AMERICAN UNIVERSITY OF BEIRUT

VALUE-AT-RISK OF COMMERCIAL BANKS IN CANADA AND THE UNITED STATES

by
RANIM SALAH ASSI

A project
submitted in partial fulfillment of the requirements
for the degree of Master of Arts
to the Department of Economics
of the Faculty/School of Arts and Sciences
at the American University of Beirut

Beirut, Lebanon
March 2021

AMERICAN UNIVERSITY OF BEIRUT

VALUE-AT-RISK OF COMMERCIAL BANKS IN CANADA AND THE UNITED STATES

by

RANIM SALAH ASSI

Approved by:

Simon Neaime

Dr. Simon Neaime, Professor — First Reader
Institute of Financial Economics

Sumru Altug

Dr. Sumru Guler Altug, Chairperson and Professor — Second Reader
Department of Economics

Date of project presentation: March 16, 2021

AMERICAN UNIVERSITY OF BEIRUT

PROJECT RELEASE FORM

Student Name: Assi Ranim Salah
Last First Middle

I authorize the American University of Beirut, to: (a) reproduce hard or electronic copies of my project; (b) include such copies in the archives and digital repositories of the University; and (c) make freely available such copies to third parties for research or educational purposes:

- ☒ As of the date of submission
- ☐ One year from the date of submission of my project.
- ☐ Two years from the date of submission of my project.
- ☐ Three years from the date of submission of my project.

_____ March 19, 2021_____

Signature Date

ACKNOWLEDGEMENTS

I would like to extend my special thanks to my advisor, Dr. Simon Neaime, as well as the Department Chairperson, Dr. Sumru Guler Altug, for their continuous help and guidance throughout my work on the project and throughout the years. I would also like to thank my family for the support and encouragement, and for teaching me to never give up.

ABSTRACT
OF THE PROJECT OF

Ranim Salah Assi for Master of Arts
Major: Financial Economics

Title: Value-At-Risk of Commercial Banks in Canada and the United States

This project aims to study the Value-at-Risk (VaR) of commercial banks in the United states and Canada with respect to changes in three risk factors which include a market index, exchange rate, and monetary policy and interest rates. The model allows for comparing different banks' risk in different countries. We employ weekly data on the S&P 500 index as a proxy for the US financial market and the S&P/TSX Composite index as a proxy for the Canadian financial market; as well as the three months' treasury bill rates for both US and Canada to test for the banks' risk exposure to changes in monetary policy and interest rates and the USD/CAD exchange rate to test for the banks' exposure to foreign exchange risk between the two countries. A 99% confidence interval is chosen so that the results obtained would be statistically significant. Results indicated that both banks, JP Morgan Chase & Co. bank and Royal Bank of Canada, have low risk of losing their value within a week of extreme changes in the variables mentioned.

TABLE OF CONTENTS

ILLUSTRATIONS

Figure

TABLES

Table

CHAPTER 1

INTRODUCTION

We define Risk to be the volatility and instability of unpredicted outcomes in values of assets, earnings and equity. The financial world has been facing so many challenges and crises throughout the years that have led to impactful consequences on different economies. The global 2008 financial crisis is an example; it had not only affected the US stock market, but several European countries as well as Canada. However, even though the impacts of this crisis on Canada were not as severe as those on European countries, they still resulted in a recession that created sharp drops in output and employment. Thus, Canada needed to implement several policies to deal with this issue; for instance, interest rate cuts were applied. And of course, not to forget, the ongoing COVID-19 pandemic, that has resulted in a world recession. The issues mentioned have resulted in market risk that is defined, by the European banking authority, as the risk of losses in on and off-balance sheet positions arising from adverse movements in market prices and rates. For such reasons, companies and banks, needed to find ways to protect themselves against said risk. Therefore, a model, such as the Value-at-risk (VaR), was created specifically for this.

Commercial banks have been growing and progressively becoming more diverse and complex over the years. Because of this increase in the variety of their portfolios, their demand for risk measurement models increased. The Value – at – Risk model became an important tool used to determine the risk profiles of banks. As mentioned previously, it became a standard measure of financial market risk that is increasingly used by both financial and nonfinancial institutions. The VaR measurement results in a single figure that makes it easy to interpret; it is based on studying percentiles of the

distribution, and summarizing the downside risk of a commercial bank due to the financial market variables. In addition to this, the model allows to compare across institutions and countries because the banks' equities at risk are independent of the size of the banks and are quoted in percentages.

This project aims to estimate the Value at Risk of commercial banks in the United states and Canada with respect to changes in three risk factors which include a market index, exchange rate, and monetary policy and interest rates. By using the VaR model, we will be attempting to measure the change in the value of the banks' equities due to changes in currency values, interest rates and equity prices. This model will give us a percentage equivalent to the bank's equity to cushion against the three risks.

The reason this topic is chosen, is to measure how any global or national change affects each bank in a certain way. The model will allow for us to observe how banks protect themselves against risk that arises due to financial, political, health or security matters. The model will explain by how much each of the largest banks, in the countries mentioned, must protect its assets given the risks it is exposed to; whether domestically or internationally. Governments have had to take action to protect their economies; thus, monetary policies have been implemented. So, banks have also had to act in order to shield themselves from those changes.

