.

Equation (3) is used to examine the relationship between the return of the bank stock and its own lagged values and new shocks. The coefficients in this regression are all positive and statistically significant in all nine regressions. The values of the coefficients are shown in the last two columns of Table 4.

The coefficient γ_1 estimate how market return is correlated with the return of bank stocks. The value of γ_1 varies from 0.4092 to 0.8079 and is 0.7874 for bank index, with the highest for National Bank of Canada and lowest for Laurentian Bank of Canada. It is statistically significant at 1% level in all the cases. The results are within the expected lines. The market rate of return explains a large part of the conditional stock bank return.

Table 4. Estimation of GARCH (1,1) Model (1)

	γ_0	γ_1	γ_2	γ_3	α_0	α_1	β
bmor	-0.0105	0.6512***	0.0482***	-0.0264	0.0228***	0.0974***	0.8964***
	(0.0274)	(0.0259)	(0.0086)	(0.0446)	(0.0056)	(0.0112)	(0.0113)
bnsr	0.0052	0.8079***	0.0288***	−0.0722*	0.0119***	0.0715***	0.9222***
	(0.0253)	(0.0252)	(0.0092)	(0.0437)	(0.0038)	(0.0111)	(0.0112)
cibcr	-0.0225	0.7676***	0.0242**	-0.0212	0.0140***	0.0571***	0.9373***
	(0.0289)	(0.0272)	(0.0096)	(0.0462)	(0.0033)	(0.0066)	(0.0072)
cwbr	0.0340	0.6749***	0.0249**	0.1923***	0.0430***	0.0693***	0.9190***
	(0.0442)	(0.0343)	(0.0126)	(0.0684)	(0.0112)	(0.0099)	(0.0108)
lbar	0.0349	0.4992***	0.0140	0.0901	0.0407***	0.0694***	0.9155***
	(0.0358)	(0.0307)	(0.0128)	(0.0614)	(0.0069)	(0.0084)	(0.0085)
nbcr	-0.0283	0.6417***	0.0218*	0.0482	0.0107***	0.0596***	0.9371***
	(0.0268)	(0.0255)	(0.0113)	(0.0471)	(0.0035)	(0.0070)	(0.0069)
rbcr	-0.0258	0.7892***	0.0356***	-0.0478	0.1130***	0.2047***	0.7482***
	(0.0290)	(0.0232)	(0.0090)	(0.0426)	(0.0168)	(0.0225)	(0.0238)
tdr	-0.0006	0.7844***	0.0437***	-0.0597	0.0077***	0.0444***	0.9515***
	(0.0264)	(0.0235)	(0.0083)	(0.0436)	(0.0023)	(0.0053)	(0.0056)
bir	-0.0109	0.7874***	0.0338***	-0.0304	0.0028**	0.0593***	0.9383***
	(0.0166)	(0.0183)	(0.0051)	(0.0276)	(0.0011)	(0.0086)	(0.0081)
Significant Case	0/9	9/9	8/9	2/9	9/9	9/9	9/9

* at 10%, ** at 5%, *** at 1%.

γ_2 measures the effect of interest rate return on the conditional bank stock returns. From Table 4 we can see that the coefficient is statistically significant in eight out of nine cases, except for Laurentian Bank of Canada. The significant values are all positive and vary from 0.0218 to 0.0482 and is 0.0338 for bank index. This result is similar to what we get before in the OLS model that the bank stock returns moves with the mid-term interest returns in the same direction.

The positive relationship between the interest rate return and bank stock return can be explained by the impact of changes of interest rate on bank's balance sheet. The dynamics is that interest rate changes can influence the net interest income and other income generated by interest-sensitive securities. Another reason that can explain this effect is that the duration period of the bank assets is shorter than the duration of bank assets for these banks. In this case, the assets will be realized first. If there is an unexpected increase in interest rate return, it will cause the positive discounted cash flows on the balance sheet of the bank. This will have a positive effect on bank stock returns since it causes the positive net interest income.

