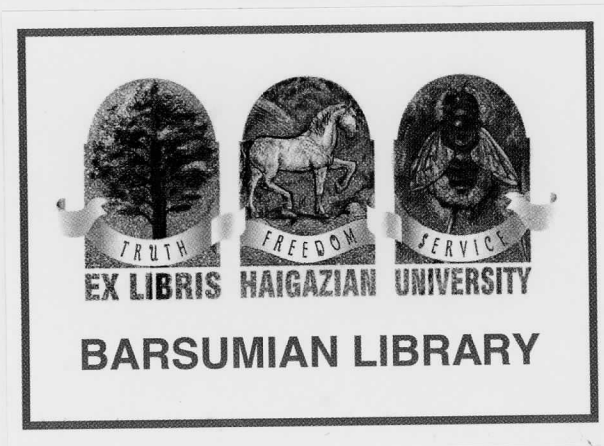


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Stress Testing of Four Lebanese Banks

By

Stress Testing of Four Lebanese Banks

By
ANI NADJARIAN

Dr. Sarah Azar, Associate Professor
Faculty of Business Administration & Economics

First Reader

A thesis submitted in partial fulfillment of the requirements
For the degree of Master in Business Administration with a major in Finance
To the faculty of Business Administration & Economics
At Haigazian University

Date of project presentation: June 15, 2011

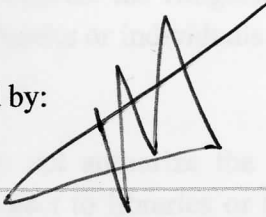
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15th Of June 2011

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Stress Testing of Four Lebanese Banks

**By
Ani Nadjarian**

Approved by:



Dr. Samih Azar, Associate Professor
Faculty of Business Administration & Economics

First Reader



Dr. Annie Tortian, Assistant Professor
Faculty of Business Administration & Economics

Second Reader

Date of project presentation: June 15, 2011

24/06/2011

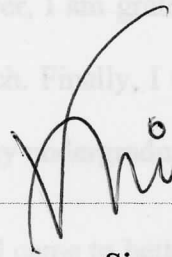
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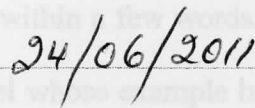
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TITLE: STRESS TESTING OF FOUR LEBANESE BANKS

Banks are the pillars of the financial system. If one bank fails, the base is threatened and a domino effect might be provoked. Moreover, the failure could expand outside the borders of the country due to the globalization and liberalization of the financial markets. Therefore, the existence of a single regime, the Basel Accord, to safeguard the financial system was crucial.

One of the purposes of this thesis is to shed light on the rules and regulations set by the Basel Committee on Banking Supervision.

The regular updates of the rules and the regulations reflect the importance of this regime on the economy. The base of these regulations originated by Basel I. The latter was replaced by Basel II, and today, there are serious discussions about Basel III which aims at introducing better risk management approaches.

The evolution of these regulations was essential to the global economy. The common international standards helped the banks all over the world to operate towards the same goal,

which is complying with the minimum standards set by the Basel Committee on Banking Supervision.

From the first day of the evolution of the international standards, the Lebanese banks proceeded in taking measures to apply the minimum required standards. The Lebanese banks' financial ratios show that they essentially comply with the minimum required standards.

However, a question perplexed of how the performance of important ratios will be, if a sudden unexpected situation occurs in Lebanon. In other words, will the Lebanese banks be ready to withstand future possible unexpected crashes?

To answer this question, stress testing is performed on a sample of four Lebanese banks. Stress testing, the main objective of this thesis, is one of the requirements of Basel rules and regulations. The stress testing is performed by adopting three stress tests. The first is by looking for the effects of increased asset risk for which banks have control. The second is by studying the effects of unexpected adverse stock movements. And the last is by adopting a standardized measure which is Value at Risk, as recommended by Basel II.

These three stress tests are based on a relatively recent contribution of option pricing to valuing the equity of a financial institution.

The results of the stress tests revealed that the sampled Lebanese banks are capable of absorbing unexpected losses for a certain period of time. Additionally, the thesis highlights the importance of the equity of a bank to protect the bank's solvency against the risk of possible losses.

The first part of the thesis covers the evolution of the Basel rules and regulations. The second part covers these rules and regulations implemented within the Lebanese banking sector.

The third part presents the adopted approaches and the results of performing stress tests on a sample of Lebanese banks under different scenarios.

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INTRODUCTION

Throughout history, the consequences of financial crises have threatened the confidence of investors in their nation's economic system. The crises have resulted in the collapse of large financial institutions, downturns in global stock markets, and bailout of banks by national governments. Undoubtedly, no investor in any country wishes to witness such a chaotic situation. After all, this condition damages the confidence of the investors in their countries, who will resort to investments outside their home country and this will surely weaken the country's economy.

To safeguard the global financial system, an international committee named the Basel Committee on Banking Supervision set common standards for banks to operate based on them. All the way through the years, these rules and regulations set by the Committee were subject to changes in order to end up with better approaches for risk management.

In Lebanon, the regulators were keen to the importance of this regime on the overall banking sector nationally and globally. Consequently, thanks to the efforts of the Lebanese regulatory bodies, Basel rules and regulations were implemented by the Lebanese banks.

The solid regulatory environment and the conservative banking practices in Lebanon resulted in excellent financial ratios for the Lebanese banks. Therefore, the banks in Lebanon were able to achieve the minimum required standards set by the Basel Committee.

The yearly financial statements of the Lebanese banks show that they are heading towards the right direction. However, the occurrence of sudden unexpected fluctuations in market factors is a probability which must be taken into consideration. For this reason, stress testing of Lebanese banks is essential to further increase the protection of the Lebanese banks.

The importance of stress testing of Lebanese banks lies in the concept that the results of the tests will reveal the readiness of the banks to absorb possible losses in the future. After the recent global financial crisis of 2008, the Basel Committee on Banking Supervision highlighted the importance of performing stress tests by all the banks in all over the world. Today, it is not up to the bank's management to perform stress tests because stress testing became compulsory.

A. Purpose of the study

The main objective of this thesis is to perform stress testing on four Lebanese banks by adopting the Black-Scholes-Merton option pricing model. The thesis also aims to study the requirements of Basel rules and regulations and its development throughout history. It also traces the Lebanese banking sector and introduces the general preparations by its regulatory bodies to implement the Basel rules and regulations.

The reason why four banks are chosen for this thesis is because of the Black-Scholes-Merton model basic requirements. The four banks have their shares listed on the Beirut Stock Exchange and the listing is a requirement of the Black-Scholes-Merton model.

This thesis attempts to provide the reader with the basic information regarding the Basel rules and regulations and its implementation in Lebanon. It also sheds light on the importance of performing stress tests to better protect the financial system in Lebanon.

B. Research Questions

The thesis aims at answering the following questions: What are the basic rules and regulations set by the Basel Committee on Banking Supervision? What are the approaches suggested by the Basel Committee in dealing with credit risk, operational risk and market risk?

What are the changes incorporated in Basel III? Where does the Lebanese banking sector stand with respect to the international minimum standards? Are the Lebanese banks ready to face sudden unexpected stock market crashes? What is the theoretical model adopted to stress test the sample of the Lebanese banks? And what are the three general stress-testing procedures performed to stress test the four Lebanese banks?

C. Methodology

Theoretical and empirical approaches are used in this study. A literature study collected information from large number of resources including books, research papers, journals, and official web sites.

After the data was collected, the Black-Scholes-Merton model was adopted to perform a statistical analysis. Statistical methods such as regression analysis, heteroskedasticity tests, and correlation analysis were used to perform:

- Stress testing to changes in the equity variance.
- Stress testing to crashes in equity prices that occur unexpectedly.
- Stress testing by using the VaR methodology which is a common measure of potential loss in adverse conditions.

D. Summary of the Contents

The first part of the thesis covers the evolution of the Basel rules and regulations, the second part traces how these rules and regulations were implemented within the Lebanese banking sector. The final part presents the adopted approaches and the results of performing stress tests on four Lebanese banks under different scenarios.

II-Literature Study

A. The Bank for International Settlements (BIS)

The Bank for International Settlements (BIS) was established in 1930. Its main role is to encourage international monetary and financial collaboration and acts as a bank for central banks. It fosters conversation and policy analysis amongst central banks and within the international financial community and enhances the international financial operations by acting as an intermediary amongst them.

The Bank does not provide banking services to corporations or individuals. It targets central banks and international organizations. The decision making within the bank is carried by three important bodies: The General Meeting of member central banks, the Board of Directors, and the Management of the bank (“About BIS,” n.d.).

The BIS was the body responsible for setting a “level playing field” for the banks, in the late 1980’s, known as Basel I (“Basel II-a Guide to Capital Adequacy,” n.d.).

B. The Basel Committee on Banking Supervision (BCBS)

At the end of 1974, the central-bank Governors of the Group of ten countries established the Basel Committee. The committee originates wide range of supervisory standards and guiding principles and recommends the countries to take steps in implementing them.

By interchanging information about countrywide supervisory issues and encouraging coordination among its members as well as with other banking authorities, the BCBS was able to set international principles on capital adequacy and released 25 Core Principles for Effective

Banking Supervision which became the basis for sound banking system globally (“History of the Basel,” 2009). The seven major areas covered were: “preconditions for effective banking supervision, licensing and structure, prudential regulations and requirements, methods of ongoing (“Experience with Basel,” 2000).

C. Basel I

The downfall of the Franklin National Bank in New York in 1971 and the Bankhaus Herstatt in Germany in 1974 convinced the bank supervisors internationally that a better coordination is a must (“The Federal Reserve Board,” 1999). Additionally, during the 1980’s, banks were becoming international in their operations. Therefore, the presence of a single regime to decide upon the minimum levels of capital that banks must hold was essential.

The BIS took the initiative in 1988 and after many meetings they came up with set of rules and regulations: Basel I. The aim was to safeguard the global financial system and their depositors (“Basel II-a Guide to Capital Adequacy,” n.d.).

The Basel Accord aimed at strengthening the soundness and the stability of the international banking system through the creation of common minimum capital adequacy requirements for internationally active banks so that they protect themselves for the amount of risks they take.

a. Definition of capital

The Basel committee developed a common framework for capital measurement, in this framework a minimum capital requirement was set and all the banks had to apply.

According to the framework, banks had to maintain a ratio of capital to risk assets of at least 8%. Capital was defined as; “paid-in-capital, retained earnings, tax-loss carry forwards, preferred shares, subordinated debts, hidden assets and loan loss reserves.” The capital was divided into two: Tier 1 and Tier 2.

“Tier 1, known as primary capital, includes common equity, qualifying non-cumulative perpetual preferred shares, and minority interests less goodwill.”

“Tier 2, known as secondary capital, includes non-allocated loan loss reserves, subordinated debt, and all the preferred shares not included in Tier 1.” (“The Federal Reserve Board,” 1999).

b. Credit risk and risk weighted assets

According to Basel I, the minimum level of capital that banks had to hold was dependent on the riskiness of the assets the banks held. The assets on the balance sheet were divided into categories and were given weightings between 0% and 100%. The percentages reflected the riskiness of the assets. For example, government bonds were given 0% risk weighting since they are the safest assets. Short term interbank credit carried 20% weighting. Loans secured on residential property were given a 50% risk weighting, and corporate debt and unsecured personal loans were given 100% risk weighting. These weightings were assigned to capture credit risk, the risk that the other party will default (“Basel II-a Guide to Capital Adequacy,” n.d.).

c. Collateral and guarantees

In order to decrease their credit risk exposure, banks and financial institutions proceeded in classifying their assets in categories which carry lower weightings. Yet, this technique did not

help them to reduce the capital charge as they were expecting. Hence, they developed credit mitigation techniques like the use of collateral, guarantees, credit derivatives.

Today, collateral and guarantees are regarded as tools to mitigate credit risk. However, the BCBS in 1988 recognized as eligible collateral and guarantees the cash and the guarantees and the securities issued by the Organization for Economic Co-operation and Development public sector entities, private sector banks, and central governments. The other mitigation technique, credit derivative, was not taken into consideration by the first Accord (El Harati, 2003).

d. Off- balance-sheet items

An item is considered to be an off-balance sheet item if it is not an asset or a liability which the bank owns or is legally liable for. Financial institutions might have huge amounts of off-balance-sheet items and for this reason the Basel I specified the way these items would be treated in the capital ratios calculations.

The calculation of risk adjusted asset value for off-balance-sheet items is a two step process: the dollar amount of the item is multiplied by the conversion factor to calculate the credit equivalent amounts and then these amounts are multiplied by their risk weights.

The conversion factors change an off-balance-sheet item into an equivalent credit or on-balance-sheet item. The conversion factors used depend on the nature of the credit risk to which the bank is exposed to. For example, to mention a few, direct credit substitute standby letters of credit have 100% conversion factor, whereas, unused portion of loan commitments with original maturity of more than one year have 50% conversion factor, and commercial letters of credit have 20% conversion factor (Saunders, 1994).

e. The Cooke ratio

It is the ratio that calculates the amount of capital that the banks should have as a percentage of their total risk-adjusted assets. The 1988 Basel Accord required the banks to adopt this ratio and calculate minimum amount of capital that they should hold in case of unexpected losses. The Basel I set the minimum adequacy standard that must be maintained by banks, that is the Cooke ratio, to be greater or equal to 8%. Of the 8% capital charge, at least 4% must be covered by Tier 1 capital.

The main critics regarding the Cooke ratio was that it pulls all borrowings from the bank on the same level, although some could be riskier than others. As a result of this, the Cooke ratio was reviewed in 1999, and was replaced by another ratio, McDonough ratio, which allows the banks to have greater control over how they calculate the ratio taking into consideration their own risk management procedures (Jorion, 1997).

f. The 1996 Amendment: market risk

In 1996, market risk was incorporated in the Basel I accord. This decision was due to the tremendous expansion of financial services and products. This expansion exposed the banks to new risks, especially market risk which is composed of interest rate risk, foreign exchange risk, and fluctuations in equity and commodity prices on and off the balance sheet.

The market risk management technique proposed by the Basel Accord is the value at risk (VaR) (discussed further in part two and part three).

The Basel Accord permits the banks to choose between two methodologies to measure market risk. The first is the standardized manner and the second is the adoption of in-house

models. The latter has to be approved by the concerned national authority because banks have to meet several criteria. The criteria will address the skills of the employees who used the complicated models. Additionally, the authority has to make sure that the models adopted by the banks are accurate, if banks are frequently conducting stress tests, and if their risk management system is sound or not (Neaime & Shahin, n.d.).

g. Critics of Basel Accord

The Basel Accord failed to confront the quick market developments and the complexity of the new financial products; and hence, it was criticized on several fronts.

First, the overall architecture of the Basel Accord was very simplified. It accounted only for credit risk although there are many other risks of equal importance, such as, operational risk, market risk, etc. In addition to this, assigning only four broad credit risk weighting categories for capital charges was not rational since the portfolio risk of the bank was ignored (Jorion, 1997 & “CEPS Task Force Report,” 2008).

Second, banks were able to get engaged in “gaming” through regulatory arbitrage since the degrees of risks were poorly differentiated. Banks adopted risk-shifting techniques such as securitization and credit derivatives. Through the use of these techniques banks were able to transfer their risk to others and hence avoid setting aside capital (“CEPS Task Force Report,” 2008). The capital requirements were fixed asset categories; therefore, if the bank changes from borrowers who carry low-risk to borrowers who carry high-risk, its regulatory capital will still remain the same, though the bank’s risk definitely rises (Emmons, Lskavyan, & Yeager, 2005).

Finally, the “one-size-fits-all” technique to risk assessment and supervision was not suitable for banks since they were not encouraged to progress their risk assessment and management techniques (“CEPS Task Force Report”, 2008).

D. Basel II

By the late 1990s, the operations of the banks became sophisticated and the need for new capital standards was a must. Hence, efforts began to create a new accord, known as Basel II. The aim of Basel II was to better associate the minimum capital required by regulators (regulatory capital) with risk (“Basel II-a Guide to Capital Adequacy,” n.d.). Consequently, U.S. and international banks supervisors met in Switzerland on June 26, 2004 and agreed on the New Basel Capital accord, Basel II (Emmons, Lskavyan, & Yeager, 2005).

The new Capital Accord has a basic structure which rests on three pillars. Pillar One: Minimum Capital Requirements. Pillar Two: Supervisory Review Process. And Pillar Three: Market Discipline Requirements.

a. Pillar One: Minimum Capital Requirements

It includes the steps that banks should follow to calculate minimum regulatory capital. Basel I required credit and market risk calculation. Basel II, added to the above two risks, the operational risk as well (“Basel II-a Guide to Capital Adequacy,” n.d.). The calculation or the approaches adopted in each of the above mentioned risks is discussed below.

1. Credit Risk Calculation

Under Basel I, lenders had only one way to calculate regulatory capital for credit risk; with Basel II, lenders had three approaches.

i. Standardized Approach

Under Basel I, the exposures were divided into risk categories. These risk categories, carried a fixed risk weighting. Under Basel II, this changed. The categories (loans to sovereigns, corporate and banks) carried weights which were set by the outside credit ratings attributed to the borrower. Loans secured on residential property continued to have fixed risk weights of 35% against 50% previously (“Basel II-a Guide to Capital Adequacy,” n.d.).

ii. Internal Ratings Based Approach

The abbreviation of this approach is IRB. Lenders could adopt their own models to determine their regulatory capital requirement. Lenders estimate a probability of default (PD), and supervisors set values for Loss Given Default (LGD), exposure at default (EAD) and maturity of exposure (M). Lenders then assign risk weights for each exposure (“Basel II-a Guide to Capital Adequacy,” n.d.).

iii. Advanced Internal Ratings Based Approach

Under this approach, the lenders estimate PD, LGD, EAD and M.

Between the 3 approaches mentioned above, regulators encourage the banks to adopt the Advanced IRB (“Basel II-a Guide to Capital Adequacy,” n.d.).

2. Operational Risk Calculation

From the major improvements under Basel II compared to Basel I was the incorporation of the operational risk measurement. The operational risk is “the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events” (“The Joint Forum,” n.d.). With the new framework, the banks have to develop a capital charge which covers the risk that arises from the above mentioned systems. There are three approaches to calculate operational risk:

i. Basic Indicator approach

Banks must hold a capital cushion against operational risks equal to 15% of their total gross income; this simply means that the larger banks have to carry higher capital since their gross income will be much higher (“CEPS Task Force Report,” 2008).

ii. Standardized approach

The gross income of the bank is divided into eight business lines: “corporate finance, trading and sales, payment and settlement, commercial banking, agency services, retail banking, asset management and retail brokerage.” For the first three lines, banks have to hold a capital equal to 18% of the total income; whereas, for the last three; it’s 12% since they are assumed to be less risky (“CEPS Task Force Report,” 2008).

iii. Internal (advanced) measurement approach

This approach is abbreviated as AMA. Banks could depend on their internal methods to evaluate their exposures, but the methods require the approval of supervisors to guarantee that

they are all-inclusive and orderly. This approach is usually adopted by internationally active banks since they are more exposed to operational risk. The internally adopted systems should estimate the expected and unexpected losses by using internal and external data, perform situation analysis and take into consideration the business atmosphere and interior controls (“CEPS Task Force Report,” 2008).

