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VALUE AT RISK ANALYSIS OF SELECTED EUROPEAN COMMERCIAL BANKS

by
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ABSTRACT
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This research investigates and examines the proper risk management of five European commercial banks employing the Value at Risk (VaR) model through 2006 until 2020. Two of these banks are located in France, while the other three are in Germany. The collected data is monthly-based such that it consists of 180 observations. In order to apply the VaR model, a pre-study is considered aiming to regress the dependent variable (bank stock prices) on the independent variables (market indices, Three-Month Treasury bill rate and exchange rate). The effectiveness of the independent variables is considered statistically significant taking into account a 95% confidence interval. The major part in the methodology intends to use the variables' coefficients and standard deviations to evaluate the VaR for the studied commercial banks. The results obtained show that the studied commercial banks are risky since they all have more than 15% as a percentage of their equity that is at risk.

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CHAPTER 1

INTRODUCTION

Every business industry aiming to gain profit through divergent types of investments, imply certain types and levels of risks associated with exposure to several factors influencing the working environment. The banking sector is one of the most sectors that are exposed to different types of risks due to its diversified portfolio in many fields. Many types of risks face commercial banks, credit risk, market risk, liquidity risk, and operational risk. Market risk majorly consists of interest rate risk, equity and commodity risk, and foreign exchange rate risk. To a certain extent, this demonstrates the massive development of the over-the-counter derivatives markets, whereby commercial banks serve as the main dealers. Major trading institutions have developed large-scale risk measurement models to handle market risks [1]. However, every one of these models evaluates and aggregates market risks in current positions at a high degree of precision.

1.1. Problem Statement

The value at risk (VaR) model is a static measuring model used to measure and control levels of risk exposure. To measure risk profiles of banks, VaR was set to be used as a standard for measuring financial market risks in both financial and non-financial institutions. However, due to their proprietary structure, there has been little empirical research on risk models in use; regarding their VaR output. The majority of public VaR studies have been limited to contrasting modeling methods and implementation procedures using illustrative portfolios [2].

1.2. Aim and Objectives

This research aims to assess and estimate VaR for commercial banks operating in different European countries such as France and Germany across 15 years starting 2006 concerning to the three factors regarding market risk. Exposure to exchange rate, interest rate, and stock market prices will be studied using VaR to quantify the interchanging exchange rate between Euro and US Dollar, adjustments and changes in the interest rate set by the central bank, as well as prices of different stocks and equities that appear on major stock indices in stated countries. The mentioned model can lead us to determine a close percentage of change in bank's different risk affiliations to their equity. To reaching these objectives, we will use regression with a time-series database to compare different VaR values and figure out how banks' equity has changed with the exposure to change in different market risk factors.

1.3. Research Structure

This research contains six chapters namely, introduction, literature, banks' overview, data and methodology, results and discussion, and conclusions. The first chapter presents an introduction to the current work, problem statement, objectives, and outline. Chapter 2 includes all details related to the Value at Risk involving types of risks and the influence on commercial banks. The main overview of the commercial banks studied is presented in chapter 3. The collected data and methods used are exhibited in chapter 4. Chapter 5 aims to display all results including analyses and discussions. The main findings are presented in chapter 6 in addition to some recommendations that offer key elements for future work.

CHAPTER 2

LITERATURE REVIEW

An organization's exposure to factors that will reduce profits or cause it to fail is referred to as business risk. Business risk is anything that jeopardizes a company's ability to meet its financial objectives. Numerous factors can come together to create business risk. It is often the top leadership or management of an organization that generates circumstances in which a corporation may be exposed to a greater or smaller degree of risk. In addition, risk associated investments are a regular generator of risk that requires proper management to assess and mitigate potential losses. Moreover, among different types of risk, estimating market risk, in particular, will lead us to use Value at Risk, which is a statistic that measures and quantifies the level of financial risk within a firm, portfolio, or position over a specific time frame, in selected three main factors: interest rate, exchange rate, and equity and commodity.

2.1. Value at Risk

The usage of VaR for the identification and control of the financial market risk has been the risk managers and regulators most favorable solution worldwide. However, it is important to notice that contemporary portfolios have a constantly changing structure of security holdings, which gives a big picture of the portfolio managers' strategies, predicted prices, and the net money flows into the portfolio. Consequently, the portfolio yields are combinations that vary with time, knowing that they cannot be approximated by standard mechanisms [3].

Berkowitz and O'Brien [4] assessed the performance of the bank trading risk models for a set of large banks holding firms. The study displayed the descriptive statistics on trading revenues of huge commercial banks and their estimated VaR forecasts. The results supported the fact that the VaR forecasts for six of the commercial banks have surpassed the minimum coverage levels. In addition, it was implied that the VaRs, which were reported, are less beneficial when measuring the main portfolio risk.

Campbell *et al.* [5] shed the light on the development of a portfolio selection model, which assigns the corresponding financial assets by increasing the predicted return that is subject to the restriction that the predicted maximum loss complies with the VaR limit, which is set by the risk manager. In this case, a Sharpe index is created just like the mean-variance proposition. Moreover, the applied model shows almost the same results as the mean-variance approach. In addition, an empirical analysis is provided using two assets that are the US stock and bonds. Accordingly, using VaR as a tool to measure the risks has the benefit of permitting the analysis risk-return trade-off for multiple confidence degrees. As the riskiness of the common assets grows with the selection of the confidence degree, which is related to the downside risk measure, the risk tends to be a result of the risk aversion level of the individual.