This result suggests that bank stock return is positively correlated with mid-term interest rate return. Although the mid-term interest rate is not a direct reflection of the government's monetary policy, it is correlated with it. Overnight rate is the direct reflection of monetary policy. Mid-term interest rate include liquidity premium which indicates higher price uncertainty, so it is often higher than the overnight rate. The investors and bank managers as well as the policies makers should refer to the shape of yield curve to see the effects of overnight rate on mid-term bond rate. Under the financial crisis environment, government has been using unusual monetary policy that keeps the overnight rate at a very low level. Further more, when the overnight rate reaches its minimum level, the traditional monetary is not effective any more. It is important for investors and bank managers to note the relationship between overnight rate and bond rate under this special condition.

γ_3 is the coefficient of effect of foreign exchange rate return on bank stock return. There are only two out of nine statistically significant cases except for Bank of Nova Scotia and Canadian Western Banks. The coefficient for bank index is not statistically significant as well. This indicates that the exchange rate return does not have a significant impact on the conditional bank stock returns for most of the banks. This result is different from what we get in the OLS model. But the coefficient in the two statistically significant cases are both negative, which means that the foreign exchange rate return have a negative effect on these two banks.

The negative effect of foreign exchange rate changes on bank stock returns can be explained by the quantity of foreign currency denominated assets and liabilities on banks' balance sheet. If the foreign currency related assets is larger than the foreign currency related liabilities, then the unexpected appreciation of domestic currency will cause a loss on the net discounted cash flow. In this case, the negative relationship happens between the return of foreign exchange rate and the return of bank stocks. The results are different between banks.

Equation (3) is the condition variance equation, which is used to analyze the relationship between the bank stock's volatility to its own lagged value and its new surprise. In this equation, ε_{t-1}^2 represent the shocks on volatility of bank stock return in the last period and is referred to as ARCH term. The coefficient of ε_{t-1}^2, α_1, is the measure of how the volatility of bank stocks is related to the new shocks in the last period. σ_{t-1}^2 is the lagged value of the conditional variance, and is referred to as GARCH term. The coefficient of this term, β, is the measure of how the volatility of bank stock return depends on its last period's volatility. The coefficients of GARCH and ARCH term should be both positive under the assumption of GARCH model. The sum of the coefficients' value of these two terms should be less than one as well. Table 5 shows the coefficient sum for each bank.

Table 5. Sum of ARCH and GARCH Term (1)

Name of the Bank	Sum of the Coefficients of ARCH and GARCH Term
Bank of Montreal	0.9938
Bank of Nova Scotia	0.9937
Canadian Imperial bank of commerce	0.9944
Canadian Western Bank	0.9884
Laurentian Bank of Canada	0.9849
National Bank of Canada	0.9967
Royal Bank of Canada	0.9529
Toronto-Dominition Bank	0.9959
Financial Sector Index	0.9976

In the results shown in Tables 4, coefficient α_0 is statistically significant in all nine cases. The values are all positive. This indicates that the process of return generation is a time-invariant system. Both ARCH coefficient α_1 and GARCH coefficient β are positive and statistically significant at 1% level, which are consistent with the assumption of GARCH model. We can also see that the GARCH parameter α_1 is much larger than the ARCH parameter for all the cases. This means that the volatility of the bank stock return is more correlated with the volatility of its past period than its new shocks. From Table 5 we can see that the sum of the coefficients of ARCH term and GARCH term are close to unity in eight out of nine cases, except for Royal Bank of Canada. This means that shocks to the bank stocks and bank index of returns have a persistent effect.

Generally, the result from the GARCH model shows that market index return plays an important role in determining the return of bank stocks. Interest rate return generally has a positive effect on bank stock return. Foreign exchange rate has a negative on bank stock return, but not very significant when using this type of GARCH model.

5.3 Empirical Estimation of the Volatility with GARCH (1,1) Model.

Table 6 reports the empirical result of the estimation between bank stock return, bank index volatility and interest rate volatility and foreign exchange rate volatility.