3. Market Risk Calculation

The amendment of 1996 is still applicable under Basel II framework. Briefly repeating the idea, the market risk is defined as the risk of losses in on and off balance sheet position that originates from fluctuations in market prices (“Amendment to the Capital Accord,” 2005).

It is worth mentioning that after the financial crisis which occurred in mid 2007, the Basel Committee on Banking Supervision added an additional risk capital charge which includes default risk as well as migration risk for un-securitized credit products. The BCBS also introduced the stressed value at risk requirement.

b. Pillar Two: The Supervisory Review Process

The aim of this process is to achieve a level of capital consistent with the whole risk profile of the bank. It encourages banks to develop improved risk management techniques.

There are four key principles for this process. First, banks must always make sure that their capital adequacy levels match the total risk that they are carrying and to be able to do this, they must follow a suitable strategy to maintain the required levels. Second, the role of the supervisors is crucial since they must always follow up the above mentioned strategies to guarantee that the figures comply with the required ratios, and in case this is not the situation,

supervisors must take corrective actions; third, supervisors should have the power to require their banks to hold capital more than the required by the national regulators and they should always encourage their banks to operate above the minimum compulsory levels; finally, supervisors shall be ready to intervene prior to the fall of the capital adequacy levels below the minimum levels (Mohanty, 2008).

c. Pillar Three: Market Disclosure

Pillar three complements pillar one and pillar two. It aims at developing certain disclosure requirements so that whoever wishes can have access to the information about the bank's capital, and about how well the risk assessment and management processes are applied, about the bank's risk exposures, and its capital adequacy ("Pillar 3," 2001).

Disclosures are required by the banks to enhance transparency with their stakeholders, such as, customers, employees, shareholders, supervisors and public authorities.

d. The General Implications of Basel II

It's true that the objective of Basel II is to safeguard the financial system; however, its implementation is not an easy process. For this reason, it's worth mentioning some of the issues related to Basel II implementation.

Pressure to implement Basel II

Many countries reported that Basel II implementation will not take place immediately in their countries. The supervisors of these countries believe that hurried implementation of Basel II might result in weaker rather than stronger supervision. The pillar one requirements need data,

skills, and systems which currently are not available in most of the developing countries. As a result of this, BCBS announced that Basel II, “may not be a first priority for all non-G 10 supervisory authorities in terms of what is needed to strengthen their banking supervision, and should adopt Basel II only in a time frame consistent with national priorities and capacities.”

A strong supervisory foundation should be a precondition for Basel II implementation

Prior to Basel II implementation, the financial services in a country should have a solid infrastructure. Banks could operate properly in an atmosphere where there is good accounting and auditing rules and practices, the financial transactions should have a proper legal framework, the banking supervision should result in reporting reliable financial information, the data sharing, the market transactions disclosure, in addition to many other actions should be done properly.

Higher capital requirements likely for loans to emerging markets

It's expected that banks which provide loans to emerging and developing markets will be subject to higher capital charges to cover the higher credit risk and operational risk which they will carry. Consequently, higher risk countries will have higher borrowing costs and capital flows will be decreased. The lending rates might also be affected since more risks should be incorporated in the rate.

Portfolio adjustments arising from Basel II

Since different capital charges will be applied based on the credit risk of a type of loan, banks might change their portfolio holdings. They might prefer holding low risk assets rather than high risk assets since the latter requires higher capital charges. Consequently, the shift in the portfolios might have macroeconomic consequences.

Increased procyclicality

To avoid financial stress, Basel II might require from banks to assign higher risk weights during an economic recession. Consequently, banks' cost of providing credit will increase and will hurt their lending activities. However, one might understand that such measures might motivate banks to better analyze risk.

Risk of selective implementation of Basel II

Basel II allows the countries to choose among simple and complicated approaches to measure their capital requirements. As a result of this, some countries might assign lower risk weights to certain asset categories without taking into consideration their previous loss experience. This could be dangerous, and to avoid negative consequences supervisors should not allow such actions unless the countries justify the lower risk weights through the use of historical loss data and suitable officially authorized judicial and accounting atmosphere.

Incentives to develop credit rating agencies

The credit rating agencies play an important role in providing ratings for major borrowers so that asset risk weights will be determined using the Standardized Approach under pillar one. Therefore, if credit rating agencies are not present in the market, the ratings for the borrowers will not be available, and hence the standards of Basel I, which were criticized, will be applied. Basel II encouraged the countries to widen credit rating agencies.

Increased resource pressures to build financial infrastructures

For countries who will implement Basel II, it's necessary to have strong financial infrastructures. The retrieval and the reporting of data should be from reliable systems.

Shortage of trained supervisors

It's essential for countries who will implement Basel II to recruit specialized staff and train their current staff. According to the Financial Stability Institute Survey on Implementation of Basel II around 9000 supervisors will require training all over the world. In the coming years, the demand for risk-based supervision, credit and operational risk management is expected to increase. All these will increase the costs of the financial institutions.

The role of the host supervisor

There are several difficult questions which are being discussed regarding the relation between home and host regulators. For example, in case the foreign subsidiary faced a capital problem, what will be the solution of this problem?

Home-host supervisory cooperation

To solve the above issue, the Accord Implementation Group (or AIG) developed a mechanism which explains how the cooperation should occur between home-host supervisors. The supervisors should constantly share information and should have effective working relationships.

Commercial bank implementation

Basel II required the banks to concentrate more on risk management. Large, internationally active banks are already on the right track in Basel II implementation. Medium-income countries are also working towards adopting different measures to be able to implement Basel II effectively. Finally, banks in lower-income countries face challenges in Basel II

implementation since they lack the basic resources (“Staffs of the International Monetary Fund,” 2005).

E. Value At Risk

The value at risk (VaR) models measure the risk of how much the market value of the portfolio will decrease due to changes in interest rates, foreign exchange rates, equity prices or commodity prices. The outcome of the VaR measure is only a single figure indicating the market risk of the whole portfolio.

Financial and regulatory communities encourage the financial institutions to use VaR models. Basel Committee on Banking Supervision also encourages the use of VaR models. The BIS Fisher report (1994) asked the financial intermediaries to reveal the VaR figures to the public. Therefore, taking the support of the above regulatory institutions, the use of VaR models by financial institutions grew.

VaR model determines “how much the value of a portfolio could decrease over a given period of time of a given probability as a result of changes in market prices or rates.”

The confidence level and the length of time are the most important two factors in the VaR models. The time period, is known as holding period. There is an assumption in VaR models that the portfolio’s composition doesn’t vary over the holding period. Usually, VaR measures are presented as percentages (Hendricks, 1996).

In April 1993, first set of proposals were issued to calculate market risk. The approach was known as the standard model. VaR was calculated for portfolios exposed to interest rate risk,

exchange rate risk, equity risk, and commodity risk following certain guidelines. Then, the banks' total VaR was calculated by summing the VARs of the four categories.

Although the standard model aims at identifying banks with unusual exposure; however, it had some basic problems, such as, duration of certain instruments could not be easily identified, the model didn't take into account diversification across risks, and puts extra reporting burden on the banks. Diversification across market risks is easy to measure. Investing in global fixed-income markets is less risky than investing in a single market. These benefits are not taken into consideration while aggregating across markets. The assumption that there is a perfect correlation across markets and across different types of risk also is inaccurate because it overestimates portfolio risk and leads to capital adequacy requirements that are essentially high.

For these reasons, in April 1995, the Basel committee introduced an extension of market risk models. This model would let the banks to use domestic methods to compute their capital charge.

The 'internal model' proposal was based on calculation of 10-day 99% VaR.

Drawbacks of the internal model are:

Performance verification: The role of the regulators in verifying VaR figures is very important because capital requirements are assigned according to the VaR. There might be a tendency to lower the VARs, so that the bank will be subject to lower requirements. Verification of the result is quite difficult because there might be situations where the losses exceed the VaR just by chance; hence, longer periods are required to find out if the model is inaccurate or not.

Endogeneity of positions: Internally calculated VARs measure risk over a short interval, such as a day. If 10-day is adopted, the fact that the positions will change is ignored. Hence, long-horizon exposure measurements disregard efficient risk management procedures and controls (Jorion, 1997).

VaR is essentially an important measure of risk. For this reason, the VaR methodology is adopted in this thesis to perform stress testing of Lebanese banks.

F. Stress Testing

Stress testing contributes to the enhancement of internal risk management and capital planning of banks. For this particular reason, Basel II required the banks to perform stress tests, and its importance was highlighted following the financial crisis in the U.S.A.

Stress testing helps the bank's management to be ready for negative sudden outcomes associated with different kinds of risks and provides a signal of how much capital is required to absorb the losses of the shocks. Stress testing plays an important role in: "providing forward-looking assessment of risks, overcoming limitations of models and historical data, supporting internal and external communication, feeding into capital and liquidity planning procedures, informing the setting of a banks' risk tolerance and facilitating the development of risk mitigation or contingency plans across a range of stressed conditions."

The importance of stress testing arises during the periods where the economy is performing at its best because many supervisors forget the losses of the past and underprice risk. The stress testing is also important during periods of expansion: this is the period where new products are innovated and no loss data is available.

Although stress testing can not address all risk management weaknesses but it strengthens bank corporate governance and the flexibility of banks and the global monetary system. After the recent U.S. financial crisis of 2008, the BCBS on May 2009 issued *Principles for sound stress testing practices and supervision*. The aim of the principles was to overcome some of the weaknesses observed in stress testing methods and to help the banks to strengthen their testing practices and supervisory assessment of the practices (“Bank for International Settlement,” 2009). Here are the summary of the principles.

First, stress testing should be an integral part of the whole governance and risk management culture of the bank. Its results should be taken into account during decision making by the Board and Senior Management. Second, the aim of stress testing should be risk identification and control. It should help the bank improve its capital and liquidity management and should complement other risk management approaches. Third, the programmes designed for stress testing should take into consideration different views across the financial institution as well as different techniques adopted within the organization. These programmes should be documented and there must be written rules and policies regarding the operations. Fourth, the infrastructure of the financial institution should be solid and flexible because stress testing operations might change at any given time given the situation. Fifth, it is essential to constantly update the stress testing framework and the framework should be able to provide the whole picture of firm-wide risk. Sixth, different forward looking scenarios should be included in stress tests and system-wide interactions and feedback effects should be taken into consideration. Seventh, stress tests should be able to uncover hidden risks and interactions among risks. They should cover complex products and reputational risk.

Finally, the rest of the principles are related to the role of the supervisors who are very essential in stress testing of banks. Supervisors should frequently assess the stress testing programmes, and they should ask the management to take necessary actions if the stress tests results show material deficiencies. Supervisors might ask the management to perform sensitivity analysis for certain portfolios if they see the need. The adequacy of capital and liquidity should be assessed by supervisors through the use of stress tests and supervisors should frequently keep in contact with other public authorities to identify possible systemic vulnerabilities (“Bank for International Settlement,” 2009).

The Basel Committee requires the banks to fully integrate stress testing programmes in their governance frameworks and the committee will regularly follow up to make sure that the principles are implemented adequately.

G. Basel III

In September 2009, the Group of Central Bank Governors and Heads of Supervision, agreed on the framework of the third set of banking rules, Basel III. In December 2009, the committee set out proposals and in 12th of November 2010, the G20 leaders officially agreed on the Basel III framework.

The aim of the set of reform measures is to “improve the banking sector’s ability to withstand shocks due to financial and economic stress; to improve risk management and governance, and to strengthen banks’ transparency and disclosures.” (“International Regulatory Framework,” n.d.).

a. The Framework

Tier 1 capital

Under Basel II, banks are required to hold Tier 1 capital ratio of 4% and core Tier 1 capital ratio of 2%. With Basel III, the Tier 1 capital ratio is increased by 2% to reach 6% and the core Tier 1 capital ratio (common equity after deductions) should be equal to 4.5%. Banks have to start preparing themselves because before 2013 the core Tier 1 capital ratio (common equity after deductions) should be 2% for the banks. This figure should increase to 3.5% as of 1st January 2013, and to 4% as of 1st January 2014. And finally it must reach its target of 4.5% as of 1st January 2015.

Capital conservation buffer

Under Basel II, there was nothing mentioned about the capital conservation buffer. After the recent financial crisis, the regulators realized that there must be a buffer for the banks to cushion themselves during the periods of stress.

Therefore, on top of Tier 1 capital, banks are required to hold capital conservation buffer of 2.5% and hence the total common equity requirements will reach 7%. The aim of this buffer is to help the banks to survive future potential periods of stress.

Taking into consideration that the capital conservation buffer is a new requirement, prior to 2016 the banks will not be required to hold this buffer; however, as of 1st January 2017, banks are required to show capital conservation buffer of 1.25%, and the figure will increase to 1.875% as of 1st January 2018, and finally it will reach the target of 2.5% as of 1st January 2019.

Basel III mentioned that the buffer belongs to the bank and during difficult periods the banks will be allowed to withdraw funds from there. However, Banks will be restricted from distributing earnings if their regulatory capital ratios approach the minimum requirement.

Countercyclical capital buffer

Countercyclical capital buffer was again not mentioned in Basel II framework. Basel III included the countercyclical buffer in its framework.

“A countercyclical buffer within a range of 0% – 2.5% of common equity or other fully loss absorbing capital will be implemented according to national circumstances.”

The bank will be restricted to pay dividends or buy back shares or distribute bonuses if its capital ratio is less than 2.5%. As capital conservation buffer, banks are not required to hold countercyclical buffer before 2016. However, as of 1st January 2016 banks' countercyclical buffer shall be 0.625%, and will increase to 1.25% as of 1st January 2017, and to 1.875% as of 1st January 2018, and to reach the target of 2.5% as of 1st January 2019 (“The Basel iii Accord,” 2011).

Capital for systemically important banks only

Basel II didn't mention anything regarding the capital of systemically important banks. The Basel Committee and the Financial Stability Board are working on certain regulations regarding these banks to be included in Basel III. The committee and the board believe that such institutions should have the ability to absorb losses beyond the standards mentioned above.

To summarize the Basel III changes and the framework, the total regulatory capital ratio under Basel III is the summation of Tier 1 capital ratio, capital conservation buffer, countercyclical capital buffer and capital for systemically important banks ('The Basel iii Accord,' 2011).

b. Preparations

Preparations to apply Basel III rules are set in motion. Hence, mitigation became the buzzword for the world's largest investment banks. The biggest concern is how the new rules will inflate banks' risk weighted assets and whether the bottom lines of their balance sheets will be hurt or not.

Many banks believe that mitigation will help them to apply the Basel III rules without harming their earnings. They believe that they could limit or shut down their exposure to business lines which carry higher risk weighting, such as, credit derivatives, correlation trading, and asset securitization (Murphy, Megan, & Masters, 2010).

The Bank for International Settlements reported that the world's largest banks have to raise around €577 billion (\$762.85 billion) in capital to meet the Basel 3 requirements.

According to BIS, "Group 1" banks, which have more than €3 billion in capital have to raise €177 billion in additional common equity to meet the new minimum ratio of 4.5% of risk weighted average (Smith, 2010).

The new rules and regulations that are going to be required by Basel III in the coming years are forcing many of the banks to think twice about their current business lines and growth plans (Lucchetti & Philbin, 2010).

According to a survey conducted by the IMF for 62 large banks in North America, Europe, and Asia 10 won't have enough retained earnings to meet the common-equity capital ratio of 7% by 2019. The rest of the banks will be able to meet the required ratio either by issuing stock or cutting dividends.

Regarding the long-term liquidity standards, the IMF seems worried and proposes that large banks should start holding more liquid assets to cover the liabilities that mature in one year or less. This fear was the result of the latest financial crisis which proved that banks had trouble to have access to short-term funding (Davis, 2010).

Many of the banks have started taking actions as a preparation for the new rules. The return on equity (ROE) which is the benchmark of profitability of many banks has already declined because of the costs incurred by the banks to comply with Basel III (Bosley, 2011).

c. Proponents and Opponents

Discussion about Basel III rules and regulations resulted in many opinions all around the world. Some accepted the idea of Basel III and became strong supporters. Others completely rejected the idea because they believed that tighter regulations will place burden on banks and will hurt the global economy. Here are the ideas of some proponents and opponents.

Years ago, Swiss regulators were trying to convince the world that more capital is essential to fight against financial crisis along with tighter liquidity and leverage rules. Initially, no one gave attention to the Swiss regulators. But after Lehman's collapse, the Swiss requirements reached a more receptive ear in different countries around the world (Simonian, 2010). Therefore, it's not a coincidence that Swiss banks have reputation for being safer than any

other banks. Swiss regulators always add a “Swiss Finish” to international capital rules. They always force their banks to follow tighter rules and regulations to safeguard their clients. When Basel Committee on Banking Supervision set the Basel III rules, regulators in Switzerland suggested a new version of the Swiss finish for their two biggest firms, UBS and Credit Suisse. According to Basel III, banks have to carry core capital of 7% of risk-adjusted assets; whereas, according to the Swiss finish, Swiss banks have to carry 10% (“Regulating Swiss Banks,” 2010).

In Britain, some bankers expected that eventually they will hold 10% of risk weighted assets as common equity as Switzerland was calling (Simonian, 2010). According to Barclay’s capital, the top 35 US banks will be short in equity capital under the new Basel 3 capital accord. This shortage is expected to be between \$100 billion and \$150 billion. Mr. Tom McGuire, head of the capital advisory group at BarCap is not worried about the shortfalls, since in his opinion shortfalls are manageable. However, he is worried about the impact of the new rules on the cost and availability of credit and bank profitability (Masters & Baer, 2010). Mr. John Varley, Barclay’s chief executive, is a big supporter of Basel III accord. In an interview with Financial Times, he said that the new rules are set to avoid financial crisis and according to him it’s not right to say that these rules will restrict banks’ ability to lend. He said; “The recommendation that will be put in front of the G-20...by the Basel authorities is very clearly sensitized to the obligation that the banks have over the course of the coming years to facilitate economic growth” (Jenkins, 2010).

US regulators also seem receptive to the adoption of the new rules and regulations as Britain. US regulators believe that they should adopt the new requirements to avoid any competitive disadvantage with any market (Simonian, 2010). Neal Wolin, US deputy treasury

secretary is very confident that US banks will be ready to apply the rules by February 2015 (Masters & Baer, 2010).

Germany, on the other hand, is opponent to supplementary measures. The regulators in Germany fear that such decisions will restrict banks' lending abilities and will therefore hinder economic recovery (Simonian, 2010). Mr. Joseph Ackerman, chief executive of Deutsche Bank and head of the International Institute of Finance, believes that Basel III will have a negative impact on the economy and will hinder economic recovery (Jenkins, 2010).

Almost the same reluctance persists in Paris. Regulators in France believe that the current regulations are enough and there is no need to burden the banks with new restrictions. Japan agrees with France as well (Simonian, 2010).

Finally, in Lebanon, the general secretary of the association of banks, Makram Sader, is certain enough that the Lebanese banks can meet Basel III conditions. Since the capital adequacy ratio of the Lebanese banks is exceeding the current international standards, Mr. Sader believes that Lebanon will easily meet the new requirements. He believes that Lebanon holds high cash reserves and thus is able to stand against any financial turbulence. On the other hand, Fouad Rahme, BLC bank's assistant general manager, considered funny talking about Basel III since he believes that Lebanon has not applied Basel II completely. According to the Association of Banks in Lebanon the profits will remain unchanged after adopting Basel III new accord. Samir Hammoud, an executive at Bank Med, is also optimistic about the effects of the application of Basel III accord in Lebanon (Qiblawi, 2010). The head of the Association of Banks in Lebanon, Joseph Torbey, claimed that the Lebanese banks will slowly start implementing Basel III recommendations to decrease risk management. According to Mr. Tobey, Lebanon has applied

most of the recommendations of Basel I and II and will do the same with Basel III recommendations. As an initial step, the central bank issued guidelines to all commercial banks in Lebanon to strengthen supervision and undermine risk management (Bertelsmann, 2009).