CHAPTER 2

LITERATURE REVIEW

The Value at Risk (VaR) model is used in assessing the maximum loss resulting from the manifestation of numerous risk categories. The history of the VaR is related to the investment bank JP Morgan since its president has had a vital part in its development. The measure of risk was popularized as the Value at Risk due to the creation of the risk metrics department in JPMorgan bank. In addition to this, the extensive use of this method is due to the Basel Committee recommendations. The Value at Risk model has been used over the years for several types of studies; several articles below mention the different uses of the VaR and the results they yield, as well as different approaches and methods of testing the VaR's accuracy.

In an article for Neaime and Shahin, they examined the risk profiles of several large commercial banks in eight different European countries. They used a three-factor multi-index model to study the sensitivity of each bank to changes in stock market, interest rate and exchange rate. Their results showed that the betas were different suggesting non-homogeneous hedging policies across banks; signs of market beta was always positive while sign for interest rate beta and exchange rate beta were mixed across the banks. Their results also allowed them to indicate that current managerial and regulatory interest in VaR modeling is justified since the technique can capture important risk differences between the differed banks and countries. Thus, they were able to support the growing evidence that VaR measures can be an effective tool for risk management in commercial banks (Neaime & Shahin,).

In an article for Balteş and Rodean (Cozma), the authors estimated currency risk portfolios for commercial banks in Romania. They estimated the maximum loss for the

euro currency due to exchange rate volatility by establishing a VaR model. The VaR was used to evaluate the foreign currency portfolio depreciation which followed an unfavorable exchange rate variation, operational risk, liquidity risk and credit risk. Their sample consisted of four commercial banks listed on the Bucharest Stock Exchange (BSE) and, in determining the VaR, they used the historical simulation method. They implemented the method proposed by the Basel Committee: 99% probability, linked with a confidence level of 2.33. After applying the VaR method to assess the maximum loss resulting from the manifestation of the various risk categories, the results they obtained where that the maximum loss noted did not exceed 2% of the total foreign currency portfolio. It was concluded that those losses are not likely going to financially unbalance any of the four banks included in the study. Therefore, they were able to exhibit the effectiveness of foreign currency portfolio management (Balteş & Rodean (Cozma), 2019).

In another article for Swami, Pandey and Pancholy, they presented a study in which they empirically tested for the appropriate VaR model for foreign exchange risk for banks in India, where they were required to quantify the market risk through their own Value-at-Risk model. Therefore, the authors tested the VaR model under two different methods, using a parametric variance–covariance method and a non-parametric historical simulation (HS) method, to see which model is best suited. Nevertheless, the HS approach is most commonly implemented by the banks for estimating the daily VaR (Pérignon & Daniel, 2010); and given that, the returns in the authors' study turned out to be leptokurtic in nature, they had to employ non-normal VaR models, such as HS and Student's t VaR model. After performing the analysis, the empirical results exhibited that the most accurate VaR estimates are obtained from the

Student's t VaR model, the HS method performed better than a normal VaR model, and that the VaR estimates based on the conventional 'normal' method are usually underestimated (Swami, Pandey, & Pancholy, 2016).

In Kontaratou's article, she studied the predictive ability of the VaR methods regarding the European stock Exchange after the global financial crises of 2008; in addition to this, one of her main objectives was to find which model best presents accurate predictions of the VaR during the crisis. She divided European countries into two groups where one group includes the countries that received EU and IMF rescue after facing difficult situations and needed the help to avoid default. Her results stated that the Historical Simulation method wasn't a sufficient method for forecasting VaR because, after back testing, it was rejected in almost all countries. Also, the resulted showed that there is no evident model that is optimal for all the countries involved in the study (Kontaratou, 2016).

In Nedzvedskas and Aniūnas, the authors demonstrated how Lithuanian commercial banks had to adopt the Basel II requirements and improve their currency exchange risk management. They exhibited the transformations of the currency exchange in banks and presented an effective model for commercial banking. And since VaR models are considered to be modern methods for risk management, the transformations, which were discussed, involved the banks moving towards the usage of internal (VaR based) models. Hence, the authors suggested the variation- covariation VaR model which was tested with real data. The authors then performed a back- testing which indicated that the proposed model is reliable, because the number of mismatches was less than 5 % in all tested currency pairs. Therefore, their outcomes proved that the

VaR is an adequate and dependable method to be used by financial institutions and traders (Nedzvedskas & Aniūnas, 2007).

In an article for Uylangco and Li, the authors used the Value at risk measures of several Australian banks, over a period that contained the global financial crisis, aiming to discover whether the methodology and parameter selection are significant for capital adequacy holdings which will support banks during a period of crisis. They tested several of the methodologies and parameter selection for computing the VaR measures including those adopted by the Basel II Accords and Basel III; that is because the Basel VaR methodology was criticized during the Global Financial crisis due to its failure of explaining the downside risk. Their results, which were consistent with prior literature such as with Berkowitz and O'brien (2002) and Weng and Trück (2011), showed that the VaR estimates, using Monte Carlo simulations, presented a high percentage of violations yet with a lower level of violations that occur. The VaR estimates, when using ARMA GARCH model, presented a high percentage of violations, but the level of violations is quite low. In addition to this, the authors were able to show that Models with a longer time horizons took longer to integrate new information; on the other hand, those with a shorter time horizon were faster to respond to the changing economic conditions and created more negative VaRs in crucial times. Nevertheless, their outcomes supported the Value at Risk methodology adopted under the Basel II revision and Basel III; and, the more sophisticated models seemed to add sufficient improvement to explain the further resources required to run such models (Uylangco & Li, 2015).