From the table we can see that the coefficient α_1 and β are statistically significant and positive in all the cases. The GARCH term coefficient β is much larger than α_1, which is the same result in the first type GARCH model. The volatility of bank stock return is more sensitive to its past period volatility, compared to the new surprise in the last period. Table 7 shows the sum of coefficients of ARCH term and GARCH term. From Table 7 we can see that the sum of the coefficients is relatively low with the entry of interest rate volatility and exchange rate volatility. It is only 0.7175 for Royal Bank of Canada. This indicates that the persistency of shocks is low when considering the effect of interest rate volatility and exchange rate volatility.

Table 6. Estimation of Volatility (1)

	γ	α_0	α_1	β	θ_1	θ_2
bmor	0.0030	-0.0006	0.1040***	0.8582***	0.0020	0.2071***
	(0.0333)	(0.0089)	(0.0143)	(0.0162)	(0.0013)	(0.0442)
bnsr	0.0155	0.0089	0.1329***	0.8279***	0.0025*	0.1676***
	(0.0327)	(0.0120)	(0.0196)	(0.0219)	(0.0015)	(0.0611)
cibcr	0.0131	0.0176	0.1462***	0.8021***	0.0015	0.3238***
	(0.0330)	(0.0136)	(0.0223)	(0.0242)	(0.0012)	(0.0804)
cwbr	0.0308	-0.0029	0.0645***	0.9137***	0.0008	0.2090***
	(0.0457)	(0.0093)	(0.0087)	(0.0095)	(0.0006)	(0.0444)
lbar	0.0661**	0.0414***	0.1107***	0.8576***	0.0004	0.1432***
	(0.0387)	(0.0105)	(0.0136)	(0.0138)	(0.0008)	(0.0474)
nbcr	0.0188	-0.0017	0.0695***	0.9069***	0.0004	0.1463***
	(0.0337)	(0.0056)	(0.0094)	(0.0110)	(0.0006)	(0.0313)
rbcr	0.0017	3.4735***	0.1416**	0.5759***	−0.0082**	−0.0232***
	(0.1482)	(0.8398)	(0.0625)	(0.1089)	(0.0044)	(0.1848)
tdr	0.0319	0.0087	0.1048***	0.8520***	0.0015	0.2220***
	(0.03220	(0.0098)	(0.0140)	(0.0165)	(0.0013)	(0.0499)
bir	0.0306	0.0080	0.1028***	0.8753***	0.0014*	0.0500***
	(0.0263)	(0.0050)	(0.0160)	(0.0169)	(0.0007)	(0.0322)
Significant Case	0/9	2/9	9/9	9/9	3/9	9/9