The second part of the thesis covers the Lebanese banking sector.

III. Basel and the Lebanese Banks

A. The Lebanese Banking Sector

The banking sector in Lebanon carries strategic importance for the Lebanese economy. It witnessed transformation over the past decade and moved from a highly fragmented market to a consolidated environment due to some restrictions set by the central bank regarding the yearly opening of new branches, and mergers and acquisitions.

The Lebanese banking sector enjoys several comparative advantages which helps the sector to grow tremendously even when the world is witnessing financial crisis. The prudent regulatory framework set by the central bank, the conservative practices and risk management of Lebanese banks themselves, the banking secrecy law, good management, a skillful workforce and relatively stable currency all contributed to the growth of the Lebanese economy in the midst of international financial turmoil.

When the world was witnessing a global financial crisis at the end of 2008, the Lebanese banking sector proved to be solid and was able to weather external shocks. During these times, Lebanon's economy was growing, the confidence in the banking sector remained high among the investors and deposit flows in Lebanon from residents as well as from the Lebanese Diaspora increased. The central bank's strict regulations protected the Lebanese banks from being exposed

to derivatives and structured products. All these contributed to the increase in the consolidated net profits of the Lebanese banks.

The Lebanese banking sector manages a large asset base domestically and given that there is a relative saturation of potential growth locally and for the purpose of adding to the existing European subsidiaries of large Lebanese banks, many of the largest banks in Lebanon are targeting towards expansion in international and regional markets (“FFA Private Bank,” 2010).

Lebanese banks diversify in their use of their funds. They depend on deposits as the primary source of funds, which represent 84% of the total assets/liabilities. They try to avoid financial / credit markets in advanced countries. The Lebanese banks maintain a high liquidity in LBP and in foreign currencies. They have a good level of capital and high solvency.

The most important requirement of the commercial banks in Lebanon is to maintain a good level of liquidity, solvency, profitability, and risk diversification. They are also required to maintain a balanced level of Lebanese pounds and foreign currencies and this policy of maintaining high liquidity in the currencies proved its efficiency during the latest global instability (“FFA Private Bank,” 2009).

To protect the stability of the banking sector, important banking measures are imposed on the banks.

Lending requirements: Lending to related parties (shareholders, chairman, members of the board of directors, top management and their families) shall not be greater than 5% of shareholders equity. Only 20% of banks' shareholders' equity can be lend to a single entity. Banks can only lend up to 50% of the value of stocks and up to 60% of the value of any real

estate projects. Additionally, credit termed 'big risk' should not exceed 8 times a banks' 'shareholders' equity. The 'big risk' credits are the credits which are greater than 15% of shareholders equity.

Investment requirements: Investment in derivative instruments are forbidden unless for hedging purposes and permitted from central bank. The investment in structured products shall not exceed 25% of bank's equity given that this product is capital guaranteed and approved by the central bank.

Capital adequacy ratio: Banks should meet a solvency ratio of total capital to RWA (credit, market and operational risk) of at least 8% based on Basel II regulation.

Accounting practices standards: The practices should conform to the international standards.

Loan classification and provisioning: This should conform to those defined by the BCBS.

Reserve requirements: Banks must hold sum of 25% of their demand liabilities in LBP and 15% of their term and other liabilities in LBP with the central bank. These reserves are interest free but there might be a decrease in the reserve requirements on LBP loans because the banking sector is improving. Additionally, banks must hold 15% of all their liabilities denominated in foreign currency with the central bank. Other than this, banks should maintain at least 10% of their liabilities denominated in foreign currencies or net liquid assets.

Internal control policies and procedures: The Basel committee on banking supervision has issued principles for the assessment of internal control system and hence the Lebanese banks should be in compliant with the issued principles ("FFA Private Bank," 2010).

B. The Regulatory Authorities

The banking sector in Lebanon is under the supervision of two independent authorities: The Central bank of Lebanon (CBL) and the Banking Control Commission (BCC).

The CBL is responsible for the monetary policy, development of the banking sector, and for licensing of banks and financial institutions. All of the Lebanese banks operate under the jurisdiction of the central bank.

The BCC is responsible for monitoring banks' operations, controlling their development and performance and supervising their systems and management. BCC frequently issues circulars and receives feedback/ reports to follow up the operations of banks.

In "problematic" situations, when the BCC faces troubles solving the situation, it refers the financial institution to the "higher Banking- Council" (H.B.C). The latter is a judicial authority which decides on the fate of the institution being tried (Awad, 2004).

C. Lebanon's Master Plan for Basel II implementation

In March 1995 and after 17 years of war and the start of reconstruction, Lebanese banks were in front of new challenge. Banks had to achieve minimum capital adequacy ratio of 8% by the end of March 1995.

In the years 1992 and 1993, banks' capital was constituted from retained earnings and cash from shareholders. However, in 1994, new money was injected from shareholders and investors, especially that the CBL permitted revaluation of banks' fixed assets, mainly property whose value was appreciated extremely since 1991. This revaluation was counted as part of the

capital, and helped the banks to meet the challenge of achieving 8% capital adequacy ratio (Zaki, 1995).

In 2004, Basel I was replaced by Basel II, and hence the Lebanese banks had to start preparing themselves for a new challenge; therefore, on April 2, 2004 Lebanon's Higher Basel II Committee met and decided to implement Basel II in Lebanon.

a. General Preparations

Lebanon started following closely the publications of Basel II since 2002. It hosted two regional conferences in 2002 and 2003 to follow the work of the Foreign Service Institute (FSI) for implementing Basel II. In this conference 22 Arab and Middle Eastern countries were invited and instructors from the Foreign Service Institute, International Monetary Fund, World Bank, Financial Services Authority and the Banking Control Commission attended too.

The members of the BCC continuously started participating in conferences to prepare the Lebanese banking sector for the implementation of Basel II. In addition to this, Lebanon tried to play a role in the development of related research in the Middle East region.

The Lebanese big banks with Lebanon's Bankers Association contributed to the consultative papers of the Basel Committee in order to help developing the research.

Lebanon was among the few countries whose supervisory authority underwent an initial assessment by the IMF in 1998 and this assessment was followed up again in March 2001 to make sure if Lebanon progressed in achieving the "Core Principles for Effective Banking Supervision". Other than this, Lebanon was also chosen to contribute to the change of the Core Principles for Effective Banking Supervision issued by the Basle Committee.

The monetary and supervisory authorities continuously followed up and prepared field surveys and empirical studies to ensure that banks and financial institutions are on the right track in applying Basel II. They made sure that 'Internal Audit', 'Corporate Governance' and 'Risk Management' are all incorporated in the institutions systems.

The BCC and the CBL cooperated and prepared statistical surveys since 2003 to prepare the banks and financial institutions of Lebanon for the application of Basel II. The aim of the surveys was to assess the effect of the application of Basel II on the capital adequacy of the banks in Lebanon. Consequently, the result of the surveys helped the authorities to identify the banks whose ratios would fall below the minimum required as a result of application of Basel II and to overcome this, the authorities set action plans (Awad, 2004).

b. Role of the Central Bank of Lebanon and Banking Control Commission

In August 2000, the BCC issued an important circular which set an action plan for banks to improve their Information Technology security. This was a very important step to deal with operational risks of the banks.

The CBL issued a circular in 2000 regarding internal control in Banks and financial institutions (F.I.). The CBL required from banks and financial institutions to establish internal systems to measure, monitor and control their risks. (Pillar I and II)

The CBL issued a circular in 2001 regarding Corporate Governance in Banks (Pillar II). It required from the board of directors to frequently participate in designing the strategy of the bank and should be fully responsible for the outcome.

The BCC issued a circular in 2001, enforcing the application of Internal Accounting Standards (I.A.S.). (Pillar III)

The BCC issued a circular on “Analyzing, managing, and processing Credit Risk in banks and financial Institution”. (Pillar I)

The CBL issued a circular which aimed at designing a general framework to solve non-performing loans (NPL) in banks and thus better manage Credit risk. (Pillar I)

The BCC issued a memo requiring the banks and financial institutions to report to BCC the list of their “Specialists in Risk management.” The aim of this memo was to make sure that banks and financial institutions really understand the importance of risk management function, and to find out if the financial sector lacks specialists in this area and hence plan trainings and to find out who is qualified to deal with the BCC and the Specialists in Lebanon and abroad.

The CBL issued a circular in 2004, stating the definition of Tier 1 and Tier 2 capital.

The BCC is continuously working to issue circulars regarding risk management, market risk and operational risk. Below is the summary of a few circulars relevant to this thesis’ purpose:

c. Basic Circulars

Implementing the Basel II Capital Adequacy Accord

In response to the international Basel agreement, the CBL issued its basic circular no. 104 regarding implementing the Basel II Capital Adequacy Accord.

The circular required from all the banks in Lebanon to implement Basel II accord and calculate their solvency ratio as of 1 January 2008. In addition to that, it required from the banks

to implement the standardized approach to calculate their credit risk, implement the Basic Indicator Approach to calculate their operational risk, start calculating their market risks as of 31 August 2007 and include in the solvency ratio as of 1 January 2008, take the approval of the CBL if the bank wishes to move from the above mentioned approach to other advanced approaches, prepare action plans which shall be approved by the BCC and apply the directions of Pillar III with respect to the rules of transparency and market discipline.

With respect to Lebanese banks which are affiliated to a banking or financial group registered in countries which apply Basel II Accord, the circular mentioned that the banks might implement the same approaches as their parent companies in calculating their solvency ratio. On the other hand, the Lebanese branches of foreign banks registered in countries which implement Basel II Accord must submit to the BCC annual reports issued by their head office on capital adequacy. However, if affiliation is in countries which are not implementing Basel II Accord, then the banks must follow the rules and regulations set by the CBL.

Finally, all the banks in Lebanon should appoint a Basel II Project Manager who should be a professional in risk management (BDL Circular, 2006).

Assessment of Bank Capital Adequacy

The Central Bank of Lebanon issued a basic circular no. 119 regarding the assessment of bank capital adequacy.

The circular confirmed in its first article that Pillar I and Pillar II shall be applied by the Lebanese banks and should be fully compliant with Basel II accord (Minimum Capital Requirements and Supervisory Review Process).

Other than Pillar I requirements, Executive Management of banks operating in Lebanon must:

- I. Prepare documents to the CBL which includes assessment of bank's capital adequacy, based on the nature and size of the bank and the variety and complexity of its banking operations and services, the nature and the type of the risks that the bank is exposed to and based on the future plans of the bank
- II. Conduct capital adequacy assessment based on the following:
 - a. Identifying, measuring, monitoring, and controlling risks which the bank is exposed to, namely:
 - i. Credit risk, market risk, and operational risk, these are the risks that should be covered through pillar I.
 - ii. Risks not addressed by Pillar I; interest rate risk, liquidity risk, reputational risk, business risk, strategic risk, and concentration risk.

The concentration risk is composed of the concentration risk of a single client or a single economic group, or of an economic sector or a specific geographical region, or concentration risks on a specific type of guarantees.

- b. Point out future capital requirements by focusing on:
 - The bank's future strategy (geographical expansion, service diversification)
 - The results of the stress tests that the bank must carry out in order to be able to assess its capital sensitivity and its ability to absorb losses during exceptional but possible events in the future.

The stress tests might include:

- Sensitivity analysis: stress testing each factor that effects the risks that the bank is exposed to; for example, fluctuation in interest rates
 - Scenario test, this test addresses the effect of changes that might occur in more than one factor; such as, a sudden decrease in interest rates and simultaneous liquidity shortage
 - Any comprehensive test that might be required from the banks
- c. Study the possibility of future risks and needs and plan accordingly. Prepare measures that might be needed to be taken if additional capital is needed in the future.
- d. Regularly verify bank's capital adequacy in order to keep the level in excess of the minimum requirements to be able to withstand sudden risks or negative fluctuations.
- III. The Internal Audit Unit of the bank should constantly make sure that the bank is complying with capital adequacy requirements and at least once a year shall hand in important proposals to the Board of Directors.

Additionally, the Board of Directors of all the banks operating in Lebanon must agree on the capital adequacy assessment mechanism, they must review regularly the mechanism of capital adequacy assessment and take corrective actions if the components require amendment due to changes in the bank's future plans. The Board must contain any new risk recognized in the mechanism of capital adequacy assessment program and make sure that the bank has efficient systems such as banking governance system, a risk management system, internal audit and control systems, to avoid bank losses.

The regular verification of bank's capital adequacy should be done by the BCC. The latter has to make sure that everything is on the right track by reviewing and evaluating the qualitative and quantitative components used in the mechanism.

The qualitative components include the bank's governance system, its risk management system, and internal audit and control systems; whereas, the quantitative elements include the calculation of required minimum capital level, which is compliant with Pillar I and II requirements.

The BCC might require from the bank to increase its own funds if it notices weaknesses in its qualitative and quantitative components (BDL Circular, 2008).

Corporate Governance

The Organization for Economic Cooperation and Development defines corporate governance as being "...a set of relationships between the company's management, its board, its shareholders, and other stakeholders." All the objectives of a financial institution are set based upon the structure provided by corporate governance. The achievement of these objectives and the institution's performance monitoring are also determined by corporate governance. Good corporate governance provides incentives for the management and the board to collaborate better and use the resources of the financial institution efficiently and hence achieves better results. The basic principles of corporate governance are: transparency, fairness, discipline, accountability and responsibility.

As the International Basel Committee issued a document in February 2006 regarding "Enhancing Corporate Governance for Banking Institutions", the central council of the CBL

decided in its meeting on July 12, 2006 to apply corporate governance in all the Lebanese banks. Consequently, the CBL issued a circular associated with corporate governance. The Basic Circular No. 106 is summarized as follows.

All the banks in Lebanon have to apply several principles regarding corporate governance. The Board of each bank should include persons who have solid knowledge about corporate governance. These persons must be able to set strategic objectives and corporate values and must have the power to efficiently communicate every incident to the staff and make sure that the objectives and the values are implemented within the institution. The Board must also identify the responsibilities and accountability rules and must guarantee that the Senior Management is the body which is monitoring the bank. The Senior Management includes the persons who are responsible for monitoring the daily business management, for example, chairman of the Board, General Manager, the assistants, the heads of main divisions and the officers responsible for specialized committees.

The Board must be the body responsible for ensuring that all the policies and activities applied by the staff are completely coherent with the bank's objectives, strategy, and its culture.

The Board and the Senior Management must make sure that the bank's operational structure does not face problems of transparency and together they must efficiently use the outcomes achieved by the internal audit unit, the internal control bodies, and the auditors.

The role of the internal audit is stressed in the circular. The internal audit unit must ensure that the corporate governance principles are well implemented at all the bank's levels. The unit must assess the regulations of corporate governance and by complete monitoring all the activities

of the bank at all the levels, must be able to state if corporate governance is adequately, efficiently and effectively applied within the institution. Finally, the unit must give a priority to the implementation of corporate governance regulations for banks that have expanded geographically to avoid divergence in organizational structure within the group (BDL Circular, 2006).

Internal Control of Banks

In 1998, the Basel Committee on Banking Supervision stressed the importance of the existence of Internal Control Systems in Banks. Therefore, to be compliant with international standards, the CBL issued the circular No. 77 related to the internal control of banks.

The circular states that all the banks operating in Lebanon must have an internal audit unit. The unit must not have executive responsibilities and must be thoroughly independent from the bank's operational management. The Board of the banks shall assign the Unit Chief whose name should be reported to the BCC.

The internal audit unit is responsible for guaranteeing that the banks in Lebanon are applying all the rules and regulations set by the governing bodies. The unit must make sure that the financial activities and statements are accurate and fully implement the procedures and special attention shall be given to money laundering.

The unit must also prepare reports at least twice per year regarding its evaluations and these reports should be given to the bank's Board of Directors or branch managers of foreign banks. These reports should be analyzed in special meetings.

In some instances, banks can assign external specialized firm to perform the task of the internal audit unit. This is possible on condition that the firm must abide by banking secrecy and must not have any relationship with the bank's auditors.

The implementation of this circular required from the banks establishment of different kinds of systems, such as, a system for risk control, information and documentation, a system for assessing quality of assets and risks and their consequences, a system for accounting and financial statements and reports and a system for monitoring internal operations and procedures.

Twice per year, the auditors of the bank must prepare reports regarding the extent of application of the circular no. 77 within the bank. This report must state if the implementation of the internal control systems is efficient or not; and if not, recommendations for improvement should be mentioned (BDL Circular, 2000).

Banks and Credit Rating Agencies

The basic circular no. 108 to banks is related to the relationship between the banks and credit rating agencies.

Banks in Lebanon shall follow the criteria, summarized below, prepared by the Basel II agreement regarding assigning the client's credit risk weights.

The credit rating agency must not have any kind of relationship with the client to avoid biased ratings. The ratings shall be available to any of the agency's actual and potential users in the domestic or global markets. The rating approaches must be clear to any of the group's actual and potential users in the domestic and global markets. The rating approach must be sound, vigorous and verifiable and to achieve this, the agency must do a complete analysis about the

client's file and must make sure that the adopted rating categories reflect the true risk of the client. The ratings by the agency must be updated whenever there's the need. The rating agency must have good human capital and technical resources in order to have a solid ground for its final decisions. Finally, the credibility of the credit rating agencies is very essential, and it all depends on the above mentioned criteria application.

Circular no. 108 prohibited the Lebanese banks to deal with agencies who don't apply the criteria set by the Basel II agreement. In addition to this, banks are allowed to deal with more than one agency, but under these circumstances, the final rating of the client will be based on the lowest rating provided by the agencies. Finally, there should be no relationship between the bank and the rating agencies whether directly or through a third party (BDL Circular, 2007).

Credit Risk Mitigation Techniques

The credit risk mitigation techniques that are acceptable to be adopted by the Lebanese banks are addressed in the circular no. 121 issued by the CBL.

The circular states that the banks who will apply the standardized approach in credit risk calculation, under Pillar I, can adopt one of the three credit risk mitigation techniques: eligible financial guarantees, or clearance operations in the balance sheet between assets and liabilities or eligible guarantees provided by counterparties, and credit derivatives to be specified in detail by the BCC.

Banks should hedge against the risks that might arise from the usage of the techniques mentioned above and must set suitable procedures to manage the risks. If the procedures are not

suitable to hedge these risks, then the central council might require from the bank to increase its equity capital, and this is in parallel to applying the Pillar II requirement.

The circular stated that the credit protection is not considered eligible as a credit risk mitigation technique in case there is a positive correlation between the borrowing client's risk exposure and risks associated with the submitted credit protection (guarantee, warranty or credit derivative...for instance, when the borrowing company submits to the bank shares from its stock as a financial guarantee against its indebtedness). Regarding real estate, the circular mentioned that banks can still use real estate as a risk mitigation tool for credit risk

The circular stated that if there is a difference between the currency of the debt and that of the credit protection, the value of the protection should be decreased by a fixed haircut of 8%

Finally, the last article was about the net-non-performing loans which must carry 100% weighting if they are not consistent with Basel II Accord and also deductions of provisions shall not be less than 15% of the given loan's total value (BDL Circular, 2009).