2.2. Market Risk Factors

An unrelated concurrent method is used by Choi and Elyasiani [6] where it identifies cross-equation dependencies and regulates serial correlation. The use of this method involves two steps. First, there is the estimation of the interest rate risk and exchange rate risk betas for individual banks. Second, there is the estimation of the betas as a function of bank basic and derivative exposure variables. The study shows the

interest rate and the exchange rate risk betas between 1975 and 1992 in 59 large US commercial banks including the bank determinants of these betas. As a result of the first step, it is shown that the exchange rate risk betas are, in general, much more significant than the interest rate risk betas. There are important changes in interest rate and exchange rate risk betas at the banks and across the periods of time. In addition, there are some changes in market conditions, which are caused by outside policy shocks that have differential impacts on bank risk and stock returns. The result of the estimation of the second step clarifies the significance of the traditional financial statement variables and derivative contract variables.

In Ref. [7], the authors showed the connection between the measures of the market risk and the external currency contingent claims activity at the commercial banks in the US. Mainly, there are four examined kinds of foreign currency contingent claims, which include the bought foreign currency option contracts, the foreign-exchange swap, commitments to purchase foreign currency, and forward contracts. They showed that there is a differentiation between the risk subjection of dealer and non-dealer banks. The obtained results state that the usage of options expands market measures of bank risk, also, the swaps are mainly used for risk-control purposes, and the usage of forward contracts and currency commitments lightly leads to any kind of risk. Furthermore, the bank risk is studied in relation to the total return risk, market risk, interest rate risk, foreign currency risk, and unsystematic risk. The bank regulators and other market participants should pay attention to the immoderate use of options because it increases the different types of bank risks. In contrast, swaps are more likely to be used for risk-control where the usage of swaps by dealer banks increases unsystematic risk, which benefits the stock investors and regulators in

maintaining orderly markets. Concerning the usage of forward contracts and currency commitments, it looks like they have a mild contribution to any type of risk.

2.3. Credit Risk

Supporting risk control is among the tasks of VaR. In fact, it is all about giving the traders the appropriate value-at-risk limits and showing the risk-adjusted pricing principles to credit officers. For instance, it is necessary to take into account the calculated technical risk and the firm's issues when using VaR for risk control. The purpose of this part is to deal with the different issues that are related to the connection between the daily VaR and the annual VaR and between the daily limit and the annual maximum suitable loss. Moreover, it is important here to show the significance of how to manage the control of accumulated losses and how to connect them to the VaR limits. In addition, the selection between a rigid and a flexible interpretation of VaR limits is favored in this discussion. However, it is very important to identify the different desks' risk contributions and possible inside hedges.

By referring to the credit risk, it is of great significance to use VaR to support risk control. The autonomy limits, which define the approved credit to the hierarchical level, can be defined in relation to VaR or to the predicted loss of the loan rather than in relation to its size. The risk-adjusted pricing target can be defined by the risk policies where it can be considered to the relationship manager as the benchmark to put a price on a new loan given the borrower's riskiness [8].

The effect of the standardized and internet ratings-based approach on the default rates of Italian banks was reported by Sironi and Zazzara [9]. In addition, the set of data

of mortality rates was used to examine the effect of the new rules on the loan portfolios of Italian banks. The results of their research can be summarized as follows:

- The rating of the Italian banks is lower than AA/Aa, as a result, they are penalized by the standardized method in their interbank funding.
- A potential increase in the regulatory risk weights is because the average default rate of the Italian banks is above the benchmark risk weight, which is applied by the Basel Committee for the IRB approach.
- The average asset correlation affects the risk weight such that it is higher than what was noted with the corporate borrowers of the Italian banks.

In Ref. [10], portfolio credit risk was evaluated using the bivariate probit method to estimate an unbiased scoring model. The VaR calculation of the credit risk was carried out using the estimation of the individual default risk. The Swedish consumer credit data used involved information consisting of 13,338 applications for loans between September 1994 and August 1995. The study had 57 variables, but approximately a quarter of them were used in the final estimation of the model. The authors state marginal variations in a default-risk-based acceptance rule which changed the loan portfolio of the bank and its VaR exposure. The results showed that the VaR could reduce 80% of the credit risk caused by the loan applicants.

CHAPTER 3

BANKS' OVERVIEW

The banks considered in this research are from the top European commercial banks; BNP Paribas, Société Générale, Commerzbank, Aareal Bank and Deutsche Bank. The upcoming sections present an overview of these five banks including ranking, locations, branches, assets, services, and missions.

3.1. BNP Paribas

BNP Paribas is the main French banking group with a high rank by total assets. Its formation was a result of a merger between Banque Nationale de Paris and Paribas in 2000. Knowing that it operates in 72 countries worldwide, it has retail-banking grids that serve more than 30 million customers. It is also considered an investment bank and a provider for international financial services across Europe, the Americas, and Asia. It became one of the five largest banks in the world after the 2008 financial crisis. In 2014, it was penalized with the largest amount for reparation for violating US sanctions but that did not affect its position in being one of the ten largest banks around the world.

The BNP Paribas has adapted to the challenges they faced and supported their clients during the hard times. Their mission was to finance their customers and give them the appropriate counseling to contribute to a maintainable and strong economy. In addition, the bank supported the clients' projects, managed their investments, and kept their goods through insurance.

Nevertheless, the bank had approved many social and environmental objectives such as the UN Sustainable Development Goals and the Principles for Responsible

Banking, and the Principles for Responsible Investment. It also brought together monetary solutions, stakeholder businesses and employer, and procurement initiatives [11].