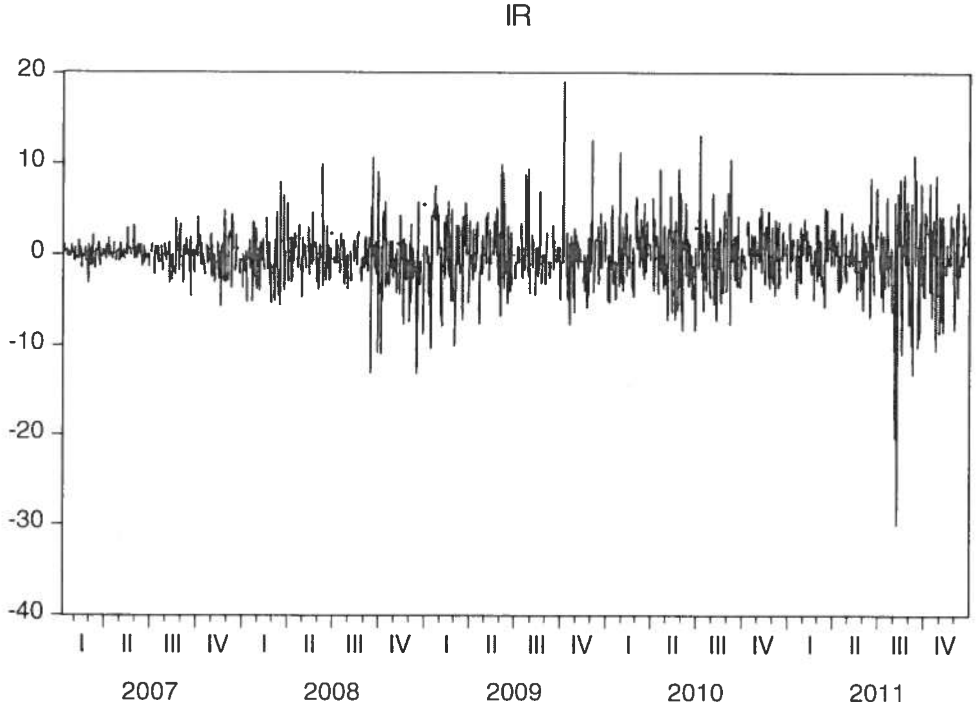
* at 10%, ** at 5%, *** at 1%

Table 7. Sum of ARCH and GARCH Term (2)

Name of the Bank	Sum of the Coefficients of ARCH and GARCH Term
Bank of Montreal	0.9622
Bank of Nova Scotia	0.9609
Canadian Imperial bank of commerce	0.9482
Canadian Western Bank	0.9782
Laurentian Bank of Canada	0.9683
National Bank of Canada	0.9763
Royal Bank of Canada	0.7175
Toronto-Dominition Bank	0.9568
Financial Sector Index	0.9781

θ_1 is the coefficient which measures the correlation between bank stock return volatility and interest rate return volatility. Since financial crisis happens during the period, the volatility of interest rate return may be affected by the changes of the economic environment and the monetary policy of the government. Figure 1 shows the evolution of the interest rate return volatility during the period.

Figure 1. Volatility of Interest Rate Return



The horizontal axis represents the time line while the vertical axis represents the value of interest rate return calculated using the continuously compounded method. Two important events are critical in the selected periods. The first event is the start of the financial crisis on August 7th, 2007. The second event is the bankruptcy of Lehman Brothers on September 15th, 2008, which plays an important role in the crisis. From Figure 1 we can see that before the start of the financial crisis, interest return volatility is relatively low. After the start of the start of the crisis in August 2007, interest rate return becomes more volatile. Interest rate return volatility continuous to increase as the unfolding of the crisis and reaches a higher level in September 2008, when the Lehman Brothers filed for bankruptcy protection. The volatility stays at this relatively high level after that. This graph reports that the financial crisis leads to the increase of the interest rate return volatility.

From Table 6 we can see that there are only three statistically significant cases out of all nine cases, with both positive and negative values, including the bank index. Also, the coefficients are relatively small in the statistically significant cases. This indicates that the volatility of interest rate return may have positive or negative effect on the volatility of bank stock returns. But the support from empirical evidence is very weak. This happens probably because the Canadian financial market is a relatively mature market with various kinds of derivative instruments and securities. Banks can use these derivative instruments to match the duration of securities in their assets and liabilities. Thus, the interest rate risk can be reduced by the operations of banks. For those banks whose stock return volatility are affected by the interest rate volatility, it can be explain that there may be duration differences in the interest rate-sensitive securities between the banks' assets and liabilities. But these differences are not large so that interest rate volatility does not have strong impact on the volatility of bank stock returns.