Operations relating to credit, investment, shareholding and participation

The CBL issued its basic circular no. 81 to banks and financial institutions titled "operations relating to credit, investment, shareholding and participation."

All the banks operating in Lebanon that will grant credits, invest in liquid assets or real estate, operate on their own account regarding structured or derived financial instruments must take the approval of specialized committees established by the Board of Directors of each bank which assigns the members of the committees.

The role of the specialized committees is essential. The committee must describe clearly the characteristics and types of the above mentioned operations, guarantee that these operations don't increase the risk of the bank, perform stress tests to analyze the economic feasibility of the operations in terms of future returns, make sure that all the activities abide by the rules and regulations set by the CBL and BCC, analyze the bank's credit risk exposure and set the ceilings and restrictions to make sure that the risk is well diversified and balanced between the operations. Finally, the committee shall prepare reports and regularly keep the Board up-to-date.

The total credits granted by banks to related parties must not be greater than 5% of the bank's shareholder's equity. Additionally, the circular mentioned that the banks in Lebanon can grant only term loans to their clients or provide facilities for them to finance their fixed assets, such as, real estate, equipment or any kinds of fixed assets. These facilities are given after revising the economic feasibility of the project to be financed and the client's financial situation. Additionally, current account facilities could be granted only if the purpose of the credit is to finance current operations or operations related to working capital. The circular defined the working capital to be: the sum of stock and advances paid to suppliers, clients, various receivables and charges computed in advance less (advances allocated from clients, suppliers, various payables and revenues computed in advance) (BDL Circular, 2001).

D. Key challenges for implementing Basel II

The implementation of Basel II was not an easy task for the Lebanese banks. It's true that according to Basel I the Lebanese banks had high liquidity ratios, yet Basel II incorporated many changes in its structure and the Lebanese banks had to abide by the new rules and regulations.

Lebanese banks faced many obstacles in the implementation process. Most of the banks in Lebanon are family owned except for banks in peer group 1. 90% of banks equity is tier one which means they have a weak capital structure. The capital market is small and underdeveloped. The management quality between groups of banks differed. Even the quality differed among the banks in the same group. The new banking activities and the new modern management techniques required professional skills. Lebanon lacked the local skills and the outside skills were too costly. Lebanon doesn't have a rating agency in the country. The sovereign risk of the country is low rated (B⁻). The availability and accuracy of data is limited. And finally, the Lebanese banks had high dollarization (Foreign Currency) which influences asset weightings

Additionally, to implement Basel II, the banks have to open their capital to the public, they should work to improve corporate governance practices and introduce new risk management techniques; develop expertise in the BCC and the industry; cooperate and communicate regularly with different supervisory bodies in the region; work hard with regional and international firms to set certain criteria which will facilitate the formation of local rating agencies and form alliances with regional capital markets to help the development of the Lebanese stock exchange (Awad, 2006).

Despite all the obstacles, as of November 2008, the Lebanese banks abided by the first and second pillars of Basel II and the compliance with the third pillar is on the way (Bertelsmann, 2009).

The Lebanese banking sector enjoys transparency and is consistent with international norms. The banks in Lebanon apply BIS standards. The BCC, in September 2010, required the banks and financial institutions to fully implement the International Financial Reporting

Standards (IFRS) as of Jan. 1, 2011. The Lebanese banking sector reached a high capital adequacy ratio in 2010, 13.7% far away from the required 8% by the Basel II. The Lebanese banking sector complies with Pillar I and II. As for Pillar III, the bank of Lebanon and the BCC will continue their efforts by issuing new circulars, so that the Lebanese banks comply with Pillar III and IFRS in 2011. In addition to this, a new committee is formed in Lebanon so that they follow the updates regarding the Basel II requirements. Moreover, Lebanon has improved in its compliance to several core recommendations. It was upgraded from “partially compliance” to “largely compliant” on different core recommendations; including timely feedback by Lebanon’s Financial Intelligence Unit (FIU) (“U.S. Department,” 2011).

Finally, as mentioned above, Lebanese banks face no problems in achieving the minimum requirements set by the Basel Committee on Banking Supervision. Therefore, the concern is not whether the Lebanese banks are compliant with the international rules and regulations but how strong are the financial ratios of the Lebanese banks in case of sudden unexpected losses. To have an explanation to this concern, this thesis performs stress testing on a sample of Lebanese banks to test their immunity against possible future losses.

IV. Empirical Study

In order to do stress testing a theoretical model for banks is needed. The theoretical model that is selected is the Black-Scholes (1973) model as modified by Merton (1974). From this model, which is described below, three general stress testing procedures are performed:

1. Stress testing to changes in the equity variance. Banks have control on this variance because they can choose the riskiness of their portfolio of assets.
2. Stress testing to crashes in equity prices that occur unexpectedly.
3. Stress testing by using the VaR methodology which is a common measure of potential loss in adverse conditions.

These stress tests will allow the determination of changes in the probability of default, in the total assets of the bank, in the capital to assets ratio, and in market debt and debt variance. It is essential to mention that Basel II requires from the banks to calculate the probability of default which is an important parameter used in capital adequacy and regulatory capital rules.

Throughout the empirical study, the importance of equity prices will be obvious. The stress testing of Lebanese banks and the statistical outputs obtained in this thesis are the result of several inputs, among which the equity prices.

The Black-Scholes formula, which was modified by Merton in 1974, is the model adopted in this thesis. The reason why this model is adopted will be thoroughly explained in the next section.

The Black-Scholes-Merton Model

Fisher Black and Myron Scholes presented a formula in the early 1970s to calculate a price of an option.

In 1974, Robert Merton modified the Black-Scholes formula and proposed a model where a company's equity is an option on the assets of the company. This major breakthrough achieved by Black-Scholes-Merton in pricing of stock options was recognized in 1997, when they were awarded the Nobel Prize for economics.

In order to clarify how the equity of a bank in this thesis is regarded as an option on the assets of the bank, a brief explanation of the mechanics of options market is a must.

In the mechanics of options market, the calculation of the option payoff is important. For a call option, which gives the holder the right to buy an asset by a certain date for a certain price, the payoff is the maximum of either the underlying price minus strike price or 0, i.e., $\max [S_T - K, 0]$. For a put option, which gives the holder the right to sell an asset by a certain date for a certain price, the payoff is the maximum of either the strike price minus underlying price or 0, i.e., $\max [K - S_T, 0]$.

Robert Merton, in his proposed model explains that the value of the equity of a company, a bank in this case, could be derived from the Black-Scholes formula. For simplicity he assumes that a bank has zero-coupon bond outstanding which matures at time T .

He explains that at time T , if the value of the assets of the bank is less than the amount of debt interest and principal due to be repaid, then the bank will definitely default. However, if the opposite is true, then the company will be able to repay its debt at time T , and the value of the

company's equity will be equal to the difference between the value of its assets at time T minus the amount of debt interest and principal paid at time T. Therefore, Merton's model states that the value of the firm's equity at time T is $E_T = \max(V_T - D, 0)$ where E_T is the value of the equity at time T, V_T is the value of the assets at time T and D is the amount of debt interest and principal due to be repaid at time T.

Comparing the value of the firm's equity at time T with the payoff obtained from the call options mechanics above, it is obvious that the two are closely related to each other. This relationship shows that the equity of a bank is a call option on the value of the assets of the bank, and its strike price is equal to the repayment required on debt.

Based on this conclusion, this thesis adopts Merton's proposed model for stress testing of Lebanese banks. And the above relationship clearly explains why, hereafter, the equity of the Lebanese banks is considered as options on their assets and hence the Black-Scholes-Merton option pricing model is used.

The Black-Scholes-Merton formula states that the value of the bank's equity today is:

$$E_0 = V_0 N(d_1) - D e^{-rT} N(d_2) \quad (1)$$

Where,

$$d_1 = \frac{\ln\left(\frac{V_0}{D}\right) + \left(r + \frac{\sigma_v^2}{2}\right)T}{\sigma_v \sqrt{T}} \quad (2)$$

$$d_2 = d_1 - \sigma_v \sqrt{T} \quad (3)$$

The function $N(x)$ is the cumulative probability distribution function of the standard normal distribution. That is the probability that a variable, which follows a standard normal distribution, will be less than x . It is also the area under the normal curve up to x . V_0 is the value of the bank's assets today, D is the amount of debt interest and principal due to be repaid at time T , r is the risk free rate and σ_v is the volatility of the bank's assets. The risk neutral probability that the bank will default on the debt is $N(-d_2)$ (Hull, 2010).

In order to calculate the impact of changes, V_0 and σ_v should be known. However, for banks, both of the figures are unknown. E_0 could be observed if banks are publicly traded only. For this reason, and for the purpose of the empirical study, four Lebanese banks are chosen. The sample of the banks includes only those banks in Lebanon whose stocks are listed on the Beirut Stock Exchange market. The banks are the following: Bank Audi, Blom Bank, Byblos Bank, and BEMO Bank.

Based on the above equations, there are two unknowns V_0 and σ_v and another equation is a must to solve the two equations simultaneously. From Ito's lemma, we have

$$\sigma_E E_0 = \frac{\partial E}{\partial V} \sigma_v V_0 \quad (4)$$

But, $\frac{\partial E}{\partial V}$ is the delta of the equity which is equal to $N(d_1)$ and hence

$$\sigma_E E_0 = N(d_1) \sigma_v V_0 \quad (5)$$

σ_E being the volatility of equity.

Comparing equations (1) and (5), there are two estimates which are unknown V_0 and σ_v and since the two equations are nonlinear equations of the form $F(x,y)=0$ and $G(x,y)=0$, the

Solver routine in Excel is used to find the values of x and y , V_0 and σ_v in this case, which will minimize $[F(x,y)]^2 + [G(x,y)]^2$. To find, $[F(x,y)]^2 + [G(x,y)]^2$, the following is illustrated:

From equation (1), equation (6) is derived:

$$F(V_0, \sigma_v) = [E_0 - V_0 N(d_1) + De^{-rT} N(d_2)] \quad (6)$$

From equation (5), equation (7) is derived:

$$G(V_0, \sigma_v) = \sigma_v E_0 - N(d_1) \sigma_v V_0 \quad (7)$$

Therefore, as mentioned above, the Solver routine in Excel is used to minimize:

$$[F(V_0, \sigma_v)]^2 + [G(V_0, \sigma_v)]^2 \quad (8)$$

Data Collection

Prior to proceeding with the simulation of the Solver routine in Excel, data collection is a must. The four main inputs of the adopted model are: the market value of bank equity, standard deviation of returns on equity, average rate of interest on deposits, and the future value of deposits. Each of these inputs had to be calculated in order to use the solver in Excel to find out the two unknowns: Value of the assets of the bank today and the volatility of the assets.

As a first step, daily stock prices of each of the sampled banks are extracted from the Beirut Stock Exchange. The available stock prices of each of the banks are from 29 July 2003 to 26 November 2010 except for BLOM bank whose daily stock prices could be obtained only from 24 August 2006 because prior to that date BLOM bank's stock prices were not listed on the Beirut Stock Exchange. Additionally, Bank Audi's stock price information was not available

during the period February 2005 to October 2006 because Bank Audi had delisted its shares during that period (“Bank Audi SAL,” 2005).

After the daily stock prices were obtained, the daily percentage changes of the stock prices are calculated to compute the return on equity figure. However, a problem arose with the daily stock prices, since the prices of the stocks on Beirut Stock Exchange don't fluctuate much from day to day and they remain constant over an extended period of time. This implies that the daily stock returns calculated resulted in many zeros for these days and this is not acceptable since the calculation of the standard deviation would be biased. Consequently, the prices were converted from a daily frequency into a monthly frequency. Other than this obstacle, the number of open days of Beirut Stock Exchange market fluctuated highly for each year and this was not acceptable as well since the opening days should be consistent for each year. After revising the data and based on a yearly calendar obtained from a bank, an accurate set of data was obtained and was ready to proceed with the rest of the calculations.

It's essential to note that, hereafter, the observation and hypothesis tests will be based on four banks. The two banks, BLC and Bank of Beirut are excluded. The first is excluded because the monthly percentage change in its equity prices resulted oftentimes in zeros since the stock prices didn't fluctuate much. Whereas, Bank of Beirut is excluded since it had very few observations and regression analysis could not be performed.

Market Value of Bank Equity

The market value of bank equity is not a published data. This value could be obtained only for those banks that have shares listed on the Beirut Stock Exchange. For this purpose, as

mentioned previously, the sampled banks are those banks in Lebanon whose shares are listed on the Beirut Stock Exchange.

The market value of each of the sampled banks is calculated step by step:

1. The number of common shares outstanding is obtained for each bank for the year 2009 (Baz 2010)
2. The yearly closing price per share is obtained for the common shares outstanding for all the banks for the year 2009 (BSE)
3. The closing prices obtained were converted from dollar currency to the Lebanese pound currency based on the prevailing exchange rate during that period

The above three figures are multiplied and the market value of each bank's equity in Lebanese Pound is obtained. However, since based on Basel II rules and regulations preferred shares are part of bank's Tier 1 capital, the value of the preferred shares is included, if available, in the market value of bank equity.

Consequently, the same steps are followed to obtain the value of the preferred shares of each bank. Finally, the market value of each bank's equity is computed by adding the value of common shares and the preferred shares together.

Since the maturity of the model is one year and for the purpose of stress testing of Lebanese banks based on recent data, hereafter, the thesis' calculation is based on the year 2009.

The Average Rate of Interest on Deposits

The average rate of interest on deposits, which is an important part in the model, is computed by referring to the consolidated balances of all commercial banks for the year 2009. It's important to mention that the balances include deposits in LBP and deposits in foreign currencies. Therefore, to calculate the average rate of interest on deposits, deposits in LBP are multiplied by the weighted average rate on LBP deposits for commercial banks (BDL) and the deposits in foreign currencies are multiplied by the weighted average rate on USD deposits for commercial banks. Hence, the average rate of interest on deposits is computed based on the following formula:

$$\frac{i(d) * Deposits\ in\ LBP + i(f) * Deposits\ in\ USD}{Deposits\ in\ LBP + Deposits\ in\ USD} \quad (9)$$

Where, $i(d)$ is the weighted average rate on LBP deposits and $i(f)$ is the weighted average rate on USD deposits.

The thesis assumes that all foreign currency deposits are in US dollar. This is an assumption which is approximately true for Lebanese banks.

Standard Deviation of Returns on Equity

The monthly stock prices per share for each of the sampled banks constitute the sample size. Since the sample size is greater than 30, the central limit theorem allows assuming that the sampled population is approximately normal.

After this assumption, inferences about the population's variability, which is the

population variance σ^2 , should be drawn. The test statistic used to test hypothesis about σ^2 is:

$$X^2 = \frac{(n - 1)s^2}{\sigma^2} \quad (10)$$

Which is chi-squared distribution with degrees of freedom, $\nu = n - 1$, when the population random variable is normally distributed with variance equal to σ^2 and n is the sample size.

From equation 10, the confidence interval estimator of the population variance is derived; the lower confidence limit (LCL) and the upper confidence limit (UCL). The upper and lower critical values of chi-squared distribution with ν degrees of freedom is obtained from the table below:

X² (critical)		Lower Critical Values	Upper Critical Values
		1- α =0.99	1- α =0.99
Banks	Degrees of Freedom	1-α=0.90	1-α=0.90
BLOM	49	27.95	78.23
		33.93	66.34
BEMO	87	56.78	124.72
		66.5	109.77
Byblos	87	56.78	124.72
		66.5	109.77
Audi	41	21.42	68.05
		27.33	56.94

Two confidence levels are taken into consideration, 90% and 99% for the critical values.

The LCL and UCL are calculated based on the following formulas:

$$LCL = \frac{(n - 1)s^2}{X^2 \alpha / 2} \quad (11)$$

$$UCL = \frac{(n-1)s^2}{\chi^2_{1-\alpha/2}}$$

(12)

The standard deviations of percentage change in monthly prices per share for each of the banks are on a monthly basis. However, since the maturity of the simulation is 1 year, the monthly standard deviations are converted to an annual standard deviation by assuming that the stock returns are independently distributed based on the following formula:

$$\text{annual variance} = 12 \times \text{monthly variance}$$

(13)

Where, 12 is the number of the months in a year.

Taking the square root on both sides of the equation, the below formula is deduced and adopted in converting the monthly standard deviations to annual standard deviations.

$$\sigma(\text{yearly}) = \sigma(\text{monthly}) \times \sqrt{12}$$

(14)

After the calculation of the yearly standard deviations, the upper and lower confidence intervals are recalculated based on 99% confidence level. These are shown in the table below:

Banks	N(observations)	σ Monthly	UCL(Yearly) (1- α =0.99)	LCL(Yearly) (1- α =0.99)
		σ Yearly		
BLOM	50	0.067810298	0.3110236	0.1859078
		0.2349018		
BEMO	88	0.089551987	0.383997	0.259094
		0.3102172		
BYBLOS	88	0.109387743	0.4690522	0.3164833
		0.3789303		
AUDI	42	0.089869566	0.4307105	0.24164685
		0.3113173		

It's of high importance to mention that when the value of the preferred stock is added to the equity (the reason is justified in the next paragraph), the standard deviation of the equity is adjusted because the price of preferred shares don't fluctuate much relative to equity. The adjustment is done only for the yearly standard deviations, since this is the maturity of the simulation.

The adjustment of the standard deviation of equity is done based on the following formula:

$$\left(\frac{\sigma \times E}{E + PS} \right) \quad (15)$$

Where E is the value of the equity, σ is the standard deviation of the equity, and PS is the value of the preferred shares.

The adjusted lower and upper confidence intervals are shown in the below table:

Bank	UCL (yearly) (1- α =0.99)	LCL (yearly) (1- α =0.99)
BLOM	0.163954104	0.282365402
BEMO	0.199186992	0.302764228
BYBLOS	0.213541764	0.316868424
AUDI	0.229644099	0.411445677

Future Value of Deposits

The last input in the model required the calculation of total deposits of each bank. The deposits represent the debt that the bank has since the deposits are liabilities to the bank. From the balance sheet of each bank, the total deposit for the year 2009 is calculated. The total deposit of each bank is composed of: deposits from central bank, deposit from banks and financial

institutions, deposits from customers, engagement by acceptances, other liabilities, regularization accounts and miscellaneous creditor accounts, provisions for risks and charges, and liabilities under financial instruments (Baz, 2010).

Based on the model, the future value of the debt that the bank is currently holding had to be calculated and hence the required value is calculated by using the following formula:

$$\text{Future Value of deposits} = \text{Deposits}_{t=0} e^{rT} \quad (16)$$

Where r is the average rate of interest on deposits (calculated above) and T is the maturity of the simulation which is 1 year.

As previously noted, given that under Basel II regulations, preferred shares are part of bank's Tier one capital, the value of the preferred shares is added to the value of common shares outstanding to obtain the market value of each bank. However, it's a fact that preferred shares are considered debts too, so to be accurate in the simulation the value of the preferred shares is added to the value of the deposits calculated above.

In summary, the Solver simulation is based on two scenarios. Once where the value of preferred shares is added to the deposits and once where the value of preferred shares is added to the value of common shares outstanding.