In the article by Campbell, Huisman, and Koedijk, the authors created a portfolio selection model that distributed financial assets by maximizing the expected return and subject to a constraint which includes that the expected maximum loss

should meet the Value-at-Risk limit which are set by a risk manager. They provided an empirical analysis using US stocks and bonds. They were able to create a generalized framework for the portfolio selection. They showed how significant the effect was on the portfolio selection decision from alternative time horizons, non-normalities, and alternative risk specifications. And in addition to this, by introducing the VaR into the measure for risk, they had the benefit of allowing the risk-return trade- off to be examined for several confidence levels. Their results showed that the use of the normal distribution to evaluate the risk-return trade-off lead to an incorrect distribution of assets for investors that have a low risk tolerance and for risk managers who wish to set 99% confidence levels; while the nature of the student-t distribution resulted in a smaller estimation of the portfolio VaR for lower confidence levels and to a greater approximation for higher confidence levels. They also showed that for daily VaR it was more appropriate to use a student-t distribution with 5 degrees of freedom rather using the normality at the 99% confidence level. However, the affect differs when the time horizon used is bi-weekly or monthly. Moreover, as they examined with higher confidence levels, they found out that it is more important to include the additional downside risk from fat tails into the risk return trade-o ff, in a shorter time horizon for the VaR estimation. The proportions held in the risky assets were the same as under the assumption of normality, but the portfolio risk was greater and to guarantee that the final portfolio selection has the VaR level desired, a greater proportion of the portfolio needs to be held at the risk-free rate (Campbell, Huisman, & Koedijk, 2000).

Berkowitz, Christoffersen and Peeltier published an article regarding evaluating the Value-at-risk model using desk-level data. They presented this study because it is important to make sure that risk measures are calculated accurately given the

widespread and sudden losses financial institutions face within periods of crises. And even though an accurate VaR measure does not really prevent volatility or traders from facing losses, it does however allow for calculating risk levels, the most fit amount of safe capital and thus having some control on the overall risk. Moreover, the authors used desk level P/Ls from four business lines in a large international commercial bank. Their results showed that there is evidence of volatility dynamics and non-normality in the desk-level data, and the volatility dynamics are not captured in the historical simulation method. Hence, this might cause clustering in the VaR violations. The authors' results also indicated a set of problems with the VaR which could be detected by external regulators or risk auditors in the real word. They concluded by suggesting that, because there is no formal back testing method recommended by the Basel Accord, there should be improvements to the future regulatory schemes such as benefiting from implementing an approach such as the conditional autoregressive value at risk (CaViar) rather than using a method based on unconditional violation rate (Berkowitz, Christoffersen, & Christoffersen, 2011).

In a paper by Perignon, Deng and Wang, they discuss whether banks overstate their Value-at-risk or not. Banks are usually obliged to compute and disclose their VaR forecasts; and disclosing their VaRs allows for reducing the information asymmetry between firms and participants in the market, providing an adequate cushion for the cumulative losses that arise from several market conditions, and back-testing the validity of the bank's VaR model. In this paper, the authors used data from six of the largest Canadian banks. They retrieved the VaR and P&L data from banks' annual reports using an innovative data extraction method. Furthermore, the authors were able to provide evidence that the VaRs disclosed by commercial banks are indeed greater

than what they should be. They attributed this VaR overstatement to several factors; they claimed that the market risk overstatement comes from the fact that banks wanted to be very cautious when setting their VaR and not that they are incapable of correctly computing their value at risk. In addition to this, banks underestimate the impact of diversification as they aggregate the VaRs across business lines or risk categories (PÉRIGNON, DENG, & WANG, 2006).

Berkowitz and O'Brien discuss how accurate are Value-at-Risk models at commercial banks. They evaluated the performance of banks' trading risk models by examining the statistical accuracy of the VaR forecasts. They analyzed the distribution of historical trading P&L and the daily performance of VaR estimates of six large U.S. banks. The results of this paper provided that the VaR forecasts for the six large commercial banks involved in the study have surpassed nominal coverage levels over the past two years. In addition to this, even though banks employed detailed information in their models, their VaR forecasts did not beat the forecasts which are based on an ARMA and GARCH model of the banks' P&L. Thus, by comparing the banks' VaRs to these reduced-form forecasts, it turned out that they did not effectively reflect changes in the P&L volatility. These results could reveal considerable computational difficulties in constructing large-scale structural models of trading risks for large and complex portfolios. Moreover, their study was limited by the fact that banks forecast a single percentile of the portfolio distribution only, and they suggest that Density forecast evaluation techniques allow researchers to assess the dimensions in which models need improvement and in which models do good (Berkowitz & O'Brien, 2002).