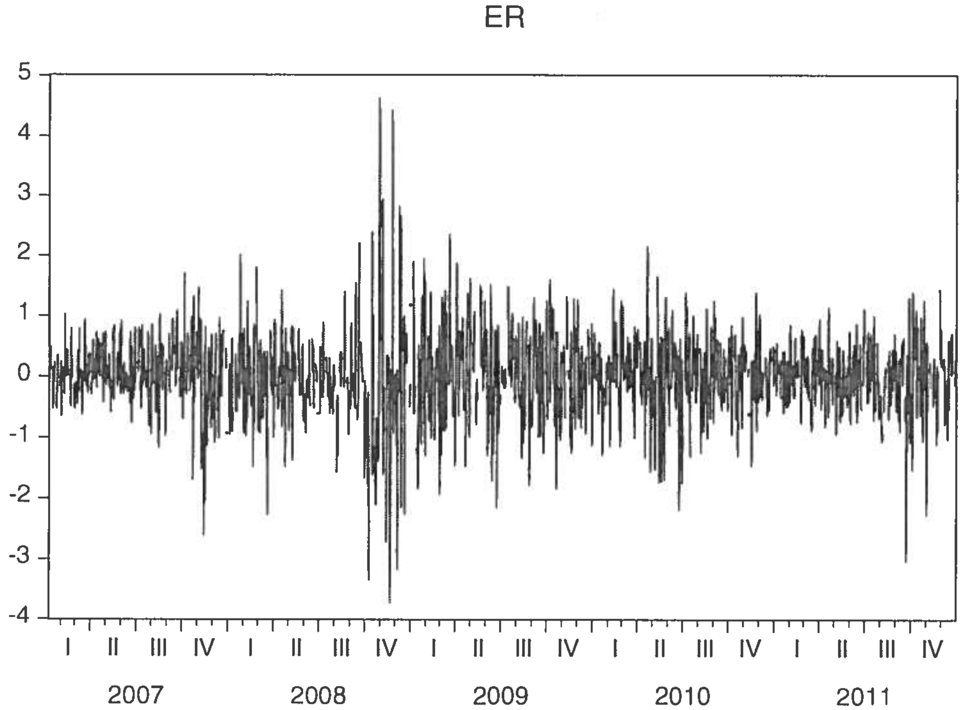
This result of the interest rate return shows that although the financial crisis increases interest rate return volatility, Canadian commercial banks can use derivative instruments to avoid shocks of this effectively. The bank stock returns are not strongly affected by the increase of interest rate return volatility. Some financial instruments can offset the increasing interest rate premium caused by the financial crisis since the Canadian financial market is relatively mature.

θ_2 is the coefficient which measure the relationship between the volatility of foreign exchange rate return and the volatility of bank stock returns. The value is statistically significant in all the cases as well as bank index. It is also positive in most cases except for Royal Bank of Canada. This means that as the fluctuations of foreign exchange rate becomes larger, bank stock returns becomes more volatile. The result is consistent with the research conducted by Choi et al. (1992) and Kasman et al. (2011), but not consistent with the result found by Ryan and Worthington (2004). This indicates that the Canadian banks are exposed to the foreign exchange rate risk in recent five years. One possible explanation for this is that the volatility of foreign exchange rate may cause the mismatch in banks' assets and liabilities through its effects on the exchange rate sensitive securities. Another possible reason is that it may be hard for commercial banks to offset the foreign exchange rate risk in Canadian market by using financial derivative instruments. Overall, foreign exchange rate exposure problem is more serious than interest rate exposure problem for Canadian Banks.

Under the economic environment of the financial crisis, exchange rate return volatility could also be different from before. Figure 2 shows the exchange rate return volatility during the selected period.

As the same in Figure 1, the horizontal axis represents the time line from January 9th, 2007 to December 30th 2011, and the vertical axis represents the value of continuously compounded exchange rate return. Figure 2 shows that the exchange rate return is more volatile after the start of the financial crisis in August 2007. The economic environment affects exchange rate return volatility. This volatility is especially large during September to December in 2007, which indicates that exchange rate return varies a lot after Lehman Brothers' bankruptcy. Since the increase in the exchange rate return volatility can cause the increase in the banks stock return volatility, we can conclude that bank stock returns become more sensitive to exchange rate return after the financial crisis and Lehman Brothers' bankruptcy increases this sensitivity. Banks' balance sheets can be affected by the liquidity problem caused by these events. Exchange rate sensitive securities can cause mismatch in the banks' asset and liabilities when the exchange rate return becomes more volatile. Once the duration difference between the banks' assets and liabilities is larger, bank stock returns will become more sensitive. The increase in the foreign exchange risk cause bank stock returns more volatile.

Figure 2 Volatility of Foreign Exchange Rate Return



5.4 Improvement of the Model

Since the shock of Lehman Brothers' bankruptcy, on September 15th, 2008, is very extensive, a dummy variable D_l is introduced to check if the slope coefficient of the control is affected by the event. When D_l equals to zero, it represents the period before the Lehman Brothers' bankruptcy; when D_l equals to one, it represents the period after Lehman Brother's bankruptcy. The dummy variable is used in both types of GARCH model to measure the slope difference of interest rate and exchange rate related variables before and after the event.