Solver Simulation

The two unknowns, V_0 and σ_v , could be obtained by using the Solver routine in excel which would minimize:

$$[F(V_0, \sigma_v)]^2 + [G(V_0, \sigma_v)]^2 \quad (17)$$

The optimization model has three parts: the target cell, the changing cells and the constraint.

The target cell of the model is the objective: minimize the value of V_0 and σ_v , by changing the value of total assets and standard deviation of total assets and subject to one constraint: the value of standard deviation of total assets should be greater than 0.

The model has two estimations as noted previously. The first is when the value of the preferred shares is added to the value of the total deposits. And second when the value of the preferred shares is added to the market value of the bank equity.

To proceed with the simulation of the model's first estimation, each bank is taken separately. To run the simulation, four of the inputs were fixed: the market value of bank equity, the average rate of interest on deposits, the future value of deposits and the maturity of the model. The solver routine is run by changing the value of the standard deviation by increments of 0.01 or 1% based on its confidence interval from the lower limit to its upper limit.

It's important to mention that the target's cell solution is very sensitive to the starting values, so the value of the total assets and the volatility of the assets required manual adjustments on Excel so that the solution can converge.

Once the solution converged, the relationship between the change in the standard deviations of returns on equity and probability of default, capital to assets ratio, total assets, market debt and standard deviation of debt is assessed.

The values were extracted to find the relationship of each pair for each bank separately. Consequently, the scatter diagrams are drawn which included the best fitted line, the estimate of the equation and the R-square. (Appendix 1)

Scatter Diagrams

For the purpose of analyzing the relationship between each pair of the variables, and for each simulation separately, scatter diagrams are drawn. The aim is to find the line that best predicts the dependent variable from the independent variable.

For each bank, the scatter diagrams are drawn to analyze the relationship between the standard deviation of returns on equity versus: probability of default, standard deviation of debt, capital to assets ratio, market debt and total assets. The drawings of the scatter diagrams are also based on two scenarios. Once when the value of preferred shares is added to the deposits and once when the value of the preferred shares is added to the value of the equity.

Appendix 1 includes the scatter diagrams of the banks when the value of the preferred shares is added to the deposits. From the scatter diagrams of Bank Audi, for example, a conclusion is reached that there is no linear relationship between the pairs. The relationship between the pairs shows that the best fit line is not a straight line, but it's a curve and a parabola in most of the cases.

The R-squared in each graph is the coefficient of determination, which is the statistical measure of how well the regression line approximates the real data points. The closer the value to 1, it means that the line perfectly fits the data. The closer the figure to 0, it means that the line doesn't fit the data. For example, in figure (1a), the R-squared for the relationship between the standard deviations of returns on equity and probability of default is 0.7481; this means that

74.81% of the variability in capital to assets is explained by the standard deviations of returns on equity. This means that a good percentage of the original variability is explained.

Appendix 2 includes the scatter diagrams when the value of the preferred shares is added to the value of the equity. All the scatter diagrams for all the banks have the same shape as Appendix 1. Hence, the conclusion is that the relationship between the pairs is not linear.

The conclusion that the relationship between the pairs is not linear is valid for all the sampled banks and for the two scenarios; therefore, non-linear or quadratic regression is run to test for the relationship between the pairs.

Stress Testing to Changes in the Equity Variance

As a first step, stress testing to changes in the equity variance is performed. The importance of this test lies in the concept that banks have control on this variance because they can choose the riskiness of their portfolio of assets.

To perform stress testing to changes in the equity variance, Eviews 7.1 is adopted, the statistical package, to run a non-linear or quadratic regression. The reason why this type of a regression analysis is run is because a conclusion is drawn from the scatter diagrams that the relationship between the variables is non-linear.

Stress testing to changes in the equity variance is done for each bank separately and based on two scenarios, once when the value of the preferred shares is added to deposits and once when the value of preferred shares is added to the market value of bank equity.

The relationship between the independent variables and the dependent variables is tested in each scenario.

The independent variables are the standard deviation of returns on equity and the square of the standard deviation of returns on equity. The dependant variables are: capital to assets ratio, total assets, probability of default, market debt and standard deviation of debt. Therefore, a non-linear regression is run for the independent variables versus each of the dependant variables.

Below is the analysis of the results of the regression output for each bank under the two different scenarios and the conclusions derived.

Bank Audi

First Scenario: value of preferred shares added to deposits

Under scenario one, five regression analyses are done to assess the relationship between the independent variables of Bank Audi and the dependent variables.

Each of the regression outputs is analyzed separately to assess the relationship between the standard deviation of returns on equity and its square and capital to assets ratio.

The following conclusions are derived from the findings of the table below:

Table 1 Regression of Capital to Assets Ratio on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Capital to Assets Ratio		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	0.104625	24848.23	0.0000
SD	-0.000298	-11.63521	0.0000
SD ²	0.000517	13.53963	0.0000
Adjusted R-squared	0.976103		
Prob (F-statistic)	0.0000		

Table 1 depicts the dependent variable to be the capital to assets ratio; whereas, the independent variables are the standard deviation of returns on equity (SD) and the square of

standard deviation of returns on equity (SD^2). The presence of a squared function explains that the best fitted line is a parabola, concluded from the scatter diagrams, and hence a quadratic curve is estimated. The presence of a squared function is also helpful in drawing conclusions regarding the existence of a minimum or a maximum depending on the signs of the estimated coefficients.

The positive sign of the estimated coefficient of SD^2 shows that there is a minimum in the relationship. Therefore, it's very important to calculate the value of the standard deviation of equity of Bank Audi where it will have the minimum capital to assets ratio. For this purpose, the following equation is obtained from table 1:

$$Y = 0.104625 - 0.000298SD + 0.000517SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2882. This means that the minimum capital to assets ratio occur when the standard deviation of returns on equity of Bank Audi is 0.2882. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The coefficient of C is the constant or the intercept in the regression; this means that if the standard deviation of returns on equity of Bank Audi reaches value 0, then the capital to assets ratio will be equal to 0.104625.

In the third and fourth columns of Table 1, the t-Statistic and P values of each variable are presented. These values are essential to the analysis because the null hypothesis will either be rejected or accepted based on the findings.

The null hypothesis states that each of the variables in the table has a coefficient equal to 0. In other words, it states that the independent variable has absolutely no effect on the dependent

variable (coefficient=0). To accept or reject this hypothesis, the values of t-Statistic or P values are studied. The rule of thumb says that if $-2 > t\text{-Statistic} > 2$, the null hypothesis is rejected. As for P, if a significance level of 5% is taken, which is the case, then to reject the null hypothesis the value of P should be less than 5%.

Whether the values of t-Statistic or P values are looked at for all the variables, the null hypothesis is rejected in the regression. Hence, the standard deviation of returns on equity can not be dropped out of the equation since its coefficient is different from 0 and thus there is a relationship between the dependent and the independent variables.

After confirming the existence of a relationship between the dependent and the independent variables, another statistic from table 1 is explained, adjusted R-squared. R-squared is a measure of goodness of fit. The value of R-squared shows how well the regression was able to predict the values of the dependent variable within the sample. The closer the value to 1, the better the prediction. However, due to certain limitations of R-squared, another measure of goodness of fit is studied which is adjusted R-squared. The adjusted R-squared penalizes the R-squared for the addition of regressors which don't contribute to the explanatory power of the model. From table 1, the value of adjusted R-squared is 0.976103 which means that 97.61% of variation in capital to assets ratio is explained by the variation in standard deviation of returns on equity and its square after adjusting the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is the last number in table 1. Based on its value, the hypothesis that the regression model is significant or not is either rejected or accepted. It tests for the success of the regression model. The null hypothesis applies for the whole model in this case and states that all slope coefficients are equal to 0. To accept or reject the null hypothesis the value of prob (F-

statistics) is studied. The above rule also applies for the whole model. If the value of Prob (F-statistic) <5%, the null hypothesis is rejected. Therefore, since Prob (F-statistic) is 0.0001, the null hypothesis is rejected and the conclusion is that the regression model is significant.

After the above conclusions, it is essential to test for heteroskedasticity. Glejser test is the test that is used to test for heteroskedasticity. The test is performed by regressing the absolute values of residuals from the main regression equation on the independent variables, which is in this case, the standard deviation of returns on equity and the square of the standard deviation of returns on equity. Hereafter, the Glejser test is the heteroskedasticity test adopted in this thesis.

Table 2 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.18
Obs*R-squared	Prob. Chi-Square (2)	0.1609
Scaled explained SS	Prob. Chi-Square (2)	0.334

From table 2, since the P values are greater than 0.05, the conclusion is that heteroskedasticity is absent. The null hypothesis states that homoskedasticity exists. Whereas, the alternate hypothesis states that heteroskedasticity exists. Since P values are greater than 0.05, the null hypothesis is not rejected, and hence conclude that there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.1609.

To avoid repetition of detailed explanation, hereafter, the figures of the tables are analyzed directly.

The relationship between total assets and standard deviation of total assets is analyzed by referring to table 3.

Table 3 Regression of Total Assets on Standard Deviation of Returns on Equity and the Square of the Standard Deviation of Returns on Equity

Dependent Variable:	Total Assets		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	4.109925	24848.07	0.0000
SD	0.011709	11.61865	0.0000
SD ²	-0.020281	-13.52381	0.0000
Adjusted R-squared	0.976106		
Prob (F-statistic)	0.0000		

The dependent variable is the total assets, whereas, the independent variables are the standard deviation of returns on equity (SD) and the square of standard deviation of returns on equity (SD²). SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.020281) shows that there is a maximum in the relationship. To find out the maximum, the following equation is obtained from table 3:

$$Y = 4.109925 + 0.011709SD - 0.020281SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2887. This means that the maximum total assets occur when the standard deviation of returns on equity of Bank Audi is 0.2887. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, the null hypothesis that each of the variables in the table has a coefficient equal to 0 is rejected. Hence, there is a significant relationship between the variables.

The value of adjusted R-squared is 0.976106 which means that 97.61% of variation in total assets is explained by the variation in standard deviation of returns on equity and its square

after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the null hypothesis is rejected and the conclusion is that the regression model is significant.

Table 4 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.1891
Obs*R-squared	Prob. Chi-Square (2)	0.1688
Scaled explained SS	Prob. Chi-Square (2)	0.347

From table 4, since the P values are greater than 0.05, the null hypothesis is failed to be rejected, and hence conclude that there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.1688.

Third, the relationship between standard deviation of returns on equity and its square and probability of default is analyzed by referring to table 5 below:

Table 5 Regression of Probability of Default on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Probability of Default		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	0.02671	13.7517	0.0000
SD	-0.191436	-16.17722	0.0000
SD ²	0.341151	19.37205	0.0000
Adjusted R-squared	0.990851		
Prob (F-statistic)	0.0000		

The dependent variable is the probability of default, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.341151) shows that

there is a minimum in the relationship. To find out the minimum, the following equation is derived from the above table:

$$Y = 0.026710 - 0.191436SD + 0.341151SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2806. This means that the minimum probability of default occur when the standard deviation of returns on equity of Bank Audi is 0.2806. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, the null hypothesis that each of the variables in the table has a coefficient equal to 0 is rejected. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.990851 which means that 99.08% of variation in probability of default is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a very high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, the null hypothesis is rejected and the conclusion is that the regression model is significant.

To test for heteroskedasticity, refer to the table below:

Table 6 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.2769
Obs*R-squared	Prob. Chi-Square (2)	0.2461
Scaled explained SS	Prob. Chi-Square (2)	0.4519

From table 6, since the P values are greater than 0.05, the null hypothesis is failed to be rejected, and hence conclude that there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.2461.

Fourth, the relationship between the standard deviation of returns on equity and the square of standard deviation of returns on equity and market debt is analyzed by referring to the table below:

Table 7 Regression of Market Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Market Debt		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	3.679925	22247.17	0.0000
SD	0.011711	11.62061	0.0000
SD ²	-0.020285	-13.52574	0.0000
Adjusted R-squared	0.976106		
Prob (F-statistic)	0.0000		

The dependent variable is the market debt, whereas, the independent variable is the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.020285) shows that there is a maximum in the relationship. To find out the maximum, the following equation is derived:

$$Y = 3.679925 + 0.011711SD - 0.020285SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2887. This means that the maximum market debt occur when the standard deviation of returns on equity of Bank Audi is 0.2887. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, the null hypothesis that each of the variables in the table has a coefficient equal to 0 is rejected. Hence, there is a significant relationship between the variables.

The value of adjusted R-squared is 0.976106 which means that 97.61% of variation in market debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, the null hypothesis is rejected and the conclusion is that the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 8 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.1881
Obs*R-squared	Prob. Chi-Square (2)	0.1679
Scaled explained SS	Prob. Chi-Square (2)	0.3457

The P values are greater than 0.05. Therefore, the null hypothesis is failed to be rejected, and hence conclude that there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.1679.

Finally, the relationship between the standard deviation of returns on equity and its square and standard deviation of debt is assessed by referring to table 9.

Table 9 Regression of Standard Deviation of Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Standard Deviation of Debt		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	0.001302	11.22885	0.0000
SD	-0.009191	-13.01256	0.0000
SD ²	0.016093	15.30965	0.0000
Adjusted R-squared	0.983021		
Prob (F-statistic)	0.0000		

The dependent variable is the standard deviation of debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable. The positive sign of its estimated coefficient (0.016093) shows that there is a minimum in the relationship. To find out the minimum, the following equation is derived from the above table:

$$Y = 0.001302 - 0.009191SD + 0.016093SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2856. This means that the minimum standard deviation of debt occur when the standard deviation of returns on equity of Bank Audi is 0.2856. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, the null hypothesis that each of the variables in the table has a coefficient equal to 0 is rejected.

The value of adjusted R-squared is 0.983021 which means that 98.30% of variation in standard deviation of debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a very high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the null hypothesis is rejected and the conclusion is that the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 10 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.2232
Obs*R-squared	Prob. Chi-Square (2)	0.1984
Scaled explained SS	Prob. Chi-Square (2)	0.3888

The P values are greater than 0.05; therefore, the null hypothesis is failed to be rejected, and hence conclude that there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.1984.

The regression analysis of Bank Audi under the first scenario is summed up as follows. The regression of the dependent variables: capital to assets ratio, probability of default, market debt and standard deviation of debt on standard deviation of returns on equity and the square of the standard deviation of returns on equity showed that significant relation exists between each of the dependent variables and the independent variables. This conclusion is reached based on the significance of P-values and t-statistics for each regression. Additionally, the adjusted R-squared for each regression was very high indicating that high percentage of variation in each of the dependent variables is explained by the independent variables. The Prob (F-statistic) of all the regressions proved that the regression model is significant. The regression analysis also proved that Bank Audi has a minimum capital to assets ratio, probability of default and standard deviation of debt and a maximum of total assets and market debt at certain values of standard deviation of returns on equity. For all optima, the value of the standard deviation of returns on equity is between 0.2806 and 0.2887. The limit is thin and the values are close to each other.

These values which are calculated for each regression lie within the confidence interval of the bank. Finally, heteroskedasticity tests showed that the models have no problem of heteroskedasticity.

The relationship between the variables of Bank Audi is analyzed under the second scenario.

Second scenario: value of preferred shares added to market value of bank equity

The same procedure is applied under the second scenario; therefore, in reference to table 11 below, the following is explained:

Table 11 Regression of Capital to Assets Ratio on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Capital to Assets Ratio		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	0.107289	34834.71	0.0000
SD	-0.000197	-9.84540	0.0000
SD ²	0.000361	11.41616	0.0000
Adjusted R-squared	0.962226		
Prob (F-statistic)	0.0000		

The dependent variable is the capital to assets ratio, whereas, the independent variable is the standard deviation of returns on equity (SD) and the square of standard deviation of returns on equity. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.000361) shows that there is a minimum in the relationship. To find out the minimum, the following equation is derived from table 11:

$$Y = 0.107289 - 0.000197SD + 0.000361SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2728. This means that the minimum capital to assets ratio occur when the standard deviation of returns on equity of Bank Audi is 0.2728. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant; therefore, the null hypothesis that each of the variables in the table has a coefficient equal to 0 is rejected. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.962226 which means that 96.22% of variation in capital to assets ratio is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the null hypothesis is rejected and the conclusion is that the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 12 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.1562
Obs*R-squared	Prob. Chi-Square (2)	0.1406
Scaled explained SS	Prob. Chi-Square (2)	0.303

From table 12, since the P values are greater than 0.05, the null hypothesis is failed to be rejected, and hence conclude that there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.1406.

The relationship between the standard deviation of returns on equity and the square of standard deviation of returns on equity and total assets is analyzed by referring to the table below:

Table 13 Regression of Total Assets on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Total Assets		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	4.101089	34435.45	0.0000
SD	0.007519	9.71842	0.0000
SD ²	-0.013798	-11.27316	0.0000
Adjusted R-squared	0.961426		
Prob (F-statistic)	0.0000		

The dependent variable is the total assets, whereas, the independent variables are the standard deviation of returns on equity (SD) and the square of SD. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.013798) shows that there is a maximum in the relationship. To find out the maximum, the following equation is derived from the above table:

$$Y = 4.101089 + 0.007519SD - 0.013798SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2725. This means that the maximum total assets occur when the standard deviation of returns on equity of Bank Audi is 0.2725. This value lies above the lower limit of the confidence intervals calculated previously and below the upper limit.

Since the values of t-Statistic and P value are all significant, the null hypothesis that each of the variables in the table has a coefficient equal to 0 is rejected.

Based on the value of adjusted R-squared, 96.14% of variation in total assets is explained by the variation in standard deviation of returns on equity and the square of standard deviation of returns on equity after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 14 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.1438
Obs*R-squared	Prob. Chi-Square (2)	0.13
Scaled explained SS	Prob. Chi-Square (2)	0.2905

Since the P values are greater than 0.05, there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.13.

Third, the relationship between the standard deviation of returns on equity and its square and probability of default is analyzed by referring to the table below:

Table 15 Regression of Probability of Default on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Probability of Default		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	0.013346	1.510107	0.1494
SD	-0.108021	-1.881507	0.0771
SD ²	0.216563	2.384308	0.0290
Adjusted R-squared	0.682029		
Prob (F-statistic)	0.000023		

The dependent variable is the probability of default, whereas, the independent variables are the standard deviation of returns on equity (SD) and square of SD. SD^2 is the square of the independent variable and the positive sign of its estimated coefficient (0.216563) shows that there is a minimum in the relationship. To find out the minimum, the following equation is used:

$$Y = 0.013346 - 0.108021SD + 0.216563SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2494. This means that the minimum probability of default occur when the standard deviation of returns on equity of Bank Audi is 0.2494. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are significant only for the squared function. Therefore, the null hypothesis that the square of the standard deviation of returns on equity has a coefficient equal to 0 is rejected. Hence, there is a relationship between the variables. The variable C and standard deviation of returns on equity have a low t-Statistic and high P value. Therefore, the null hypothesis is failed to be rejected and claim that the relationship is not significant between the variables.

The value of adjusted R-squared is 0.682029 which means that only 68.20% of variation in probability of default is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is not a good percentage and further confirms the existence of a weak relationship between the tested variables.

Although there are insignificant variables in the model, yet the Prob (F-statistic) of the model is less than 5%, thus the null hypothesis is rejected and the conclusion is that the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 16 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.284
Obs*R-squared	Prob. Chi-Square (2)	0.2525
Scaled explained SS	Prob. Chi-Square (2)	0.0807

From table 16, since the P values are greater than 0.05, the null hypothesis is failed to be rejected and hence conclude that there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.0807.