And finally, a paper by Kuester, Mittnik, and Paolella, examines the predictive performance of new advanced VaR models, since risk predication plays a vital role in

banking and finance, given the increasing need to manage financial risk of the years. In the paper, the authors used 30 years of daily data on the NASDAQ composite index. They found out that most approaches performed inefficiently; however, several models were acceptable under the regulatory assessment rules for model adequacy. The results in the paper revealed that all of the unconditional models generate clustered VaR violations; however, some pass as acceptable when considering only the (unconditional) violation frequencies. Results also showed that the Conditional VaR models led to more volatile VaR predictions than the unconditional models; that may perhaps cause problems in allocating capital for trading purposes. Nonetheless, they showed that only conditionally heteroskedastic models yield acceptable forecasts; and, taking heteroscedasticity into account yields reasonably unclustered VaR violations. As for the fully parametric models, when accounting for scale dynamics takes place, a major improvement in terms of violation frequencies is attained (Kuester, Mittnik, & Paolella, 2006).

CHAPTER 3

METHODOLOGY AND DATA

Our aim is to measure the Value-at-risk of a commercial bank's exposure to several factors of risk. This VaR model attempts to measure the change in the value of the bank due to adverse changes in exchange rates in case the bank is invested in assets denominated in foreign currency, to changes in interest rates if it has treasury bills in the domestic market, and equity and commodity prices if the bank's assets include stock or even commodities. This model is a 2-stage approach and includes a cross-country time series.

The banks chosen for this project are JPMorgan Chase & Co. Bank in the United states and the Royal Bank of Canada. The market indices which will be used are the S&P 500 as a proxy for the US financial market and the S&P/TSX Composite as a proxy for the Canadian financial market. The three months Treasury bill rates for both US and Canada will be used to test for the banks' risk exposure to changes in monetary policy and interest rates. In addition to the USD/CAD exchange rate which will be used to test for the banks' exposure to foreign exchange risk between the two countries. The model is a 2-stage approach, and a 99% confidence interval will be chosen so that the results obtained would be statistically significant.

The data used in this project are obtained from Yahoo Finance, and they include the stock prices for JPMorgan Chase & Co. (JPM), the stock prices for the Royal Bank of Canada (RY), the prices of the S&P 500 index, the prices of the S&P/TSX Composite, the 13 weeks US T-bills rate, and the USD/CAD exchange rate. Data for the Canadian 3 months' treasury bills rate is obtained from Bank of Canada website. The data is obtained weekly and for a period of 10 years – 31 December 2009 till 31

December 2020 – sufficiently long in order to provide a rich set of observations and produce reliable results.

In order to apply the Value-at-Risk model, first, the weekly returns for the stock prices, weekly returns on the market indices and the rate of change of the exchange rate need to be computed; the log return formula is applied for computing the returns:

$$R_t = [\log(P_t) - \log(P_{t-1})] * 100$$

Table 1 Descriptive Statistics of Bank Stock Prices

Table 1
Descriptive Statistics of Bank Stock Prices

UNITED STATES	Mean	Median	Maximum	Minimum	Standard Deviation	Obs.
JPMORGAN CHASE &CO.	62.8244	52.1905	133.3042	22.0006	30.3348	575
CANADA						
ROYAL BANK OF CANADA	53.5958	51.3349	82.4720	29.2057	13.6902	575

The first stage of the VaR model which is the estimation phase is then applied; and it includes a three-factor capital asset pricing model (CAPM) which consists of:

$$R_{i,t} = \alpha_{i,t} + \beta_{m,t} R_{m,j,t} + \beta_{r,t} R_{r,j,t} + \beta_{x,t} R_{x,j,t} + u_{i,t}$$

such that $R_{i,t}$ represents the returns on the bank's stock i during the time period t, $\alpha_{i,t}$ is a bank-specific constant, $\beta_{m,t} R_{m,j,t}$ represent the market beta and the return on the market index in the country j at time t, $\beta_{r,t} R_{r,j,t}$ represent the interest rate beta and the return on the short term government securities in country j at time t, $\beta_{x,t} R_{x,j,t}$ represents the foreign exchange beta and the return on a foreign exchange rate in country j at time t, and $u_{i,t}$ which is a random error term.

The individual betas which are obtained in the first stage for each of our banks are then used in the second stage in order to construct the bank's Value at Risk (VaR) which is defined as:

$$VaR = c\sqrt{(\beta_{m,i}\sigma_{m,j})^2 + (\beta_{r,i}\sigma_{r,j})^2 + (\beta_{x,i}\sigma_{x,j})^2}$$

such that c is a given level of statistical confidence where a one tail 99% confidence level implies that c is 2.326, the betas are specific to the individual bank, and $\sigma_{m,j}, \sigma_{r,j}, \sigma_{x,j}$ represent, respectively, the standard deviations of the market index, interest rate and exchange rate series in country j.