After the introduction of the dummy variable, the first type of GARCH model becomes:

$$r_t = \gamma_0 + \gamma_1 mr_t + \gamma_2 imr_t + \gamma_3 er_t + \gamma_4 D_l mr_t + \gamma_5 D_l imr_t + \gamma_6 D_l er_t + \varepsilon_t \qquad (6)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \qquad (7)$$

$D_l = 0, if\ before\ September\ 15th, 2008$
$D_l = 1, if\ after\ September\ 15th, 2008$

γ_4, γ_5 and γ_6 are the coefficients which measure the difference of the relationship between market rate return, interest rate return, exchange rate return and bank stock return after Lehman Brothers' bankruptcy.

The empirical result after the introduction of the dummy variable for Equation 8 is shown in Table 8. From Table 8 we can see that the coefficient of market return increases after Lehman Brothers' bankruptcy except for Canadian Western Bank. The coefficient for interest rate return decreases except for Canadian Imperial bank of commerce and Laurentian Bank of Canada. This means after the bankruptcy, market return becomes more determinant in bank stock return and interest rate return becomes less correlated with bank stock return. The value of γ_3 shows that the bank stock return is negatively correlated with foreign exchange rate return before the bankruptcy with six out of nine statistically significant cases. After the bankruptcy, the coefficient increases with five out of nine statistically significant cases. This indicates that the effect of exchange rate return almost vanishes after the bankruptcy. Since there are only two out of nine statistically significance before, the model improves after the introduction of the dummy variable.

Table 8 Estimation of GARCH (1,1) Model (2)

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6
bir	-0.0087	0.6455***	0.1017***	−0.1343***	0.2042***	−0.0793***	0.1208**
bmor	-0.0042	0.4952***	0.1200***	-0.1030	0.2218***	−0.0833***	0.0767
bnsr	0.0080	0.6794***	0.1150***	−0.2025***	0.1793***	−0.1020***	0.1808**
cibcr	-0.0174	0.6319***	0.1411***	−0.1308***	0.1783***	-0.1288	0.1247
cwbr	0.0324	0.6003***	0.1421***	0.2732***	0.1042	−0.1284**	-0.1144
lbar	0.0427	0.3384***	0.0439	−0.2484**	0.2014***	-0.0414	0.4343***
nbcr	-0.0230	0.5193***	0.1142***	-0.1348	0.1675***	−0.1062***	0.2286**
rbcr	-0.0203	0.6834***	0.1188***	−0.2276***	0.1467***	−0.0989***	0.2479**
tdr	0.0003	0.5680***	0.1620***	-0.1107	0.3004***	−0.1345***	0.0372
significant case	0/9	9/9	8/9	6/9	8/9	7/9	5/9

* at 10%, ** at 5%, *** at 1%

After the introduction of the dummy variable, the second type of GARCH model becomes:

$$r_t = \gamma_0 + \varepsilon_t \quad (8)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \theta_1 \mathrm{imr}_t^2 + \theta_2 \mathrm{er}_t^2 + \theta_3 D_l \mathrm{imr}_t^2 + \theta_4 D_l \mathrm{er}_t^2 \quad (9)$$

$D_l = 0, if\ before\ September\ 15th, 2008$
$D_l = 1, if\ after\ September\ 15th, 2008$

θ_3 and θ_4 represent the difference of the interest rate return and exchange rate return volatility after Lehman Brothers' bankruptcy. Table 9 shows the empirical result of Equation 9. From Table 9 we can see that the volatility of interest rate return are positively correlated with the volatility of bank stock return for most banks as well as bank index except the Canadian Imperial bank of commerce. After the bankruptcy the coefficient decreases and the effect of interest rate return volatility on bank stock return almost vanishes. But there are only two out of nine significant cases for θ_3 and θ_4, which are the coefficients for the effect of exchange rate volatility. This indicates that the entry of the dummy variable is an improvement in estimating the effect of interest rate return volatility on bank stock return volatility, but not efficient for exchange rate.