3.2. Société Générale

Société Générale is a French multinational bank that provides both investment and financial services. It is considered a worldwide company that has departments that support French Networks, Global Transaction Banking, International Retail Banking, Financial Services, Private Banking, and Asset Management.

The group has the third rank in France by total assets. In addition, it has a long-term active support policy such as its sponsorship of rugby, music, contemporary art, disabled sport, corporate citizenship, and professional integration.

The Group has three complementary businesses that fulfil the financial requirements of their individual and corporate clients. They provide a set of services and solutions, which maintain safe transactions, protected and developed savings, and full access to advanced technological services. These businesses include the French Retail Banking networks, the International Retail Banking operations, Insurance, and Financial Services and the Global Banking and Investor Solutions. They provide the shared skills of employees devoted to asset management, corporate and investment banking, and private banking activities [12].

3.3. Commerzbank

Commerzbank is one of the leading German banks, which was the second largest in Germany in 2019 by the total value of its balance sheet. It is spread in more

than 50 countries worldwide where, in 2017, it dealt with 13 million clients in Germany alone and 5 million clients in Central and Eastern Europe. It had been a subject of corruption investigations in 2015 where it was penalized with $1.5 billion. This did not erase the fact that Commerzbank has a strategy that represents the client-centricity, digitalization, sustainability, and profitability. Additionally, they aim for creating benefits for their clients, employees, investors, and shareholders, and for the whole society.

In its Private and Small-Business Customers segment, the company has almost 450 sites in Germany where clients are advised on matters such as account and consumer credit. The clients are also given the necessary support in using the digital offerings. Moreover, in the Corporate Clients Segment, the international branch network of the bank has a main role in linking the German and world economies. In addition, digitalization is a key part of the bank's strategies where its corporate culture is mainly characterized by openness, cultural diversity, and strong teamwork [13].

3.4. Aareal Bank

Aareal Bank is located in Wiesbaden, Germany where it has branches in other European countries, North America, and the Asia-Pacific region. This bank plays a major part in the transition towards global and sustainable growth where it offers financing structures and creates attractive investment opportunities as well as developing advanced payment/software solutions and digital services for the property industries.

As a result, the bank offers a customized financing solution with high organizing skills in national and international commercial property financing. It packs the services

for target groups from the residential and commercial property, and energy and waste disposal sectors. For example, BK01 is Aareal Bank's powerful and multi-functional solution for the housing and commercial property industries [14].

3.5. Deutsche Bank

Deutsche Bank is an international investment and financial services bank that is located in Frankfurt, Germany. Its shares are traded on the Frankfurt Stock Exchange and the New York where it acquires the 21st rank by total assets. It has three main divisions including the Private and Commercial Bank, the Corporate & Investment Bank, and Asset Management. Its investment banking processes regularly require considerable deal flow. The company withdrew from the Euro Stoxx 50 in 2016 due to the low value of the shares and the decline of the market capitalization.

On the other hand, the methodical addition of environmental and social matters into the company’s decision-making criteria has a major role in understanding corporate behavior. The bank has few rules when it comes to environmental and social risk identification, valuation, and decision-making. In addition, it eases the shifting of economies towards sustainable and low-carbon growth where it gives the needed support by leading financial flows towards sustainable and climate-friendly solutions. This is shown in the company’s commitment to delivering at least £200 billion by 2025 in sustainable finance where they use their market knowledge and services to help their clients in the transition towards sustainable and low-carbon businesses [15, 16].

CHAPTER 4

DATA AND METHODOLOGY

One of the main objectives of this research is to compute the log return of the variables used in the considered regression. This chapter presents the data and methodology used to find out the VaR, based on the output of the independent variables' log return. Five European commercial banks were studied to apply the mentioned approach to investigate their financial status.

4.1. Collected Data

The data used in this study was obtained from Yahoo Finance and Investing.com. There is one dependent variable (return on banks stock) [17, 18, 19, 20, 21], and three independent variables (return on market indices [22, 23], three-month bond yield [24, 25], and the change in the exchange rate [26]). The monthly data consists of 180 observations between January 2006 and December 2020.

4.1.1. Descriptive Statistics

Table 1 displays a summary of the bank stock prices for the five European banks where center, location (Mean, Median, and Mode), dispersion (Std. Dev.), and skewness are calculated for each bank at the stock prices variable.

Table 1 Descriptive Statistics

Descriptive Statistics of Bank Stock Prices					
	BNP Paribas	**Société Générale**	**Commerzbank**	**Aareal Bank**	**Deutsche Bank**
Mean	35.32078	27.58139	46.9397	17.80508	25.04258
Median	35.36825	24.63897	11.39197	19.39943	23.15038
Maximum	53.65802	71.94171	245.4883	32.45689	63.31345
Minimum	14.88786	9.633397	3.102491	2.315547	5.969000
Std. Dev.	8.238423	13.27546	68.34904	7.381864	14.55723
Skewness	-0.189823	1.351706	1.685275	-0.169956	0.811681
Kurtosis	2.806766	4.319276	4.268803	2.037679	2.963075
Sum	6357.741	4964.65	8449.147	3204.915	4507.664
Sum Aq. Dev.	12149.02	31546.57	836214.9	9754.054	37932.44
Observations	180	180	180	180	180

4.1.1.1. BNP Paribas:

On average, the price of bank stock at BNP Paribas bank is £35.32078, with a standard deviation of 8.238423, which represents the average distance from each stock price to the average (£35.32078). The minimum stock price is £14.88786, and the maximum is £53.65802. The median is £35.36825, which means that 50% of the stock prices lie below £35.36825 and 50% lie above. The skewness that is used to study the distribution of the variable is -0.189823, which means that the variable stock price is slightly skewed to the left.