Figure 1 Stock Market Indices for US and Canada: 2010-2020

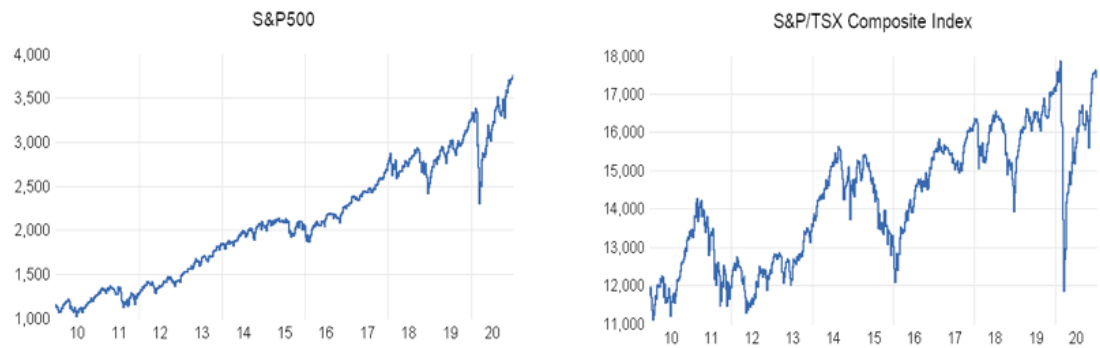


Figure 2 US and Canada 3 months Treasury Bill Rates: 2010-2020

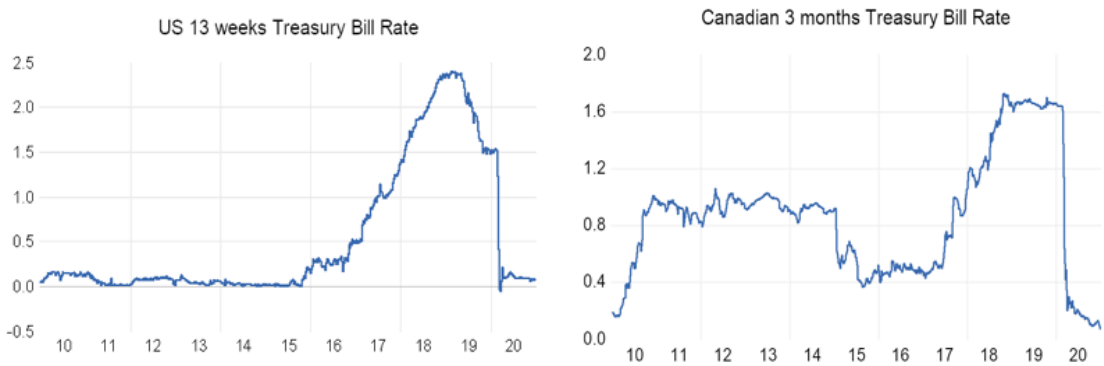
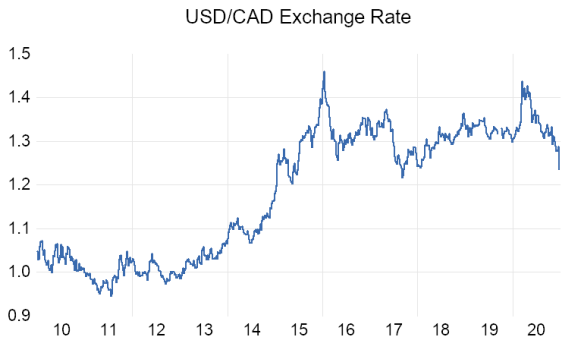


Figure 3 USD/CAD Exchange Rate: 2010-2020



In Figure 1, we can observe how volatile prices in Stock markets are; prices in US stock market seem to follow an upward trend while prices in Canadian stock market are extremely unstable. In Figure 2, the US treasury bill rate seemed to be stable around 0 for about 5 years, but showed extreme changes after 2015. As for the Canadian treasury Bill rates, they demonstrate extreme fluctuations. And finally, in Figure 3, it is obvious that the USD/CAD exchange rate also changes over the years.

Therefore, all of these factors play an important role in affecting banks' equities. Banks face several risks from different sectors, and for such reasons we are measuring the VaR for commercial banks to see how much should they cushion against said risks when they face extreme changes.

CHAPTER 4

OVERVIEW OF BANKS

4.1 JPMorgan Chase & Co.

JPMorgan Chase & Co. is an American multinational financial holding company headquartered in New York. Its services include investment banking, financial services for consumers and small businesses, commercial banking, financial transaction processing and asset management (Reuters, 2020). It is ranked as the largest bank in the United States and the 7th largest bank in the world by S&P global (The world's 100 largest banks, 2020, 2020). Also, as of February 20201, JPMorgan Chase & Co. has a market cap of $459.27B. and is considered as one of world's most valuable companies by market cap (Market capitalization of JPMorgan Chase (JPM), 2020).

JPMorgan Chase & Co.'s stock prices have increased since 2015 up to 2020 from around $66 to $139.4. Annual dividends have also increased from $1.68 to $3.30 within the same period (JPMorgan Chase & Co., 2020). Nevertheless, JPMorgan's history of growing profits is strong. It has been able to grow revenue by 7% and core earnings by 11% compounded annually over the past five years. It has also increased its core earnings margin year-to-year in the past ten years from around 11% in 2009 to 23% TTM.

The bank had been enjoying double digit earnings per share up until April of this year, due to the COVID crisis. It's first quarter earnings per share dropped by 71% (Peters, 2020). However, although it has shown this drop in its earnings over the TTM period due to the COVID-19's effect on the overall economy, it's profits are still expected to rebound over the long term (Trainer, 2020).