Table 9 Estimation of Volatility (2)

	α_0	α_1	β	θ_1	θ_2	θ_3	θ_4
bir	0.0056	0.0918***	0.8785***	0.0147***	0.0163	−0.0131**	0.0282
bmor	-0.0008	0.0887***	0.8580***	0.0341***	0.1181	−0.0320***	0.1037
bnsr	0.0048	0.1179***	0.8343***	0.0228***	0.1126	−0.0205**	0.0585
cibcr	3.9045**	0.1361*	0.5723***	−0.0046***	-0.0314	-0.0043	-0.0154
cwbr	−0.0161*	0.0463***	0.9258***	0.0242**	0.2592***	−0.0226**	-0.0827
lbar	0.0321***	0.0914***	0.8716***	0.0174**	0.1427*	−0.0169*	-0.0149
nbcr	0.0050	0.0721***	0.8742***	0.0448***	-0.0085	−0.0443***	0.2423***
rbcr	0.0443***	0.1176***	0.8133***	0.0301**	0.0841	−0.0277**	0.1651
tdr	0.0122	0.0905***	0.8539***	0.0346***	0.0515	−0.0332***	0.1714**
Significant cases	4/9	9/9	9/9	9/9	2/9	8/9	2/9

* at 10%, ** at 5%, *** at 1%

6. Conclusion

This study examines the sensitivity of bank stock returns to market index return, interest rate return and foreign exchange rate return by conducting both OLS model and GARCH model. Daily price of eight major Canadian commercial banks, market index, 2-year Government of Canada Benchmark bond yield and Canadian Dollar Effective Exchange Rate Index (CERI) are used to calculate the returns used in each model. ARCH test shows that there are heterosedatsicity and autocorrelation problems in the residuals, which indicates that the returns vary with time. In this case, GARCH model is more suitable than OLS to analyze such kind of data. GARCH model also allows the to introduce the volatility of interest rate and foreign exchange rate into the estimation.

The result shows that market return have a strong impact on bank stock return. It plays an important role in explaining it. Interest rate return generally has a positive effect on bank stock return. Exchange rate return is correlated with bank stock return as well, but the effect is very weak. Exchange rate return is found to have a stronger conditional bank stock return volatility than interest rate. Under the financial crisis economic environment, the effect of increasing interest rate return volatility can be offset by using some financial instruments. But the volatility of bank stock returns will still rise due to the increase of exchange rate return volatility. Overall it indicates that bank stock returns will be affected by the changes of interest rate and the fluctuations in the foreign currency market. Since Lehman Brothers' bankruptcy has a great influence on the financial market, a dummy variable is added to distinguish the period before and after the event.

The first type GARCH model shows improvement with the introduction of the dummy variable as well as the estimation of interest rate return volatility in the second model.

This empirical evidence found by this study provides investors and bank managers with important information. Since the interest rate and foreign exchange rate can affect returns of bank stocks through the impact on bank's balance sheet, it is important for commercial banks to consider interest risk and exchange risk exposure when make changes to their management. Mid-term interest rate will be affected by the overnight rate through the dynamic of structure of interest rate, changes in monetary policy is also important to the volatility of bank stock returns. Investors should be aware of the government's monetary policy and fluctuation of the foreign currency markets. The interest rate and exchange rate return as well as its volatility have predicted power on the bank stock return volatility. They should pay more attention to the interest rate and exchange rate changes when their portfolios include stock and securities of commercial banks. It is also important for the policy makers to consider the impacts when making decisions since the stable of financial system is one of the key determinant of the whole economic growth.

Reference

Bae, S.C. (1990). Interest rate changes and common stock returns of financial institutions: revisited. *Journal of Financial Research,* 13, 71–79.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics,* 31, 307–327.

Brailsford, T.J., Faff, R.W. and Oliver, B.R. (2000). Volume 1: Research Design Issues in the Estimation of Beta, Brailsford, T.J. and Faff, R.W. (eds.), Sydney: McGraw-Hill.

Carson, J.M., Elyasiani, E. and Mansur, I. (2008). Market risk, interest rate risk, and interdependencies in insurer stock returns: a system-GARCH model. *Journal of Risk and Insurance*, Vol. 75 No. 4, pp. 873-91.