Next, the relationship between the standard deviation of returns on equity, the square of standard deviation of returns on equity and market debt is analyzed.

Table 17 Regression of Market Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Market Debt		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	3.661089	30777.95	0.0000
SD	0.00752	9.732087	0.0000
SD ²	-0.0138	-11.28855	0.0000
Adjusted R-squared	0.961514		
Prob (F-statistic)	0.0000		

The dependent variable is the market debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and the square of standard deviation of returns on equity. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.0138) shows that there is a maximum in the relationship. To find out the maximum, the following equation is derived from table 17:

$$Y = 3.661089 + 0.007520SD - 0.0138SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2725. This means that the maximum market debt occur when the standard deviation of returns on equity of Bank Audi is 0.2887. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

Since the values of t-Statistic and P value are all significant, the null hypothesis is rejected.

Based on the value of adjusted R-squared, 96.15% of variation in total assets is explained by the variation in standard deviation of returns on equity and square of standard deviation of returns on equity after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 18 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.145
Obs*R-squared	Prob. Chi-Square (2)	0.131
Scaled explained SS	Prob. Chi-Square (2)	0.2914

Since the P values are greater than 0.05, the null hypothesis is failed to be rejected and hence the conclusion is that there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.131.

Finally, the relationship between standard deviation of returns on equity and the square of standard deviation of returns on equity and standard deviation of debt is tested by referring to the table below:

Table 19 Regression of Standard Deviation of Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Standard Deviation of Debt		
Method:	Least Squares		
Sample:	1 20		
Number of Observations:	20		
Variable	Coefficient	t-Statistic	Prob.
C	0.000836	9.52418	0.0000
SD	-0.006264	-10.98541	0.0000
SD ²	0.011585	12.84207	0.0000
Adjusted R-squared	0.972059		
Prob (F-statistic)	0.0000		

The dependent variable is the standard deviation of debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and the square of standard deviation of returns on equity. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.011585) shows that there is a minimum in the relationship. To find out the minimum, the following equation is derived from table 19:

$$Y = 0.000836 - 0.006264SD + 0.011585SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2704. This means that the minimum standard deviation of debt occur when the standard deviation of returns on equity of Bank Audi is 0.2704. This value lies above the lower limit of the confidence intervals calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.972059 which means that 97.20% of variation in standard deviation of debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the null hypothesis is rejected and the conclusion is that the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 20 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.1949
Obs*R-squared	Prob. Chi-Square (2)	0.1738
Scaled explained SS	Prob. Chi-Square (2)	0.349

All the P values are greater than 0.05; therefore, heteroskedasticity is absent in the model; and the minimum probability under the null hypothesis of no heteroskedasticity is 0.1738.

The regression analyses of the variables of Bank Audi under the second scenario revealed different results only for probability of default variable. The regression analysis of the dependent variables: capital to assets ratio, market debt and standard deviation of debt revealed that significant relation exists between each of the dependent variables and the independent variables. This conclusion is reached based upon on the significance of P-values and t-statistics for each regression. Additionally, the adjusted R-squared for each regression was very high indicating that high percentage of variation in each of the dependent variables is explained by the independent variables. The Prob (F-statistic) for all the regressions, including probability of default, proved that the regression models are significant. The regression analysis also proved that Bank Audi has a minimum capital to assets ratio, probability of default and standard deviation of debt and a maximum of total assets and market debt at certain values of standard deviation of returns on equity. For all optima, the value of the standard deviation of equity is between 0.2494 and 0.2728. These values which are calculated for each regression lie within the confidence interval of the bank. Finally, heteroskedasticity tests showed that the models, including the probability of default model, have no problem of heteroskedasticity.

With respect to the variable probability of default, the regression analysis showed that the constant variable and the standard deviation of returns on equity have a low t-Statistic and P value. Therefore, the relationship is not significant between the variables. Additionally, low percentage of variation in probability of default is explained by the variation in standard deviation of returns on equity and its square which further confirmed the existence of a weak relationship between the tested variables.

BLOM Bank

First Scenario: value of preferred shares added to deposits

The regression output between the standard deviation of returns on equity and its square of BLOM bank and capital to assets ratio is analyzed based on the table below:

Table 21 Regression of Capital to Assets Ratio on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Capital to Assets Ratio		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	0.085509	465832.30	0.0000
SD	-9.88E-06	-6.468584	0.0000
SD ²	2.28E-05	7.333518	0.0000
Adjusted R-squared	0.934863		
Prob (F-statistic)	0.0000		

The dependent variable is the capital to assets ratio, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (2.28E-05) shows that there is a minimum in the relationship. To find out the minimum, the following equation is used:

$$Y = 0.085509 - (9.88E - 06)SD + (2.28E - 05)SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2167. This means that the minimum capital to assets ratio occur when the standard deviation of returns on equity of BLOM bank is 0.2167. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant; therefore, the null hypothesis is rejected and the conclusion is that there is a relationship between the variables.

The value of adjusted R-squared is 0.934863 which means that 93.48% of variation in capital to assets ratio is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 22 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.0752
Obs*R-squared	Prob. Chi-Square (2)	0.0723
Scaled explained SS	Prob. Chi-Square (2)	0.2136

All the P values in the table are greater than 0.05; hence, heteroskedasticity is absent. The minimum probability under the null hypothesis of no heteroskedasticity is 0.0723.

Second, the regression analysis between standard deviation of returns on equity and the square of standard deviation of returns on equity and total assets is presented in table 23.

Table 23 Regression of Total Assets on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Total Assets		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	3.157568	471977.70	0.0000
SD	0.000353	6.34825	0.0001
SD ²	-0.000817	-7.216641	0.0000
Adjusted R-squared	0.9347		
Prob (F-statistic)	0.0000		

The dependent variable is the total assets, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.000817) shows that there is a maximum in the relationship. To find out the maximum, the following equation is written:

$$Y = 3.157568 + 0.000353SD - 0.000817SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2160. This means that the maximum total assets occur when the standard deviation of returns on equity of BLOM bank is 0.2160. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant; therefore, the null hypothesis is rejected and thus there is a relationship between the variables.

The value of adjusted R-squared is 0.934700 which means that 93.47% of variation in total assets is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 24 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.7455
Obs*R-squared	Prob. Chi-Square (2)	0.6949
Scaled explained SS	Prob. Chi-Square (2)	0.8604

All the P-values are highly greater than 0.05; therefore, heteroskedasticity is absent in the model and the minimum probability under the null hypothesis of no heteroskedasticity is 0.6949.

Third, the relationship between the standard deviation of returns on equity and square of standard deviation of returns on equity and probability of default is assessed.

Table 25 Regression of Probability of Default on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Probability of Default		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	0.002058	6.044450	0.0001
SD	-0.019087	-6.740333	0.0000
SD ²	0.043664	7.575589	0.0000
Adjusted R-squared	0.932883		
Prob (F-statistic)	0.000000		

The dependent variable is the probability of default, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.043664) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.002058 - 0.019087SD + 0.043664SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD

equals 0.2186. This means that the minimum probability of default occur when the standard deviation of returns on equity of BLOM bank is 0.2186. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, the null hypothesis that each of the variables in the table has a coefficient equal to 0 is rejected.

The value of adjusted R-squared is 0.932883 which means that 93.28% of variation in probability of default is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Since the prob (F-statistic) is less than 5%, the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 26 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.3249
Obs*R-squared	Prob. Chi-Square (2)	0.2742
Scaled explained SS	Prob. Chi-Square (2)	0.4462

Since the P values are greater than 0.05, the null hypothesis is failed to be rejected, and hence conclude that there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.2742.

The regression of market debt on the independent variables is analyzed in table 27.

Table 27 Regression of Market Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Market Debt		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	2.887562	435704.40	0.0000
SD	0.000354	6.426098	0.0000
SD ²	-0.000819	-7.303396	0.0000
Adjusted R-squared	0.936003		
Prob (F-statistic)	0.0000		

The dependent variable is the market debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.000819) shows that there is a maximum in the relationship. To find out the maximum, the following equation is written:

$$Y = 2.887562 + 0.000354SD - 0.000819SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2161. This means that the maximum market debt occurs when the standard deviation of returns on equity of BLOM bank is 0.2161. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.936003 which means that 93.60% of variation in market debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%; hence the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 28 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.7843
Obs*R-squared	Prob. Chi-Square (2)	0.739
Scaled explained SS	Prob. Chi-Square (2)	0.877

All the P values are greater than 0.05; hence, heteroskedasticity is absent in the regression model and the minimum probability under the null hypothesis of no heteroskedasticity is 0.7390.

The last relationship in the first scenario is assessed by referring to the table below:

Table 29 Regression of Standard Deviation of Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Standard Deviation of Debt		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	5.51E-05	5.63650	0.0002
SD	-0.000509	-6.26209	0.0001
SD ²	0.001159	7.007118	0.0000
Adjusted R-squared	0.918552		
Prob (F-statistic)	0.0000		

The dependent variable is the standard deviation of debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.001159) shows that there is a minimum in the relationship. To find out the minimum, refer to the following equation:

$$Y = (5.51E - 05) - 0.000509SD + 0.001159SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2196. This means that the minimum standard deviation of debt occur when the standard

deviation of returns on equity of BLOM bank is 0.2196. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.918552 which means that 91.85% of variation in standard deviation of debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 30 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.2516
Obs*R-squared	Prob. Chi-Square (2)	0.2115
Scaled explained SS	Prob. Chi-Square (2)	0.3811

The P values are all greater than 0.05; hence, heteroskedasticity is absent in the model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.2115.

Here is the summary of the regression analysis of BLOM Bank under the first scenario.

The regression of the dependent variables: capital to assets ratio, probability of default, market debt and standard deviation of debt on standard deviation of returns on equity and the square of the standard deviation of returns on equity revealed that significant relation exists between each of the dependent variables and the independent variables. This conclusion is reached based upon the significance of P-values and t-statistics for each regression. Additionally,

the adjusted R-squared for each regression was very high indicating that high percentage of variation in each of the dependent variables is explained by the independent variables. The Prob (F-statistic) of all the regressions proved that the regression model is significant. The analysis also proved that BLOM Bank has a minimum capital to assets ratio, probability of default and standard deviation of debt and a maximum of total assets and market debt at certain values of standard deviation of returns on equity. For all optima, the value of the standard deviation of returns on equity is between 0.2160 and 0.2196. The limit is thin and the values are close to each other. These values which are calculated for each regression lie within the confidence interval of the bank. Finally, heteroskedasticity tests showed that the models have no problem of heteroskedasticity.

Second scenario: value of preferred shares added to market value of bank equity

The relationship between the standard deviation of returns on equity and its square and capital to assets ratio is shown in the table below:

Table 31 Regression of Capital to Assets Ratio on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Capital to Assets Ratio		
Method:	Least Squares		
Sample:	1 13		
Number of Observations:	13		
Variable	Coefficient	t-Statistic	Prob.
C	0.092038	945554.2	0.0000
SD	-5.68E-06	-6.293665	0.0001
SD ²	1.41E-05	6.890177	0.0000
Adjusted R-squared	0.896914		
Prob (F-statistic)	0.000005		

The dependent variable is the capital to assets ratio, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the

independent variable and the positive sign of its estimated coefficient (1.41E-05) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.092038 - (5.68E - 06)SD + (1.41E - 05)SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2014. This means that the minimum capital to assets ratio occur when the standard deviation of returns on equity of BLOM bank is 0.2014. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, the null hypothesis that each of the variables in the table has a coefficient equal to 0 is rejected. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.896914 which means that 89.69% of variation in capital to assets ratio is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, hence the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 32 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.0009
Obs*R-squared	Prob. Chi-Square (2)	0.0075
Scaled explained SS	Prob. Chi-Square (2)	0.0068

The P values in the table are less than 0.05; therefore, heteroskedasticity is present in the regression model.

Second, the regression analysis between standard deviation of returns on equity and its square and total assets is presented in the table below:

Table 33 Regression of Total Assets on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Total Assets		
Method:	Least Squares		
Sample:	1 13		
Number of Observations:	13		
Variable	Coefficient	t-Statistic	Prob.
C	3.150874	706653.80	0.0000
SD	0.00025	6.04575	0.0001
SD ²	-0.000604	-6.449322	0.0001
Adjusted R-squared	0.845907		
Prob (F-statistic)	0.000035		

The dependent variable is the total assets, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.000604) shows that there is a maximum in the relationship. To find out the maximum, the following equation is written:

$$Y = 3.150874 + 0.000250 - 0.000604SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2069. This means that the maximum total assets occur when the standard deviation of returns on equity of BLOM bank is 0.2069. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.845907 which means that 84.59% of variation in total assets is explained by the variation in standard deviation of returns on equity and its square

after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus null hypothesis is rejected and the model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 34 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.0262
Obs*R-squared	Prob. Chi-Square (2)	0.0347
Scaled explained SS	Prob. Chi-Square (2)	0.0441

All the P-values are less than 0.05; therefore, heteroskedasticity is present in the model.

The third relationship between standard deviation of returns on equity and square of standard deviation of returns on equity and probability of default is assessed based on the table below:

Table 35 Regression of Probability of Default on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Probability of Default		
Method:	Least Squares		
Sample:	1 13		
Number of Observations:	13		
Variable	Coefficient	t-Statistic	Prob.
C	0.000489	4.707229	0.0008
SD	-0.005023	-5.210182	0.0004
SD ²	0.012676	5.801567	0.0002
Adjusted R-squared	0.882552		
Prob (F-statistic)	0.000009		

The dependent variable is the probability of default, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the

independent variable and the positive sign of its estimated coefficient (0.012676) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.000489 - 0.005023SD + 0.012676SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.1981. This means that the minimum probability of default occur when the standard deviation of returns on equity of BLOM bank is 0.1981. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, the conclusion is that there is a relationship between the variables.

The value of adjusted R-squared is 0.882552 which means that 88.25% of variation in probability of default is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 36 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.1302
Obs*R-squared	Prob. Chi-Square (2)	0.1134
Scaled explained SS	Prob. Chi-Square (2)	0.2899

Since the P values are greater than 0.05, heteroskedasticity is absent in the model and the minimum probability under the null hypothesis of no heteroskedasticity is 0.1134.

Regression of market debt on the independent variables is analyzed in table 37.

Table 37 Regression of Market Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Market Debt		
Method:	Least Squares		
Sample:	1 13		
Number of Observations:	13		
Variable	Coefficient	t-Statistic	Prob.
C	2.860875	661767.10	0.0000
SD	0.000245	6.108225	0.0001
SD ²	-0.000593	-6.528487	0.0001
Adjusted R-squared	0.852209		
Prob (F-statistic)	0.000028		

The dependent variable is the market debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.000593) shows that there is a maximum in the relationship. To find out the maximum, the following equation is derived:

$$Y = 2.860875 + 0.000245SD - 0.000593SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2066. This means that the maximum market debt occurs when the standard deviation of returns on equity of BLOM bank is 0.2066. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.852209 which means that 85.22% of variation in market debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 38 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.0186
Obs*R-squared	Prob. Chi-Square (2)	0.0282
Scaled explained SS	Prob. Chi-Square (2)	0.0329

All the P values are less than 0.05; hence, heteroskedasticity is present in the regression model.

The last relationship in the second scenario is assessed by referring to the table below:

Table 39 Regression of Standard Deviation of Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Standard Deviation of Debt		
Method:	Least Squares		
Sample:	1 13		
Number of Observations:	13		
Variable	Coefficient	t-Statistic	Prob.
C	1.26E-05	4.481473	0.0012
SD	-0.000129	-4.948873	0.0006
SD ²	0.000325	5.495451	0.0003
Adjusted R-squared	0.866834		
Prob (F-statistic)	0.000017		

The dependent variable is the standard deviation of debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.000325) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = (1.26E - 05) - 0.000129SD + 0.000325SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.1985. This means that the minimum standard deviation of debt occur when the standard

deviation of returns on equity of BLOM bank is 0.1985. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.866834 which means that 86.68% of variation in standard deviation of debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 40 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.0959
Obs*R-squared	Prob. Chi-Square (2)	0.0878
Scaled explained SS	Prob. Chi-Square (2)	0.2424

The P values are all greater than 0.05. Hence, heteroskedasticity is absent in the model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.0878.

The regression analysis of BLOM Bank under the second scenario is summed up as follows. The regression of the dependent variables: capital to assets ratio, probability of default, market debt and standard deviation of debt on standard deviation of returns on equity and the square of the standard deviation of returns on equity revealed that significant relation exists between each of the dependent variables and the independent variables. This conclusion is based on the significance of P-values and t-statistics for each regression. Additionally, the adjusted R-squared for each regression was high indicating that high percentage of variation in each of the

dependent variables is explained by the independent variables. The Prob (F-statistic) of all the regressions proved that the regression model is significant. The regression analysis also proved that BLOM Bank has a minimum capital to assets ratio, probability of default and standard deviation of debt and a maximum of total assets and market debt at certain values of standard deviation of returns on equity. For all optima, the value of the standard deviation of returns on equity is between 0.1981 and 0.2069. The limit is thin and the values are close to each other. These values which are calculated for each regression lie within the confidence interval of the bank. Finally, heteroskedasticity tests revealed different results compared to the first scenario. Heteroskedasticity is absent from the models of regression analysis of probability of default and standard deviation of debt. But, heteroskedasticity is present in the regression models which included the capital to assets ratio, total assets and market debt variables.

Byblos Bank

First Scenario: value of preferred shares added to deposits

The regression output between the standard deviation of returns on equity and its square of Byblos bank and capital to assets ratio is analyzed based on the table below:

Table 41 Regression of Capital to Assets Ratio on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Capital to Assets Ratio		
Method:	Least Squares		
Sample:	1 16		
Number of Observations:	16		
Variable	Coefficient	t-Statistic	Prob.
C	0.063729	19982.91	0.0000
SD	-0.000306	-18.279440	0.0000
SD ²	0.000466	21.48973	0.0000
Adjusted R-squared	0.9963		
Prob (F-statistic)	0.000000		

The dependent variable is the capital to assets ratio, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD^2 is the square of the independent variable and the positive sign of its estimated coefficient (0.000466) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.063729 - 0.000306SD + 0.000466SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.3283. This means that the minimum capital to assets ratio occur when the standard deviation of returns on equity of Byblos bank is 0.3283. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.9963 which means that 99.63% of variation in capital to assets ratio is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a very high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 42 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.2971
Obs*R-squared	Prob. Chi-Square (2)	0.256
Scaled explained SS	Prob. Chi-Square (2)	0.492

All the P values are greater than 0.05. Therefore, heteroskedasticity is absent in the model and the minimum probability under the null hypothesis of no heteroskedasticity is 0.256.