It's increasing profitability has assisted in generating significant free cash flow. JPMorgan created positive free cash flow within each year for the past ten years. Within the past five years, it had even cumulated $109 B; which this is equivalent to 39% of the market cap. In addition to this, over the past 12 months, JPMorgan's $31B in free cash flow resulted in a 10% fast cash flow yield which is much higher than the financial sector's average of 4% (Trainer, 2020).

Additionally, JPMorgan Chase & Co. is assumed to be positioned for continued growth, even when in a low interest situation. Lower interest rates don't mean profits would decline for JPMorgan. For instance, the federal funds rate had dropped from 4.48% in 1998 to 0.05% today; while, in the meantime, JPMorgan's net operating profit after-tax increased from $3.8 B to $34.7 B within the same period. Therefore, even if a lower rate situation persists, JPMorgan is expected to resume its capability to increase earnings in the long term (Trainer, 2020). Nonetheless, although the Fed had kept interest rates near zero in effort to hold the economy, and given that this policy has hurt profit banks, the Fed said that the capital positions of large banks have remained strong during the third quarter of this year while such restrictions were in place (Peters, 2020).

4.2 Royal Bank of Canada

Royal Bank of Canada (RBC) is a Canadian multinational diversified financial services company. It serves personal and commercial banking, management services, insurance, investor services, capital market products as well as it provides services on an international basis (Reuters, 2021). It is considered to be the largest bank in Canada; and, as of February 2021, the bank has a market cap of $127.24B. RBC is public

company which trades on the Toronto Stock Exchange, New York Stock Exchange and others (Bonham, 2020).

According to RBC's annual report for 2020, it reported a net income of 11.4 billion CAD (Canadian dollars) in 2020 down from a 12.9B CAD in 2019, down 11% Year-Over-Year (YoY). Its diluted earnings per share decreased from $8.75 in 2019 to $7.82 in 2020. Their capital position remained robust; common equity tier 1 (CET1) ratio increased from 12.1% in 2019 to 12.5% in 2020. Return on equity fell from 16.8% to 14.2%. However, RBC's compounded annual growth of ten years is 8%; and, as 63% of the profits where returned to shareholders through dividends and repurchases, the bank is left with $4.2 billion to reinvest in future growth (Royal Bank of Canada, 2020).

In addition to this, given the severe impact of the COVID pandemic on economies, RBC faced a massive increase of its provisions for credit losses (PCL); 2020 PCL increased from $2.5B to 44.4 billion YoY. This huge increase was due to businesses closing because of the pandemic and thus increasing the risk of people not being able to pay back loans. However, RBC is still considered to be safe because only 0.87% of its total loan portfolio is estimated to be at risk of being harmed. Therefore, even though the provisions for credit losses impacted the company's quarterly results, they were still able to stand strong. Their share prices are increasing, by around 22%, and there is no risk of dividends being cut (Parsh, 2020).

CHAPTER 5

EMIPIRICAL RESULTS AND ANALYSIS

The model is performed on both banks; JPMorgan & chase bank (JPM) and Royal Bank of Canada (RY). After computing the weekly returns, the three-factor capital asset pricing model (CAPM) is estimated on E-views, and the results are:

Figure 4 Estimation of a Three Factor Capital Asset Pricing Model for JPM

Dependent Variable: R_JPM
Method: Least Squares
Date: 02/24/21 Time: 12:01
Sample (adjusted): 1/04/2010 12/28/2020
Included observations: 570 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.052925	0.125274	-0.422473	0.6728
R_S_P500	1.256510	0.052064	24.13376	0.0000
US3MTB	0.059763	0.135731	0.440306	0.6599
ER_RETURNS	0.005711	0.106308	0.053726	0.9572

R-squared	0.582054	Mean dependent var	0.248941
Adjusted R-squared	0.579839	S.D. dependent var	3.763794
S.E. of regression	2.439684	Akaike info criterion	4.628607
Sum squared resid	3368.866	Schwarz criterion	4.659103
Log likelihood	-1315.153	Hannan-Quinn criter.	4.640506
F-statistic	262.7478	Durbin-Watson stat	2.155683
Prob(F-statistic)	0.000000		

Figure 5 Estimation of a Three Factor Capital Asset Pricing Model for RY

Dependent Variable: R_RY
Method: Least Squares
Date: 02/24/21 Time: 12:27
Sample (adjusted): 1/04/2010 12/28/2020
Included observations: 570 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.183299	0.159649	1.148138	0.2514
R_S_P_TSX	0.838676	0.038436	21.82011	0.0000
CA3MTB	-0.085863	0.167462	-0.512731	0.6083
ER_RETURNS	-0.928967	0.069180	-13.42831	0.0000

R-squared	0.659692	Mean dependent var	0.144829
Adjusted R-squared	0.657889	S.D. dependent var	2.868703
S.E. of regression	1.677913	Akaike info criterion	3.879971
Sum squared resid	1593.512	Schwarz criterion	3.910467
Log likelihood	-1101.792	Hannan-Quinn criter.	3.891870
F-statistic	365.7335	Durbin-Watson stat	2.174762
Prob(F-statistic)	0.000000		

For JPMorgan Chase & Co., according to Figure 4, the probabilities of the coefficients for the constant parameter, the 13 weeks US treasury bill, and the return on the exchange rate are 0.6728, 0.6599, and 0.9572, respectively. These probabilities are very high, indicating that $\alpha_{i,t}$, $\beta_{r,i}$, and $\beta_{x,i}$ coefficients are not significant at the 90%, 95% and 99% significance levels. However, the probability of the coefficient for the return of the market index is 0.0000 indicating that the coefficient, $\beta_{m,i}$, is highly significant at the 99% significant level.