4.1.1.2. Société Générale:

The mean stock price of this bank is £27.58139, with a standard deviation of 13.27546. The median stock price is £24.63897 where the minimum is £9.633397, and the maximum is £71.94171. The stock price of this bank is skewed to the right since it has a skewness of 1.351706.

4.1.1.3. Commerzbank:

For Commerzbank, the numbers are quite different where we notice that the mean stock price is £46.9397 and the standard deviation is 68.34904. Whereas, the median stock price is £11.39197 knowing that the minimum is £3.102491 and the maximum is £245.4883. Since this bank has a skewness of 1.685275, we conclude that the stock price of this bank has skewed to the right.

4.1.1.4 Aareal Bank:

Concerning the mean stock price of Aareal bank, it corresponds to a value of £17.80508 with a standard deviation of 7.381864. The median stock price is £19.39943 with a minimum of £2.315547, and a maximum of £32.45689. Furthermore, the stock price of this bank is skewed to the left that is clearly represented by the skewness of -0.169956.

4.1.1.5. Deutsche Bank:

This bank has a mean stock price of £25.04258 and a standard deviation of 14.55723. The median stock price shown is £23.15038 where the minimum value is given as £5.969, and the maximum value is £63.31345. The stock price is skewed to the right because of the skewness of 0.811681.

4.1.2. Effective Variables

Having said that, the variables studied in this research are the bank stock prices, market indices, Three-Month Treasury bill rate, and exchange rate. The former is considered the dependent variable, while the rest are the independent variables.

4.1.2.1. Stock Prices

Figure 1 shows the trend line of the stock prices for each of the five banks, where all the banks except Commerzbank have a starting stock price of a value between £20 and £50 in 2006, and during the period from 2006 until 2020, these four banks' stock prices remain stable, with some fluctuations. On the other hand, Commerzbank starting stock price in 2006 was much higher compared to the others, where its value is four times higher than the values of the other banks. The starting stock price was approximated as £190 then it appreciated slightly until it reached £246 in the second quarter of 2007. After that, it depreciated until it reached its minimum (£20) in the first quarter of 2009. Then, between 2009 and 2020 the bank stock price's trend line acted the same as the others' trend lines.

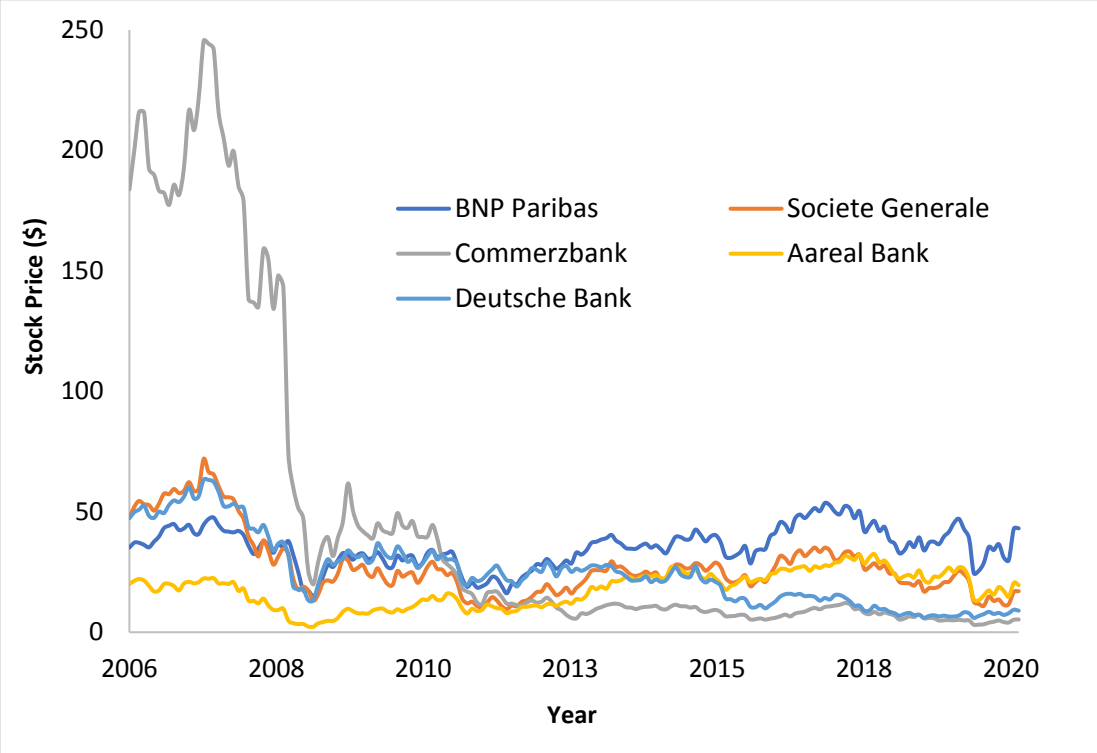
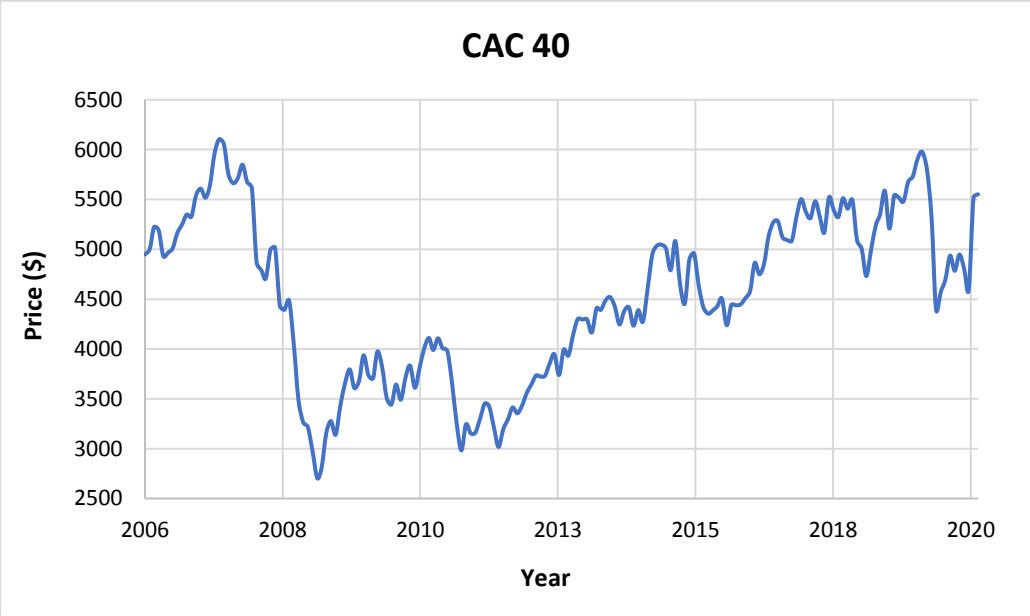