Second, the regression analysis between standard deviation of returns on equity and its square and total assets is presented in the table below:

Table 43 Regression of Total Assets on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Total Assets		
Method:	Least Squares		
Sample:	1 16		
Number of Observations:	16		
Variable	Coefficient	t-Statistic	Prob.
C	2.039888	19454.07	0.0000
SD	0.009788	17.79057	0.0000
SD ²	-0.014928	-20.92267	0.0000
Adjusted R-squared	0.996111		
Prob (F-statistic)	0.000000		

The dependent variable is the total assets, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.014928) shows that there is a maximum in the relationship. To find out the maximum, the following equation is written:

$$Y = 2.039888 + 0.009788SD - 0.014928SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.3278. This means that the maximum total assets occur when the standard deviation of returns on equity of Byblos bank is 0.3278. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.996111 which means that 99.61% of variation in total assets is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 44 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.2687
Obs*R-squared	Prob. Chi-Square (2)	0.2313
Scaled explained SS	Prob. Chi-Square (2)	0.4476

All the P-values are greater than 0.05. Therefore, heteroskedasticity is absent in the model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.2313.

The third relationship is between standard deviation of returns on equity and its square and probability of default.

Table 45 Regression of Probability of Default on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Probability of Default		
Method:	Least Squares		
Sample:	1 16		
Number of Observations:	16		
Variable	Coefficient	t-Statistic	Prob.
C	0.057595	29.443620	0.0000
SD	-0.367039	-35.761820	0.0000
SD ²	0.591165	44.41412	0.0000
Adjusted R-squared	0.999466		
Prob (F-statistic)	0.000000		

The dependent variable is the probability of default, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the

independent variable and the positive sign of its estimated coefficient (0.591165) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.057595 - 0.367039SD + 0.591165SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.3104. This means that the minimum probability of default occur when the standard deviation of returns on equity of Byblos bank is 0.3104. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.999466 which means that 99.94% of variation in probability of default is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a very high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 46 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.2929
Obs*R-squared	Prob. Chi-Square (2)	0.2523
Scaled explained SS	Prob. Chi-Square (2)	0.488

Since the P values are greater than 0.05, there is no problem of heteroskedasticity and the minimum probability under the null hypothesis of no heteroskedasticity is 0.2523.

The relationship between the standard deviation of returns on equity and its square and market debt is assessed based on the regression output in the table below:

Table 47 Regression of Market Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Market Debt		
Method:	Least Squares		
Sample:	1 16		
Number of Observations:	16		
Variable	Coefficient	t-Statistic	Prob.
C	1.909887	18245.67	0.0000
SD	0.009789	17.823100	0.0000
SD ²	-0.014929	-20.96047	0.0000
Adjusted R-squared	0.996124		
Prob (F-statistic)	0.000000		

The dependent variable is the market debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.014929) shows that there is a maximum in the relationship. To find out the maximum, the following equation is written:

$$Y = 1.909887 + 0.009789SD - 0.014929SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.3278. This means that the maximum market debt occurs when the standard deviation of returns on equity of Byblos bank is 0.3278. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.996124 which means that 99.61% of variation in market debt is explained by the variation in standard deviation of returns on equity and its square

after adjusting for the degrees of freedom. This is a very high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 48 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.2703
Obs*R-squared	Prob. Chi-Square (2)	0.2326
Scaled explained SS	Prob. Chi-Square (2)	0.4504

Since the P values are greater than 0.05, heteroskedasticity is absent in the regression model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.2326.

The last relationship in the first scenario is assessed by referring to the table below:

Table 48 Regression of Standard Deviation of Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Standard Deviation of Debt		
Method:	Least Squares		
Sample:	1 16		
Number of Observations:	16		
Variable	Coefficient	t-Statistic	Prob.
C	2.13E-03	18.992380	0.0000
SD	-0.013146	-22.304090	0.0000
SD ²	0.020394	26.68085	0.0000
Adjusted R-squared	0.99797		
Prob (F-statistic)	0.000000		

The dependent variable is the standard deviation of debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.020394) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = (2.13E - 03) - 0.013146SD + 0.020394SD^2$$

Taking the first derivative of the equation and setting it equal to 0, the value of SD equals 0.3223. This means that the minimum standard deviation of debt occur when the standard deviation of returns on equity of Byblos bank is 0.3223. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.997970 which means that 99.79% of variation in standard deviation of debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a very high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 49 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.3067
Obs*R-squared	Prob. Chi-Square (2)	0.2645
Scaled explained SS	Prob. Chi-Square (2)	0.5098

The P values are all greater than 0.05. Hence, heteroskedasticity is absent in the model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.2645.

The regression analysis of Byblos Bank under the first scenario is summed up as follows. The regression of the dependent variables: capital to assets ratio, probability of default, market debt and standard deviation of debt on standard deviation of returns on equity and the square of the standard deviation of returns on equity revealed that significant relation exists between each of the dependent variables and the independent variables. This conclusion is based on the

significance of P-values and t-statistics for each regression. Additionally, the adjusted R-squared for each regression was very high indicating that high percentage of variation in each of the dependent variables is explained by the independent variables. The Prob (F-statistic) of all the regressions proved that the regression model is significant. The regression analysis also proved that Byblos Bank has a minimum capital to assets ratio, probability of default and standard deviation of debt and a maximum of total assets and market debt at certain values of standard deviation of returns on equity. For all optima, the value of the standard deviation of returns on equity is between 0.3104 and 0.3283. The limit is thin and the values are close to each other.

These values which are calculated for each regression lie within the confidence interval of the bank. Finally, heteroskedasticity tests showed that the models have no problem of heteroskedasticity.

Second scenario: value of preferred shares added to market value of bank equity

The relationship between the standard deviation of returns on equity and its square and capital to assets ratio is shown in the table below:

Table 50 Regression of Capital to Assets Ratio on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Capital to Assets Ratio		
Method:	Least Squares		
Sample:	1 11		
Number of Observations:	11		
Variable	Coefficient	t-Statistic	Prob.
C	0.093085	298995.40	0.0000
SD	-1.99E-05	-8.206059	0.0000
SD ²	4.24E-05	9.120115	0.0000
Adjusted R-squared	0.973217		
Prob (F-statistic)	0.000000		

The dependent variable is the capital to assets ratio, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the

independent variable and the positive sign of its estimated coefficient (4.24E-05) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.093085 - (1.99E - 05)SD + (4.24E - 05)SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2347. This means that the minimum capital to assets ratio occur when the standard deviation of returns on equity of Byblos bank is 0.2347. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.973217 which means that 97.32% of variation in capital to assets ratio is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 51 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.4189
Obs*R-squared	Prob. Chi-Square (2)	0.3413
Scaled explained SS	Prob. Chi-Square (2)	0.6466

The P values in the table are greater than 0.05. The null hypothesis is rejected, and hence heteroskedasticity is absent in the regression model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.3413.

Second, the regression analysis between standard deviation of returns on equity and its square and total assets is presented in the table below:

Table 52 Regression of Total Assets on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Total Assets		
Method:	Least Squares		
Sample:	1 11		
Number of Observations:	11		
Variable	Coefficient	t-Statistic	Prob.
C	2.041151	227940.50	0.0000
SD	0.000417	5.98666	0.0003
SD ²	-0.000897	-6.714719	0.0002
Adjusted R-squared	0.956992		
Prob (F-statistic)	0.000001		

The dependent variable is the total assets, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.000897) shows that there is a maximum in the relationship. To find out the maximum, the following equation is derived:

$$Y = 2.041151 + 0.000417SD - 0.000897SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2324. This means that the maximum total assets occur when the standard deviation of returns on equity of Byblos bank is 0.2324. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.956992 which means that 95.69% of variation in total assets is explained by the variation in standard deviation of returns on equity and its square

after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 53 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.971
Obs*R-squared	Prob. Chi-Square (2)	0.9605
Scaled explained SS	Prob. Chi-Square (2)	0.9909

All the P-values are highly greater than 0.05. Hence, heteroskedasticity is absent in the model and the minimum probability under the null hypothesis of no heteroskedasticity is 0.9605.

Third, in reference to the table below the regression between standard deviation of returns on equity and its square and probability of default is explained:

Table 54 Regression of Probability of Default on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Probability of Default		
Method:	Least Squares		
Sample:	1 11		
Number of Observations:	11		
Variable	Coefficient	t-Statistic	Prob.
C	0.003501	7.272359	0.0001
SD	-0.029952	-8.004109	0.0000
SD ²	0.063776	8.875226	0.0000
Adjusted R-squared	0.970838		
Prob (F-statistic)	0.000000		

The dependent variable is the probability of default, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.063776) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.003501 - 0.029952SD + 0.063776SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2348. This means that the minimum probability of default occur when the standard deviation of returns on equity of Byblos bank is 0.2348. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.970838 which means that 97.08% of variation in probability of default is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 55 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.3569
Obs*R-squared	Prob. Chi-Square (2)	0.2868
Scaled explained SS	Prob. Chi-Square (2)	0.5719

Since the P values are greater than 0.05, there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.2868.

The relationship between the standard deviation of returns on equity and its square and market debt is assessed based on the regression output in table 56 below:

Table 56 Regression of Market Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Market Debt		
Method:	Least Squares		
Sample:	1 11		
Number of Observations:	11		
Variable	Coefficient	t-Statistic	Prob.
C	1.851151	215433.90	0.0000
SD	0.000418	6.265080	0.0002
SD ²	-0.0009	-7.020797	0.0001
Adjusted R-squared	0.960091		
Prob (F-statistic)	0.000001		

The dependent variable is the market debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.0009) shows that there is a maximum in the relationship. To find out the maximum, the following equation is derived:

$$Y = 1.851151 + 0.000418SD - 0.0009SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2322. This means that the maximum market debt occurs when the standard deviation of returns on equity of Byblos bank is 0.2322. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.960091 which means that 96% of variation in market debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 57 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.9145
Obs*R-squared	Prob. Chi-Square (2)	0.8855
Scaled explained SS	Prob. Chi-Square (2)	0.9752

All the P values are highly greater than 0.05; hence, heteroskedasticity is absent in the model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.8855.

The last relationship under the second scenario is assessed by referring to the table below:

Table 58 Regression of Standard Deviation of Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Standard Deviation of Debt		
Method:	Least Squares		
Sample:	1 11		
Number of Observations:	11		
Variable	Coefficient	t-Statistic	Prob.
C	0.000869	2.885545	0.0203
SD	-0.006541	-2.793792	0.0234
SD ²	0.012234	2.721158	0.0262
Adjusted R-squared	0.426671		
Prob (F-statistic)	0.044256		

The dependent variable is the standard deviation of debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.012234) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.000869 - 0.006541SD + 0.012234SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2673. This means that the minimum standard deviation of debt occur when the standard

deviation of returns on equity of Byblos bank is 0.2673. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.426671 which means that only 42.66% of variation in standard deviation of debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom.

Prob (F-statistic) is slightly less than 5%, but the regression model is still significant.

Heteroskedasticity is tested by referring to the table below:

Table 59 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.0007
Obs*R-squared	Prob. Chi-Square (2)	0.0099
Scaled explained SS	Prob. Chi-Square (2)	0.0155

The P values are all less than 0.05. Hence, heteroskedasticity is present in the model.

The regression analysis of Byblos Bank is summed up under the second scenario. The regression of the dependent variables: capital to assets ratio, probability of default, market debt and standard deviation of debt on standard deviation of returns on equity and the square of the standard deviation of returns on equity revealed that significant relation exists between each of the dependent variables and the independent variables. This conclusion is based on the significance of P-values and t-statistics for each regression. Additionally, the adjusted R-squared for each regression, except for standard deviation of debt, was very high indicating that high percentage of variation in each of the dependent variables is explained by the independent variables. The Prob (F-statistic) of all the regressions proved that the regression model is

significant. The regression analysis also proved that Byblos Bank has a minimum capital to assets ratio, probability of default and standard deviation of debt and a maximum of total assets and market debt at certain values of standard deviation of returns on equity. For all optima, the value of the standard deviation of equity is between 0.2322 and 0.2673. These values which are calculated for each regression lie within the confidence interval of the bank. Finally, heteroskedasticity tests showed that the models have no problem of heteroskedasticity except for the variable standard deviation of debt. It's important to note that the regression of standard deviation of debt revealed that the model has heteroskedasticity and low percentage of variation in this variable is explained by the independent variable. Additionally, though the Prob F (statistic) value was slightly lower than 0.05, yet the model was still significant.

BEMO Bank

First Scenario: value of preferred shares added to deposits

The regression output between the standard deviation of returns on equity and its square of BEMO bank and capital to assets ratio is presented in the table below:

Table 60 Regression of Capital to Assets Ratio on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Capital to Assets Ratio		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	0.098916	45314.78	0.0000
SD	-0.000153	-10.923890	0.0000
SD ²	0.000279	12.55714	0.0000
Adjusted R-squared	0.986709		
Prob (F-statistic)	0.000000		

The dependent variable is the capital to assets ratio, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the

independent variable and the positive sign of its estimated coefficient (0.000279) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.098916 - 0.000153SD + 0.000279SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2742. This means that the minimum capital to assets ratio occur when the standard deviation of returns on equity of BEMO bank is 0.2742. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.986709 which means that 98.67% of variation in capital to assets ratio is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a very high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 61 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.4504
Obs*R-squared	Prob. Chi-Square (2)	0.3887
Scaled explained SS	Prob. Chi-Square (2)	0.5394

All the P values are greater than 0.05. Therefore, heteroskedasticity is absent in the model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.3887.

Second, the regression analysis between standard deviation of returns on equity and its square and total assets is presented in the table below:

Table 62 Regression of Total Assets on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Total Assets		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	0.190067	40775.01	0.0000
SD	0.00025	8.33859	0.0000
SD ²	-0.000467	-9.844833	0.0000
Adjusted R-squared	0.983728		
Prob (F-statistic)	0.000000		

The dependent variable is the total assets, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.000467) shows that there is a maximum in the relationship. To find out the maximum, the following equation is derived:

$$Y = 0.190067 + 0.000250SD - 0.000467SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2677. This means that the maximum total assets occur when the standard deviation of returns on equity of BEMO bank is 0.2677. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.983728 which means that 98.37% of variation in total assets is explained by the variation in standard deviation of returns on equity and its square

after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 63 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.0929
Obs*R-squared	Prob. Chi-Square (2)	0.0858
Scaled explained SS	Prob. Chi-Square (2)	0.1007

All the P-values are greater than 0.05. Therefore, heteroskedasticity is absent in the model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.0858.

The third relationship is between standard deviation of returns on equity and its square and probability of default.

Table 64 Regression of Probability of Default on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Probability of Default		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	0.019174	12.637940	0.0000
SD	-0.140297	-14.399380	0.0000
SD ²	0.25656	16.616	0.0000
Adjusted R-squared	0.992692		
Prob (F-statistic)	0.000000		

The dependent variable is the probability of default, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.25656) shows that there is a minimum in the relationship. To find out the minimum the following equation is derived:

$$Y = 0.019174 - 0.140297SD + 0.25656SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2734. This means that the minimum probability of default occur when the standard deviation of returns on equity of BEMO bank is 0.2734. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.992692 which means that 99.26% of variation in probability of default is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a very high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 65 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.5083
Obs*R-squared	Prob. Chi-Square (2)	0.4447
Scaled explained SS	Prob. Chi-Square (2)	0.648

Since the P values are greater than 0.05, there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.4447.

The relationship between the standard deviation of returns on equity and its square and market debt is assessed based on the regression output in the table below:

Table 66 Regression of Market Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Market Debt		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	0.171266	39189.18	0.0000
SD	0.000254	9.051670	0.0000
SD ²	-0.000474	-10.65445	0.0000
Adjusted R-squared	0.985661		
Prob (F-statistic)	0.000000		

The dependent variable is the market debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-0.000474) shows that there is a maximum in the relationship. To find out the maximum, the following equation is derived:

$$Y = 0.171266 + 0.000254SD - 0.000474SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2679. This means that the maximum market debt occurs when the standard deviation of returns on equity of BEMO bank is 0.2679. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Hence, there is a relationship between the variables.

The value of adjusted R-squared is 0.985661 which means that 98.56% of variation in market debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 67 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.1853
Obs*R-squared	Prob. Chi-Square (2)	0.1575
Scaled explained SS	Prob. Chi-Square (2)	0.1771

All the P values are greater than 0.05. Hence, heteroskedasticity is absent in the model.

The minimum probability under the null hypothesis of no heteroskedasticity is 0.1575.

The last relationship in the first scenario is assessed by referring to the table below:

Table 68 Regression of Standard Deviation of Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Standard Deviation of Debt		
Method:	Least Squares		
Sample:	1 14		
Number of Observations:	14		
Variable	Coefficient	t-Statistic	Prob.
C	0.000778	10.627600	0.0000
SD	-0.005627	-11.974410	0.0000
SD ²	0.010159	13.64262	0.0000
Adjusted R-squared	0.987502		
Prob (F-statistic)	0.000000		

The dependent variable is the standard deviation of debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.010159) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.000778 - 0.005627SD + 0.010159SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2769. This means that the minimum standard deviation of debt occur when the standard

deviation of returns on equity of BEMO bank is 0.2769. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.987502 which means that 98.75% of variation in standard deviation of debt is explained by the variation in standard deviation of returns on equity and its square after adjusting the degrees of freedom. This is a very high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 69 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.467
Obs*R-squared	Prob. Chi-Square (2)	0.4046
Scaled explained SS	Prob. Chi-Square (2)	0.5957

The P values are all greater than 0.05. Hence, heteroskedasticity is absent in the model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.4046.

The regression analysis of BEMO Bank under the first scenario is summed up as follows. The regression of the dependent variables: capital to assets ratio, probability of default, market debt and standard deviation of debt on standard deviation of returns on equity and the square of the standard deviation of returns on equity revealed that significant relation exists between each of the dependent variables and the independent variables. This conclusion is based on the significance of P-values and t-statistics for each regression. Additionally, the adjusted R-squared for each regression was very high indicating that high percentage of variation in each of the

dependent variables is explained by the independent variables. The Prob (F-statistic) of all the regressions proved that the regression model is significant. The regression also proved that BEMO Bank has a minimum capital to assets ratio, probability of default and standard deviation of debt and a maximum of total assets and market debt at certain values of standard deviation of returns on equity. For all optima, the value of the standard deviation of returns on equity is between 0.2677 and 0.2769. The limit is thin and the values are close to each other. These values which are calculated for each regression lie within the confidence interval of the bank. Finally, heteroskedasticity tests showed that the models have no problem of heteroskedasticity.

Second scenario: value of preferred shares added to market value of bank equity

The relationship between the standard deviation of returns on equity and its square and capital to assets ratio is shown in the table below:

Table 70 Regression of Capital to Assets Ratio on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Capital to Assets Ratio		
Method:	Least Squares		
Sample:	1 12		
Number of Observations:	12		
Variable	Coefficient	t-Statistic	Prob.
C	0.056182	141697.20	0.0000
SD	-1.45E-05	-4.429161	0.0016
SD ²	2.98E-05	4.45228	0.0016
Adjusted R-squared	0.619074		
Prob (F-statistic)	0.005268		

The dependent variable is the capital to assets ratio, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (2.98E-05) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.056182 - (1.45E - 05)SD + (2.98E - 05)SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2433. This means that the minimum capital to assets ratio occur when the standard deviation of returns on equity of BEMO bank is 0.2433. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.619074 which means that 61.90% of variation in capital to assets ratio is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a good percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 71 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.0002
Obs*R-squared	Prob. Chi-Square (2)	0.0062
Scaled explained SS	Prob. Chi-Square (2)	0.0042

All the P values are less than 0.05; therefore, heteroskedasticity is present in the model.