As for the Royal Bank of Canada, according to Figure 5, the probabilities of the coefficients for the constant parameter and the Canadian 3 months' treasury bill are 0.2514 and 0.6083 respectively. These probabilities are very high, indicating that $\alpha_{i,t}$ and $\beta_{r,i}$ coefficients are not significant at the 90%, 95% and 99% significance levels. However, the probabilities of the coefficients for the return of the market index and the return on the exchange rate are both 0.0000 indicating that the coefficients $\beta_{m,i}$, and $\beta_{x,i}$ are highly significant at the 99% significant level.

Table 2 Betas obtained from estimation of the three factor CAPM

Table 2
Estimation of a Three Factor Capital Asset Pricing Model (CAPM)

$$R_{i,t} = \alpha_{i,t} + \beta_{m,t}R_{m,j,t} + \beta_{r,t}R_{r,j,t} + \beta_{x,t}R_{x,j,t} + u_{i,t}$$

	Market Beta	**Exchange Rate Beta**	**Interest Rate Beta**
UNITED STATES			
JPMORGAN CHASE & CO.	1.256510	0.005711	0.059763
CANADA			
ROYAL BANK OF CANADA	0.838676	−0.928967	−0.085863

In Table 2, the betas specific to JPMorgan Chase & Co. bank and Royal Bank of Canada are obtained to be used in the second stage of the model. The standard deviations for all three series, mentioned previously, are obtained from the Stats table from E-views; and they are presented in Table 3 below.

Table 3 Standard Deviations of Independent Variables

Table 3
Standard Deviations of Independent Variables

	Std. Dev. Of Market Return	**Std. Dev. Of Exchange Rate Return**	**Std. Dev. Of Interest Rate**
UNITED STATES			
JPMORGAN CHASE & CO.	2.280997	1.12058	0.757281
CANADA			
ROYAL BANK OF CANADA	2.011941	0.424367	1.12058

Therefore, by using the above data, we can compute the Value-at-Risk for both banks that are represented in Table 4 below:

Table 4 Weekly Value-at-Risk in percent of a Bank Equity in Risk

Table 4
Weekly VaR in percent of a Bank Equity in Risk

$$VaR = c\sqrt{(\beta_{m,i}\sigma_{m,j})^2 + (\beta_{r,i}\sigma_{r,j})^2 + (\beta_{x,i}\sigma_{x,j})^2}$$

for c=99%

	Bank VaR at 99% Confidence
UNITED STATES	
JPMORGAN CHASE & CO.	6.667%
CANADA	
ROYAL BANK OF CANADA	4.612%

Nevertheless, the percentages in Table 4 indicate the amount of capital needed, by each bank, against the risk exposure due to currency, interest rates and equity price volatility. Thus, at a 1% level of significance, JPMorgan Chase & Co. bank might lose around 6.667% of its value within a week of extreme changes in the market index in the US, in the interest rate or in the USD/CAD exchange rate; while the Royal Bank of Canada would lose around 4.612% of its value within a week.

Moreover, after performing the Value-at-Risk model for two different banks, in the two different countries, we can conclude that both have a low risk to losing its value; and in general, investors would be encouraged to invest in such banks. However, the Canadian Bank, the Royal Bank of Canada, has a lower VaR. According to our results, its value is impacted by both the Canadian stock market, in which they have a positive relationship, and the changes in the USD/CAD exchange rate, in which they have a negative relationship. Hence, if the Canadian Dollar depreciates, then this results in a decrease in the returns on the RBC's stocks. The exchange rate has an effect on banks in Canada because their banking system is much smaller than that in the US, and banks look to make international deals in order to continue to grow. Whereas, the US bank, JPMorgan Chase & Co., is only impacted by changes in the US stock market; any changes in interest rates due to monetary policies employed or changes in the exchange rate do not have any impact on the bank's value.

In addition to this, we observe in Table 2, that signs of market beta were always positive for both banks while signs for interest rate beta and exchange rate beta were mixed across the banks.

These disparities between the two banks are due to several matters including different Government regulations, approaches and client base. The Canadian banking

system is known for promoting safety and soundness while the US banking system focuses on different keys which include privacy, anti-money laundering, consumer protection measure, etc.

CHAPTER 6

CONCLUSION

In conclusion, this project studied the Value at Risk of commercial banks in the United states and Canada with respect to changes in three risk factors which include a market index, exchange rate, and monetary policy and interest rates. The model allows for comparing different banks' risk in different countries. After performing the VaR model for both JP Morgan Chase & Co. bank and Royal Bank of Canada, our findings were that the banks have a Value-at-Risk that is around 6.67% and 4.61%, respectively. These values make JPMorgan's and RBC's stocks of low risk to losing their value which is an endorsement to invest in banks that pay well.