Figure 1 Stock price over the five banks investigated

4.1.2.2. Stock Market Indices

Figure 2 is used to compare the stock market indices between the two areas studied (France and Germany); with CAC 40 represents the French market index, while DAX represents the German market index. Both areas have approximately the same starting point at 2006 (between £4,900 and £5,700) with a slight appreciation between 2006 and 2007, and then both market indices depreciated until reaching their minimums in the first quarter of 2009 (CAC 40: £2,702 and DAX: 3,844). After that shock, both market indices started to recover and appreciate, but it is obvious that DAX index was appreciating much higher than CAC 40 index, since DAX trend line increased until it reached £13,719 at the end of 2020, which is approximately more than the double of the starting stock price at 2006. While, CAC 40 appreciated with a lower slope and it reached £5,552 at the end of 2020, which is approximately the same stock price at the starting point in 2006.



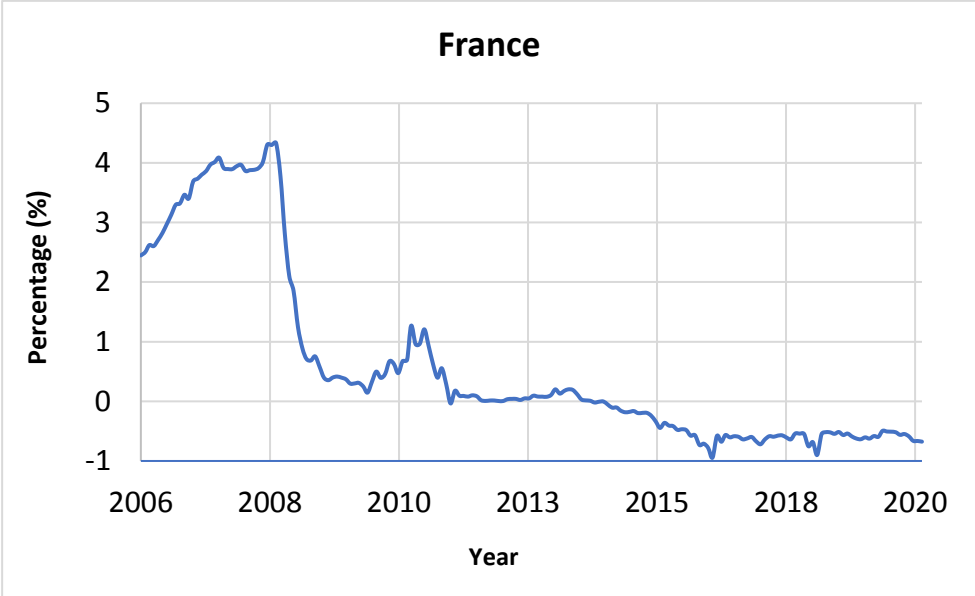
(a)

(b)

Figure 2 Stock market indices for (a) CAC 40 and (b) DAX

4.1.2.3. Three-Month Bond Yield

In Figure 3, we can see a comparison of the three-month bond yield for the two selected areas (France and Germany), where the two graphs are approximately the same concerning the starting point, trend shape, and ending point. The starting points of both rates were approximately 2.4% and then they increase until reaching their maximum 4.3% at the third quarter of 2008. There was a sharp decrease in 2009 until they became near to zero and then they decreased slightly between the periods 2011 until 2020, where they reached -0.7%.



(a)

(b)

Figure 3 Three-month bond yield for (a) France and (b) Germany

4.1.2.4. Exchange Rate

Figure 4 shows a plot of the EUR/USD exchange rate over 2006 until the 2020 period. The followings represent the three major parts of the plot:

Part one, where the Euro started to increase over the Dollar starting from 2006 until it reached its maximum ($1.58) in the second quarter of 2008.

The second part, starting from the third quarter of 2008 where it started decreasing to become almost steady with some fluctuations until the third quarter of 2014 where it decreased considerably until the end of 2014 starting 2015.

In the third part, from the first quarter in 2015, we can notice that the exchange rate is stable until it reached its minimum in the fourth quarter in 2016 ($1.058), and then started to appreciate between 2017 and 2018, and then it became stable until the end of 2020 where it reached $1.230.