Calvet, A.L. and Rahman, A. (1995). Persistence of Stock Return Volatility in Canada. *Canadian Journal of Administrative Sciences,* Vol 12, Issue 3, 224-237.

Chamberlain, S., Howe, J. and Popper, H., (1997). The exchange rate exposure of US and Japanese banking institutions. *Journal of Banking & Finance,* 21, 871–892.

Choi, J.J., Elyasiani, E. and Kopecky, K. (1992). The sensitivity of bank stock returns to market, interest, and exchange rate risks. *Journal of Banking & Finance,* 16, 983–1004.

Elyasiani, E. and Mansur, I. (1998). Sensitivity of bank stock returns distribution to changes in the level of volatility of interest rate: a GARCH-M model. *Journal of Banking & Finance,* 22, 535–563.

Eun, C.S. and Bruce G. (1998). Exchange Rate Uncertainty, Forward Contracts, and International Portfolio. *The Journal of Finance*, Vol. 43, No. 1 (Mar., 1988), 197-215

Faff, R.W. and Howard, P.F. (1999). Interest Rate Risk of Australian Financial Sector Companies in a Period of Regulatory Change. *Pacific-Basin Finance Journal*, Vol. 7, pp. 83–101.

Flannery, M. and James, C. (1984). The effect of interest rate changes on the common stock returns of financial institutions. *The Journal of Finance* 39, 1141–1153.

Grammatikos, T., Saunders, A. and Swary, I. (1986). Returns and risks of US bank foreign currency activities. *The Journal of Finance,* 41, 671–683.

John D. Martin and Arthur J. Keown. (1997). Interest Rate Sensitivity and Portfolio Risk. *Journal of Financial and Quantitative Analysis*, Vol 12, Issue 2, 181 - 195.

Joseph, N.L. and Vezos P. (2006). The sensitivity of US banks' stock returns to interest rate and exchange rate changes. *Managerial Finance*, Vol. 32 Iss: 2, 182 – 199

Kane, E.J. and Unal, H. (1988). Change in market assessment of deposit institution riskiness. *Journal of Financial Services Research*, Vol. 1 No. 3, pp. 207-29.

Karolyi, G.A. (1995). A Multivariate GARCH Model of International Transmissions of Stock Returns and Volatility: The Case of the United States and Canada. *Journal of Business and Economic Statistics,* Vol 13, Issue1, 11-25.

Kasman, S., Vardar, G. and Tunc, G. (2011). The Impact of Interest Rate and Exchange Rate Volatility on Banks' Stock Returns and Volatility: Evidence from Turkey. *Economic Modelling,* Vol 28, Issue 3, 1328-1334

Lloyd, W.P. and Shick, R.A. (1977). A test of stone's two-index model of returns. *Journal of Financial and Quantitative Analysis,* 12, 363–376.

Lynge, M.J. and Zumwalt, J.K. (1980). An empirical study of the interest rate sensitivity of commercial bank returns: a multi-index approach. *Journal of Financial and Quantitative Analysis*, 15, 731–742.

Merton, R.C.(1973). An intertemporal capital asset pricing model. *Econometrica,* 41, 867–887.

Park, J. and Choi, B.P. (2011). Interest Rate Sensitivity of US Property/Liability Insurer Stock Returns. *Managerial Finance,* Vol 37, Issue 1-2, 134-150.

Ryan, S.K. and Worthington, A.C. (2004). Market, interest rate and foreign exchange rate risk in Australian banking: A GARCH-M approach. *International Journal of Applied Business and Economic Research,* 2(2), 81-103.

Saunders, A. and Yourougou, P. (1990). Are banks special? The separation of banking from commerce and interest rate risk. *Journal of Economics and Business,* 42, 171–182.

Stone, B. (1974). Systematic interest rate risk in a two index model of returns. *Journal of Financial and Quantitative Analysis,* 9, 709–721.

Sweeney, R. and Warga, A. (1986). The pricing of interest rate risk: evidence from the stock market. *The Journal of Finance,* 41, 393–410.

Vaz, J. J., Ariff, M. and Brooks, R. D. (2008). The effect of interest rate changes on bank stock returns. *Investment management and financial innovation*, 5(4), 221-236. □