JPMorgan is one of the largest US banks as we have mentioned above. The bank has low risk as measured, a market value of around $459 billion, double digit earnings and is expected to continue gaining positive profits in the long term. For this reason, the stock would always be a good buy as a long-term investment. However, I do not recommend investing or buying this stock today due to the uncertainty that is flowing through the economy due to several factors. In the past few years, JPMorgan's stock has been lagging the S&P index. We can also view this from the results of our regression as well. The coefficient for S&P500 returns is highly significant and positive; and so, any change in the market returns, whether positive or negative, affects JPMorgan's stock returns by 1.256. Moreover, the economy right now, has been severely impacted by the coronavirus pandemic, and we are not sure of how much this virus might have caused or will cause damage to the earnings of banks, firms, markets and the overall economy in general. Therefore, the risk that accompanied the pandemic could result in a negative impact on the bank's stocks. For this reason, my recommendation is not to buy the stock

today; since an investor might get further chances in the future to buy the stock at lower prices which would give him higher long-term returns.

Furthermore, as for the Royal Bank of Canada, it has a lower risk than a US bank as observed from the results above, a market value of around $127 billion, and is expected to continue growing in the long term. For this reason, the stock would also always be a good buy as a long-term investment. And of course, as any other company or bank in the world, RBC was impacted by the COVID-19 pandemic and had to undertake several actions to protect itself against the market risk and exchange rate risk they faced. Yet, this bank was able to remain at the top given all the issues it was tackling. Nevertheless, in the moment, investing in the bank depends on what type of investor you are – an income or value investor. A value investor might prefer to not buy the stock in the moment, since the bank shows promise of continuing to grow further in the long term; whereas an income investor might want to buy the stock today given that it yields a good dividend that doesn't seem to be facing any risk of falling.

REFERENCES

(2020, November). Retrieved from Reuters: https://in.reuters.com/finance/stocks/company-profile/JPM.N

(2020). Retrieved from JPMorgan Chase & Co.: https://jpmorganchaseco.gcs-web.com/ir/shareholder-information/overview

Balteş, N., & Rodean (Cozma), M.-D. (2019, April 16). Technical analysis in estimating currency risk portfolios: case study: commercial banks in Romania. Economic Research-Ekonomska Istraživanja.

Berkowitz, J., & O'Brien, J. (2002). How Accurate Are Value-at-Risk Models at Commercial Banks. The Journal of Finance, 57, 1093–1111.

Berkowitz, J., Christoffersen, P., & Christoffersen, P. (2011). Evaluating Value-at-Risk Models with Desk-Level Data. Management Science, pp. 2213–2227.

Bonham, M. S. (2020, September 18). The Canadian Encylcopedia. Retrieved February 2021, from Royal Bank of Canada (RBC): https://www.thecanadianencyclopedia.ca/en/article/royal-bank-of-canada

Campbell, R., Huisman, R., & Koedijk, K. (2000, July 24). Optimal portfolio selection in a Value-at-Risk framework. Journal of Banking & Finance.

Kontaratou, C. -C. (2016, October). Value at Risk: An analysis for the European Stock Exchanges. Thessaloniki, Greece.

Kuester, K., Mittnik, S., & Paolella, M. S. (2006). Value-at-Risk Prediction: A Comparison of Alternative Strategies. Journal of Financial Econometrics, 4(1), 53–89.

Macrotrends. (n.d.). Macrotrends. Retrieved February 2021, from Royal Bank Of Canada Market Cap 2006-2021.

Market capitalization of JPMorgan Chase (JPM). (2020). Retrieved from Market Cap: https://companiesmarketcap.com/jp-morgan-chase/marketcap/

Neaime, S., & Shahin, W. (n.d.). Basel II and Market Risk of Selected European Commercial Banks: A VAR Analysis .

Nedzvedskas, J., & Aniūnas, P. (2007, July 25). Transformations in risk management of currency exchange in Lithuanian commercial banks. Technological and Economic Development of Economy, 191-197.

PÉRIGNON, C., DENG, Z. Y., & WANG, Z. J. (2006, September 12). Do Banks Overstate their Value-at-Risk? .

Parsh, N. (2020, June 8). Is Royal Bank of Canada Still a Buy After a 22% Gain?

Peters, B. (2020, 10 23). Is The Biggest Bank Stock By Market Cap A Buy Now? Retrieved from Investor's Business Daily.

Reuters. (2021). Reuters. Retrieved February 2021, from https://www.reuters.com/companies/RY

Royal Bank of Canada. (2020, December). Annual Report 2020. Retrieved February 2021, from https://annualreports.rbc.com/ar2020/site-content/uploads/2021/01/01-EN-2020-Annual-Report-English-Final.pdf

Swami, O. S., Pandey, S. K., & Pancholy, P. (2016, March 1). Value-at-Risk Estimation of Foreign Exchange Rate Risk in India. Asia-Pacific Journal of Management Research and Innovation.

The world's 100 largest banks, 2020. (2020). Retrieved from S&Pglobal: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/the-world-s-100-largest-banks-2020-57854079

Trainer, D. (2020). Bank On The Best: JPMorgan Chase & Company. Retrieved from Forbes: https://www.forbes.com/sites/greatspeculations/2020/06/11/bank-on-the-best-jpmorgan-chase--company/?sh=332472207cba

Uylangco, K., & Li, S. (2015, May 6). An evaluation of the effectiveness of Value-at-Risk (VaR) models for Australian banks under Basel III. Australian Journal of Management.