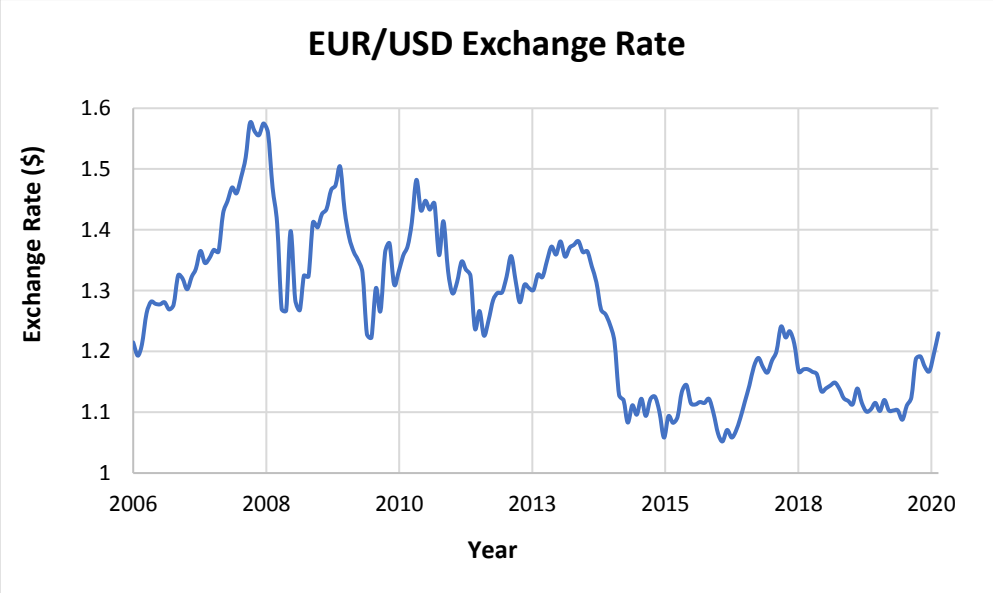


Figure 4 EUR/USD exchange rate

4.2. Methodology

The aim of this section is to present the method used to find the log return of the variables. The second objective is to regress the log return of banks' stock prices on the log return of the market index's stock price, Three-Month Treasury bill rate, and the change in the exchange rate. These steps are used to obtain the VaR for the five commercial banks.

4.2.1. Regression

From the 180 observations, we compute 179 return on the stock, return on the market index, and the change in the exchange rate, using the log return formula as shown in equation (4.1).

$$R_t = [\log(P_t) - \log(P_{t-1})] * 100 \tag{4.1}$$

In the first step, we regress the return on stock over the three independent variables using the following model:

$$R_{i,t} = \alpha_{i,t} + \beta_{m,t} R_{m,j,t} + \beta_{r,t} R_{r,j,t} + \beta_{x,t} R_{x,j,t} + u_{i,t} \tag{4.2}$$

Where $R_{i,t}$ represents the return on banks stocks, $R_{m,j,t}$ represents the return on market index, $R_{r,j,t}$ represents the percentage return on the three-month treasury bonds, and $R_{x,j,t}$ represents the change in the exchange rate. $\alpha_{i,t}$, $\beta_{m,t}$, $\beta_{r,t}$ and $\beta_{x,t}$ are the coefficients estimated using the model, where $\alpha_{i,t}$ represents the constant term, $\beta_{m,t}$ is the market coefficient, $\beta_{r,t}$ is the interest rate coefficient, and $\beta_{x,t}$ is the exchange rate coefficient, while t represents the period time, and $u_{i,t}$ is the error random term.

4.2.2. Value at Risk

After obtaining the βs and σs from the previous regression, the following equation can be used to compute the VaR:

$$VAR = c\sqrt{(\beta_{m,i}\sigma_{m,j})^2 + (\beta_{r,i}\sigma_{r,j})^2 + (\beta_{x,i}\sigma_{x,j})^2} \tag{4.3}$$

Where c is 2.326 from the student's t distribution table at 1 tail 95% confidence level, where $\sigma_{m,j}$, $\sigma_{r,j}$, and $\sigma_{x,j}$ represent the standard deviations of the three independent variables.

CHAPTER 5

RESULTS AND DISCUSSION

In this chapter, the output of the methodology (Chapter 4) is exhibited. The results are mainly summarized by the Value at Risk for each of the investigated commercial banks. These outputs include the coefficients, standard deviations, probabilities, and error terms.

5.1. BNP Paribas Bank

Table 2 represents the estimated model of the dependent variable over the three independent variables for BNP Paribas bank taking into consideration the p-value of each independent variable in the probability column. Comparing p-values to 0.05 (95% confidence level) makes it possible to infer that the return on the market index has a p-value less than 0.05. This result shows that $\beta_{m,t}$ is significant, which points to the eventual result that the return on market index is a significant predictor for return on the stock.

The estimated coefficients ($\alpha_{i,t}$, $\beta_{m,t}$, $\beta_{r,t}$, and $\beta_{x,t}$) are given in the coefficient column of the table where the estimated values are -0.109917, 1.539880, 0.206520, and 0.144870, respectively. Thus, a 1% change in the return of the market index, will lead to a 1.539880% change in return on the stock of the bank, holding all other variables constant.

Using equation (4.3), the value at risk for BNP Paribas bank is calculated as 18.19356%. This percentage represents the amount of capital needed against the risk exposure due to the stock market, Treasury bill rates, and exchange rate fluctuations.

This means that BNP Paribas bank will lose around 18.19356% of its value in case there is an extreme change in the three variables.

Table 2 BNP Paribas bank results summary

Dependent Variable: BNP_PARIBAS_RETURNS
Method: Least Squares
Date: 03/24/21 Time: 13:20
Sample (adjusted): 2006M02 2020M12
Included observations: 179 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.109917	0.530539	-0.207179	0.8361
CAC_40_RETURNS	1.539880	0.101599	15.15647	0.0000
_3_MONTH_BOND_YIE...	0.206520	0.326408	0.632707	0.5278
CHANGE_EURUSD	0.144870	0.184581	0.784861	0.4336

R-squared	0.592377	Mean dependent var	0.113875
Adjusted R-squared	0.585389	S.D. dependent var	10.23885
S.E. of regression	6.592821	Akaike info criterion	6.631933
Sum squared resid	7606.426	Schwarz criterion	6.703159
Log likelihood	-589.5580	Hannan-Quinn criter.	6.660814
F-statistic	84.77284	Durbin-Watson stat	2.020298
Prob(F-statistic)	0.000000		

5.2. Société Générale Bank

After looking at the p-values of each independent variable in Table 3, we can conclude that both the return on market index and the three-month treasury bonds are significant predictors (p-value is less than 0.05), while the change in the exchange rate is not a significant predictor (p-value greater than 0.05).

The estimated coefficients ($\alpha_{i,t}$,$\beta_{m,t}$, $\beta_{r,t}$, and $\beta_{x,t}$) are given in the coefficient column of the table where the estimated values are 23.64197, 0.406866, 6.337695, and 0.254527 respectively. Thus a 1% change in the return of the market index, will lead to a 0.406866% change in return on the stock of the bank, holding all other variables constant. On the other hand, a 1% change in the three-month bond yield will lead to a

6.337695% change in return on the stock of the bank, holding all other variables constant.

The value at risk for Société Générale bank is calculated as 23.16191% using equation (4.3). Subsequently, the previous percentage shows the sum of capital needed against the risk exposure in relation to the stock market, Treasury bill rates, and exchange rate fluctuations. As a result, Société Générale bank will lose around 23.16191% of its value in case there is an extreme change in the three variables.

Table 3 Société Générale bank results summary

Dependent Variable: SOCIETE_GENERALE
Method: Least Squares
Date: 03/24/21 Time: 13:44
Sample (adjusted): 2006M02 2020M12
Included observations: 179 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	23.64197	0.724790	32.61908	0.0000
CAC_40_RETURNS	0.406866	0.138798	2.931349	0.0038
_3_MONTH_BOND_YIE...	6.337695	0.445918	14.21268	0.0000
CHANGE_EURUSD	0.254527	0.252163	1.009377	0.3142

R-squared	0.544109	Mean dependent var	27.46897
Adjusted R-squared	0.536293	S.D. dependent var	13.22649
S.E. of regression	9.006713	Akaike info criterion	7.255910
Sum squared resid	14196.16	Schwarz criterion	7.327137
Log likelihood	-645.4040	Hannan-Quinn criter.	7.284792
F-statistic	69.62113	Durbin-Watson stat	0.130389
Prob(F-statistic)	0.000000		

5.3. Commerzbank

Table 4 provides us with the p-values of each independent variable to conclude that both the return on the market index and the change in the exchange rate are significant predictors (p-value is less than 0.05), while the three-month bond yield is not a significant predictor (p-value greater than 0.05).

The estimated coefficients ($\alpha_{i,t}$, $\beta_{m,t}$, $\beta_{r,t}$ and $\beta_{x,t}$) are given in the coefficient column of the table where the estimated values are -2.518435, 1.556412, -0.451391, and 0.890888 respectively. This means that for every 1% change in the return of the market index, there will be a 1.556412% change in return on the stock of the bank, holding all other variables constant. On other hand, every 1% change in the exchange rate will lead to a 0.890888% change in return on the stock of the bank, holding all other variables constant.

Furthermore, the value at risk for Commerzbank is calculated as 20.72044% using equation (4.3). This percentage signifies the amount of capital needed against the risk exposure due to the stock market, Treasury bill rates, and exchange rate fluctuations. In case there is an extreme change in the three variables, Commerzbank will lose around 20.72044% of its value.

Table 4 Commerzbank results summary

Dependent Variable: COMMERZBANK_RETURNS
Method: Least Squares
Date: 03/24/21 Time: 13:57
Sample (adjusted): 2006M02 2020M12
Included observations: 179 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.518435	0.839373	-3.000377	0.0031
DAX_RETURNS	1.556412	0.148316	10.49389	0.0000
_3_MONTH_BOND_YIE...	-0.451391	0.510474	-0.884259	0.3778
CHANGE_EURUSD	0.890888	0.293024	3.040326	0.0027

R-squared	0.448605	Mean dependent var	-1.984676
Adjusted R-squared	0.439153	S.D. dependent var	14.09405
S.E. of regression	10.55500	Akaike info criterion	7.573169
Sum squared resid	19496.40	Schwarz criterion	7.644396
Log likelihood	-673.7987	Hannan-Quinn criter.	7.602051
F-statistic	47.45895	Durbin-Watson stat	1.901981
Prob(F-statistic)	0.000000		

5.4. Aareal Bank

In Table 5, after looking at the p-values of each independent variable, we can conclude that all the variables are significant predictors with a p-value less than 0.05.

The estimated coefficients ($\alpha_{i,t}$, $\beta_{m,t}$, $\beta_{r,t}$ and $\beta_{x,t}$) are given in the coefficient column of the table where the estimated values are -0.270304, 1.574098, -0.987330, and 0.743752, respectively. Thus a 1% change in the return of the market index, will lead to a 1.574098% change in return on the stock of the bank, holding all other variables constant. Whereas, 1% change in the three-month bond yield will lead to a 0.987330% change in an opposite way in the return on the stock of the bank. On other hand, a 1% change in the exchange rate will lead to a 0.743752% change in return on the stock of the bank, holding all other variables constant.

As indicated, the value at risk for Aareal bank is calculated as 20.93996% using equation (4.3) which represents the amount of capital needed against the risk exposure due to the stock market, Treasury bill rates and, exchange rate fluctuations. In fact, Aareal bank will lose around 20.93996% of its value in case there is an extreme alteration in the three variables.

Table 5 Aareal bank results summary

Dependent Variable: AAREAL_BANK_RETURNS
Method: Least Squares
Date: 03/24/21 Time: 13:51
Sample (adjusted): 2006M02 2020M12
Included observations: 179 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.270304	0.742317	-0.364136	0.7162
DAX_RETURNS	1.574098	0.131166	12.00077	0.0000
_3_MONTH_BOND_YIE...	-0.987330	0.451448	-2.187028	0.0301
CHANGE_EURUSD	0.743752	0.259142	2.870058	0.0046

R-squared	0.513079	Mean dependent var	-0.013847
Adjusted R-squared	0.504732	S.D. dependent var	13.26393
S.E. of regression	9.334532	Akaike info criterion	7.327411
Sum squared resid	15248.36	Schwarz criterion	7.398638
Log likelihood	-651.8033	Hannan-Quinn criter.	7.356293
F-statistic	61.46702	Durbin-Watson stat	2.241693
Prob(F-statistic)	0.000000		

5.5. Deutsche Bank

Table 6 gives us a detailed explanation for the p-values of each independent variable to conclude that both the return on the market index and the change in the exchange rate are significant predictors (p-value is less than 0.05), while the three-month treasury bonds is an insignificant predictor (p-value greater than 0.05).

The estimated coefficients ($\alpha_{i,t}$, $\beta_{m,t}$, $\beta_{r,t}$, and $\beta_{x,t}$) are given in the coefficient column of the table where the estimated values are -1.553555, 1.358207, -0.094746, and 0.560219, respectively. Thus a 1% change in the return of the market index, will lead to a 1.358207% change in return on the stock of the bank, holding all other variables constant. On the other hand, a 1% change in the exchange rate will lead to 0.560219% in return on the stock of the bank, holding all other variables constant.

Moreover, the value at risk for Deutsche bank is calculated as 17.69077%, which is done using equation (4.3). This percentage represents the amount of capital needed against the risk exposure in relation to the stock market, Treasury bill rates and,

exchange rate fluctuations. This implies that Deutsche bank is going to lose around 17.69077% of its value if an extreme change in the three variables occurs.

Table 6 Deutsche bank results summary

Dependent Variable: DEUTSCHE_BANK_RETURNS
Method: Least Squares
Date: 03/24/21 Time: 14:02
Sample (adjusted): 2006M02 2020M12
Included observations: 179 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.553555	0.644242	-2.411446	0.0169
DAX_RETURNS	1.358207	0.113837	11.93119	0.0000
_3_MONTH_BOND_YIE...	-0.094746	0.391803	-0.241821	0.8092
CHANGE_EURUSD	0.560219	0.224904	2.490924	0.0137

R-squared	0.493868	Mean dependent var	-0.930182
Adjusted R-squared	0.485192	S.D. dependent var	11.29093
S.E. of regression	8.101257	Akaike info criterion	7.044008
Sum squared resid	11485.31	Schwarz criterion	7.115235
Log likelihood	-626.4388	Hannan-Quinn criter.	7.072890
F-statistic	56.91992	Durbin-Watson stat	1.935295
Prob(F-statistic)	0.000000		

CHAPTER 6

CONCLUSIONS

In this research, the Value at Risk of five European commercial banks was evaluated and analyzed. Three different market risk variables were taken into consideration namely, exposure to the stock market, exposure to treasury bill rates, and exposure to exchange rate fluctuations. The upcoming sections present the main outcomes of this research.

6.1. Value at Risk

VaR is calculated by combining the coefficients of the three independent variables with the standard deviation of each. VaR was obtained as 18.19% and 23.16% for both French Banks; BNP Paribas and Société Générale Banks, respectively. While the VaR for the German Banks (Commerzbank, Aareal Bank, and Deutsche Bank) are 20.72%, 20.93%, and 17.69% respectively. These values make the investigated banks' stocks risky in losing their values since the VaRs are all greater than 15%. The VaR analysis enabled us to rank each bank and allowed us to identify a wide range of risk exposures.

6.2. Recommendations

Upon the five European commercial banks used in this study, and after calculating the VaR of them, we found that all the five banks are risky investments. We suggest investors to invest in BNP Paribas bank if they want to invest in France since BNP Paribas bank has the lowest VaR between the two French banks and has a high

rank by total assets. It also spread out over 72 countries worldwide with retail banking grids that serve more than 30 million customers. On the other hand, we suggest investors to invest in Deutsche Bank if they want to invest in Germany since Deutsche Bank has the lowest VaR among the three German banks and ranked 21st worldwide by total assets. Between the two chosen banks, we suggest the investors invest in Deutsche Bank since it is the bank with the lowest VaR.

6.3. Future Work

It could be interesting to study the VaR for more banks in further different European countries, such as UK, Italy, Switzerland, etc… This would help to gain more views about these countries and the Value at Risk of their commercial banks specifically. Hence, we can suggest less risky commercial banks for investments.

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