Second, the regression analysis between standard deviation of returns on equity and its square and total assets is presented in the table 72 below:

Table 72 Regression of Total Assets on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Total Assets		
Method:	Least Squares		
Sample:	1 12		
Number of Observations:	12		
Variable	Coefficient	t-Statistic	Prob.
C	0.178	2.16E+12	0.0000
SD	-2.05E-12	-2.999993	0.0150
SD ²	4.16E-12	2.994411	0.0151

The dependent variable is the total assets, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (4.16E-12) shows that there is a minimum in the relationship; which is impossible. The results shown in the table are counter to the expectations and this can be attributed to a sampling error.

The third relationship is between standard deviation of returns on equity and its square and probability of default, the regression output is presented in the table below:

Table 73 Regression of Probability of Default on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Probability of Default		
Method:	Least Squares		
Sample:	1 12		
Number of Observations:	12		
Variable	Coefficient	t-Statistic	Prob.
C	0.002264	6.323503	0.0001
SD	-0.020692	-6.984335	0.0001
SD ²	0.046901	7.771936	0.0000
Adjusted R-squared	0.95079		
Prob (F-statistic)	0.000001		

The dependent variable is the probability of default, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.046901) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = 0.002264 - 0.020692SD + 0.046901SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2206. This means that the minimum probability of default occur when the standard deviation of returns on equity of BEMO bank is 0.2206. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.95079 which means that 95.07% of variation in probability of default is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 74 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.3253
Obs*R-squared	Prob. Chi-Square (2)	0.2658
Scaled explained SS	Prob. Chi-Square (2)	0.4895

Since the P values are greater than 0.05, there is no problem of heteroskedasticity. The minimum probability under the null hypothesis of no heteroskedasticity is 0.2658.

The relationship between the standard deviation of returns on equity and its square and market debt is assessed based on the regression output in the table 75 below:

Table 75 Regression of Market Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Market Debt		
Method:	Least Squares		
Sample:	1 12		
Number of Observations:	12		
Variable	Coefficient	t-Statistic	Prob.
C	0.168	2380433.00	0.0000
SD	2.59E-06	4.429160	0.0016
SD ²	-5.30E-06	-4.452279	0.0016
Adjusted R-squared	0.619074		
Prob (F-statistic)	0.005268		

The dependent variable is the market debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the negative sign of its estimated coefficient (-5.30E-06) shows that there is a maximum in the relationship. To find out the maximum, the following equation is derived:

$$Y = 0.168 + (2.59E - 06)SD - (5.30E - 06)SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2443. This means that the maximum market debt occurs when the standard deviation of returns on equity of BEMO bank is 0.2443. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.619074 which means that 61.9% of variation in market debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a good percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 76 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.0002
Obs*R-squared	Prob. Chi-Square (2)	0.0062
Scaled explained SS	Prob. Chi-Square (2)	0.0042

All the P values are less than 0.05; hence, heteroskedasticity is present in the model.

The last relationship in the second scenario is assessed by referring to the table below:

Table 77 Regression of Standard Deviation Debt on Standard Deviation of Returns on Equity and the Square of Standard Deviation of Returns on Equity

Dependent Variable:	Standard Deviation of Debt		
Method:	Least Squares		
Sample:	1 12		
Number of Observations:	12		
Variable	Coefficient	t-Statistic	Prob.
C	3.89E-05	5.868094	0.0002
SD	-0.000355	-6.456412	0.0001
SD ²	0.000800	7.152416	0.0001
Adjusted R-squared	0.938999		
Prob (F-statistic)	0.000001		

The dependent variable is the standard deviation of debt, whereas, the independent variables are the standard deviation of returns on equity (SD) and its square. SD² is the square of the independent variable and the positive sign of its estimated coefficient (0.0008) shows that there is a minimum in the relationship. To find out the minimum, the following is the equation:

$$Y = (3.89E - 05) - 0.000355SD + 0.0008SD^2$$

Taking the first derivative of the above equation and setting it equal to 0, the value of SD equals 0.2219. This means that the minimum standard deviation of debt occur when the standard

deviation of returns on equity of BEMO bank is 0.2219. This value lies above the lower limit of the confidence interval calculated previously and below the upper limit.

The values of t-Statistic and P value are all significant. Therefore, there is a relationship between the variables.

The value of adjusted R-squared is 0.938999 which means that 93.89% of variation in standard deviation of debt is explained by the variation in standard deviation of returns on equity and its square after adjusting for the degrees of freedom. This is a high percentage and further confirms the existence of a strong relationship between the tested variables.

Prob (F-statistic) is less than 5%, thus the regression model is significant.

Heteroskedasticity is tested by referring to the table below:

Table 78 Heteroskedasticity

Heteroskedasticity Test: Glejser		
F-statistic	Prob. F(2,17)	0.2569
Obs*R-squared	Prob. Chi-Square (2)	0.2093
Scaled explained SS	Prob. Chi-Square (2)	0.4238

The P values are all greater than 0.05. Hence, heteroskedasticity is absent in the model. The minimum probability under the null hypothesis of no heteroskedasticity is 0.2093.

The regression analysis of BEMO Bank under the second scenario showed different results compared to the first scenario. The regression analysis of the two dependent variables, probability of default and standard deviation of debt, showed that significant relation exists between each of the dependent variables and the independent variables. This conclusion is based on the significance of P-values and t-statistics. The Prob (F-statistic) for the mentioned variables also proved that the regression model is significant. Additionally, the adjusted R-squared for each regression was very high indicating that high percentage of variation in the two dependent

variables is explained by the independent variables. Finally, the heteroskedasticity tests showed that the two models have no problem of heteroskedasticity. The regression of total assets showed that BEMO bank has a minimum at certain level of standard deviation of returns on equity which is impossible. This is attributed to a sampling error. Finally, the regression analysis of capital to assets ratio and market debt revealed that the models have heteroskedasticity problems and low percentage of variation in each of the dependent variables is explained by the independent variables. Yet, the regression models are significant and significant relation exists between each of the dependent variables and the independent variables. The minimum capital to assets ratio and the maximum of market debt occur at a level of standard deviation of equity which is within the confidence interval calculated for BEMO bank. For all optima, the value of the standard deviation of returns on equity is between 0.2206 and 0.2443.

Stock Market Crash

Stress testing to changes in equity variance allowed determining the changes in the probability of default, total assets, capital to assets ratio, market debt and standard deviation of market debt for all the sampled banks.

The results are very important because it shows that banks have total control on this variance because they can choose the riskiness of their portfolio of assets.

After reaching this conclusion, the concern is how well these banks will perform if unexpected declines occur in the stock market. In other words, are the sampled banks ready to absorb huge losses if stock market crashes occur in Lebanon?

Stock market crash is a sudden decline in stock prices which might result in significant losses especially if the market is not ready to absorb the losses. This might create a chaos in the country and automatically result in bankruptcies and financial stress.

The stress testing to stock market crashes of Lebanese banks is essential especially because the political situation in Lebanon is unstable during the last couple of years. The inconsistent political situation, as well as other factors, might lead to stock market crash. Therefore, stress testing is performed to crashes in equity prices that occur unexpectedly.

The crashing results are obtained by using the Solver routine in excel. For each of the sampled banks, the crashing results are analyzed under the two scenarios as previously, once when the value of preferred shares is added to equity and once when it is added to deposits.

The crashing is done by fixing four of the inputs in the Excel sheet for each of the banks: the average rate of interest on deposits, the future value of deposits, maturity of the model, and the value of the standard deviation of equity is set at its average limit for each bank according to each bank's confidence interval. To calculate the effect of a crash in the stock market, the fall in the equity is varied by multiplying the market value of equity by 0.95 to 0.3 in increments of 0.05. Then, the Solver routine is run in Excel and after the solution converged for each variation in the value of equity, the values for each bank are extracted.

Also, to assess the strength of the relationship between the independent and numerous dependent variables, the coefficient of correlation is calculated for each bank and under each scenario and tested the null hypothesis that the actual coefficient of correlation is zero.

Here is the presentation of the crashing outcome and the correlation coefficient for each bank followed by a brief analysis.

Bank Audi

First Scenario: value of preferred shares added to deposits

Table 79 Equity Crashing of Bank Audi (First Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	Probability of Default	Capital to Assets Ratio	Standard Deviation of Debt
0.4085	4.090088	0.030971	0.000360027	0.099875607	1.1062E-05
0.387	4.06859	0.029497	0.000370772	0.095118956	1.0854E-05
0.3655	4.04709	0.028006	0.000381892	0.090311812	1.0618E-05
0.344	4.025589	0.0265	0.00039335	0.085453329	1.0353E-05
0.3225	4.004089	0.024978	0.000405109	0.080542665	1.0053E-05
0.301	3.982591	0.023438	0.00041722	0.075578948	9.7196E-06
0.2795	3.961091	0.021883	0.000429736	0.070561368	9.3503E-06
0.258	3.93959	0.02031	0.000442626	0.065489048	8.9421E-06
0.2365	3.91809	0.01872	0.00045601	0.060361045	8.4948E-06
0.215	3.896591	0.017112	0.000469722	0.055176434	8.0020E-06
0.19355	3.875091	0.015487	0.000483906	0.049934309	7.4637E-06
0.172	3.853593	0.013843	0.000498419	0.04463367	6.8745E-06
0.1505	3.832094	0.012181	0.00051346	0.039273568	6.2342E-06
0.129	3.810594	0.0105	0.000529054	0.033852986	5.5396E-06

The above table shows that there is a positive relationship between the equity of a bank subject to crash and total assets of a bank, standard deviation of total assets, capital to assets ratio, and standard deviation of debt. On the other hand, the probability of default is the only variable which has a negative relationship with the equity.

To evaluate the strength of the relationship between the variables, the correlation coefficient is calculated and presented in the table 80 below:

Table 80 Correlation Coefficients (First Scenario)

Dependent Variable	Independent Variables	Correlation Coefficient
Equity	Total Assets	0.999999989
Equity	Standard Deviation of Total Assets	0.99980963
Equity	Probability of default	-0.998512043
Equity	Capital to Assets Ratio	0.999810505
Equity	Standard Deviation of Debt	0.985495623

Since the correlation coefficient between equity and each of total assets, standard deviation of total assets, capital to assets ratio and standard deviation of debt is greater than 0.8, it means that there is a strong positive correlation between each pair. The negative coefficient correlation for the relationship between equity and probability of default indicates a strong negative correlation between the pair.

In order to test for the relationship between the pairs statistically, the r critical is calculated based on the following formula:

$$r_c = \frac{t_c}{\sqrt{n-2+t_c^2}} \quad (18)$$

Where t_c is the t-critical and $n-2$ is the degrees of freedom, which is 12 for all the scenarios.

The derivation of the formula can be found in Appendix 3.

At the 0.01 level of significance, with degrees of freedom 12, the value of r_c calculated is 0.6119. Since the values of coefficient correlations in the above table are all greater than 0.6119, the null hypothesis that the actual r is zero is rejected and hence the correlation coefficient is statistically significant.

Second Scenario: value of preferred shares added to market value of bank equity

Table 81 Equity Crashing of Bank Audi (Second Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	Probability of Default	Capital to Assets Ratio	Standard Deviation of Debt
0.418	4.080087	0.031769	0.00035432	0.102448785	1.1165E-05
0.396	4.058088	0.030261	0.000365206	0.097582911	1.0966E-05
0.374	4.036088	0.028736	0.000376435	0.092663996	1.0737E-05
0.352	4.01409	0.027194	0.000388005	0.087691107	1.0477E-05
0.33	3.99209	0.025635	0.000399984	0.082663464	1.0186E-05
0.308	3.970089	0.024059	0.000412315	0.077580125	9.8581E-06
0.286	3.94809	0.022465	0.000425016	0.072440083	9.4924E-06
0.264	3.92609	0.020854	0.000438241	0.067242479	9.0894E-06
0.242	3.90409	0.019224	0.000451815	0.061986273	8.6422E-06
0.22	3.882092	0.017576	0.000465762	0.056670483	8.1485E-06
0.198	3.860093	0.015908	0.000480143	0.051294106	7.6064E-06
0.176	3.838093	0.014222	0.000495054	0.045856103	7.0144E-06
0.154	3.816094	0.012516	0.000510442	0.040355402	6.3678E-06
0.132	3.794093	0.010791	0.000526386	0.034790927	5.66384E-06

When crashing occurs, as shown in the table above, a positive relationship between the equity of a bank and its total assets, standard deviation of total assets, capital to assets ratio, and standard deviation of debt is observed. Negative relationship persists between equity and probability of default.

The correlation coefficient is presented below:

Table 82 Correlation Coefficients (Second Scenario)

Equity	Variables	Correlation Coefficient
Equity	Total Assets	1
Equity	Standard Deviation of Total Assets	0.999799142
Equity	Probability of default	-0.998425021
Equity	Capital to Assets Ratio	0.999800006
Equity	Standard Deviation of Debt	0.984296301

There is a strong positive correlation between equity and each of standard deviation of total assets, capital to assets ratio and standard deviation of debt. A perfect positive correlation

exists between equity and total assets and a strong negative relationship between equity and probability of default.

Since the correlation coefficient values in the table are all greater than r_c , calculated above, the null hypothesis that the actual r is zero is rejected and hence the correlation coefficient is statistically significant.

BLOM Bank

First Scenario: value of preferred shares added to deposits

Table 83 Equity Crashing of BLOM Bank (First Scenario)

Equity (in 10^{13} LBP)	Total Assets (in 10^{13} LBP)	Standard Deviation of Total Assets	Probability of Default	Capital to Assets Ratio	Standard Deviation of Debt
0.2565	3.1441	0.018764	3.00E-06	0.081581376	5.6159E-08
0.243	3.1306	0.017853	3.14E-06	0.077620904	5.5809E-08
0.2295	3.117099	0.016934	3.28E-06	0.07362615	5.5299E-08
0.216	3.103599	0.016007	3.42E-06	0.06959663	5.4602E-08
0.2025	3.090099	0.015072	3.57E-06	0.065531891	5.3696E-08
0.189	3.076599	0.014129	3.73E-06	0.061431463	5.2574E-08
0.1755	3.0631	0.013178	3.90E-06	0.057294901	5.1232E-08
0.162	3.049599	0.012218	4.07E-06	0.053121732	4.9633E-08
0.1485	3.036099	0.011249	4.25E-06	0.048911449	4.7702E-08
0.135	3.0226	0.010273	4.44E-06	0.044663535	4.5516E-08
0.1215	3.0091	0.009287	4.63E-06	0.040377522	4.2990E-08
0.108	2.995599	0.008292	4.84E-06	0.036052892	4.0094E-08
0.0945	2.982099	0.007289	5.06E-06	0.031689087	3.6865E-08
0.081	2.9686	0.006276	5.29E-06	0.027285589	3.3136E-08

The above table shows that there is a negative relationship between the value of equity of the bank and probability of default when crashing occurs in the market. The rest of the variables in the table have a positive relationship with the value of the equity.

The coefficient of correlation between variables is presented in the below table:

Table 84 Correlation Coefficients (First Scenario)

Equity	Variables	Correlation Coefficient
Equity	Total Assets	1
Equity	Standard Deviation of Total Assets	0.999875739
Equity	Probability of default	-0.996893562
Equity	Capital to Assets Ratio	0.999875067
Equity	Standard Deviation of Debt	0.961321549

On one hand, a strong positive correlation exists between equity and each of standard deviation of total asset, capital to assets ratio and standard deviation of debt; on the other hand, there is a strong negative relationship between equity and of probability of default. Perfect positive correlation exists between equity and total assets.

All the coefficient correlations in the table are greater than 0.6119. Therefore, the null hypothesis that the actual r is zero is rejected and this means that the correlation coefficients in the analysis are statistically significant.

Second Scenario: value of preferred shares added to market value of bank equity

Table 85 shows that there is a positive relationship between the equity of BLOM bank and its other variables, such as, total assets, standard deviation of total assets, capital to assets ratio, and standard deviation of debt. Negative relationship exists between its equity and probability of default.

Table 85 Equity Crashing of BLOM Bank (Second Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	Probability of Default	Capital to Assets Ratio	Standard Deviation of Debt
0.2755	3.136398	0.019325	1.03E-06	0.087839609	1.9783E-08
0.261	3.121898	0.018393	1.08E-06	0.083602982	1.9822E-08
0.2465	3.107398	0.017452	1.14E-06	0.079326808	1.9803E-08
0.232	3.092898	0.016502	1.20E-06	0.075010545	1.9715E-08
0.2175	3.078398	0.015544	1.26E-06	0.070653626	1.9552E-08
0.203	3.0639	0.014576	1.33E-06	0.066255427	1.9306E-08
0.1885	3.0494	0.0136	1.40E-06	0.061815445	1.8972E-08
0.174	3.0349	0.012613	1.47E-06	0.057333031	1.8518E-08
0.1595	3.0204	0.011618	1.55E-06	0.05280758	1.7970E-08
0.145	3.005898	0.010612	1.63E-06	0.048238489	1.7289E-08
0.1305	2.991399	0.009597	1.72E-06	0.043625075	1.6459E-08
0.116	2.976899	0.008575	1.81E-06	0.03896673	1.5493E-08
0.1015	2.962399	0.007538	1.91E-06	0.034262773	1.4340E-08
0.087	2.947899	0.006492	2.01E-06	0.029512542	1.3006E-08

The coefficient of correlation between the variables is present in the below table:

Table 86 Correlation Coefficients (Second Scenario)

Equity	Variables	Correlation Coefficient
Equity	Total Assets	1
Equity	Standard Deviation of Total Assets	0.999854567
Equity	Probability of default	-0.995726104
Equity	Capital to Assets Ratio	0.999854523
Equity	Standard Deviation of Debt	0.926542032

Table 86 shows that there is a strong positive correlation between equity and each of standard deviation of total assets, capital to assets ratio and standard deviation of debt. A perfect positive correlation exists between equity and total assets and a strong negative correlation between equity and probability of default.

The correlation coefficients are all significant since they are greater than 0.6119.

Byblos Bank

First Scenario: value of preferred shares added to deposits

Byblos bank's results in the below table again confirm that when crashing occurs, the relationship between the equity of bank and each of the variables: total assets, standard deviation of total assets, probability of default and standard deviation of debt is positive; whereas, the relationship between the equity and probability of default is negative.

Table 87 Equity Crashing of Byblos Bank (First Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	Probability of Default	Capital to Assets Ratio	Standard Deviation of Debt
0.1235	2.034964	0.022514	0.002813661	0.060689048	6.2923E-05
0.117	2.028465	0.021398	0.002847632	0.057679081	6.0546E-05
0.1105	2.021966	0.020275	0.002882535	0.054649769	5.8090E-05
0.104	2.015468	0.019145	0.002918489	0.051600929	5.5556E-05
0.0975	2.008968	0.018007	0.002954124	0.048532369	5.2909E-05
0.091	2.002471	0.016862	0.002990599	0.045443861	5.0174E-05
0.0845	1.995972	0.015709	0.003027321	0.042335265	4.7334E-05
0.078	1.989474	0.014549	0.003064054	0.039206337	4.4384E-05
0.0715	1.982975	0.013381	0.003102563	0.036056929	4.1349E-05
0.065	1.976477	0.012205	0.003140801	0.032886798	3.8193E-05
0.0585	1.96998	0.011021	0.003178583	0.029695738	3.4915E-05
0.052	1.963482	0.00983	0.003218175	0.026483569	3.1540E-05
0.0455	1.956983	0.00863	0.003258902	0.023250074	2.8051E-05
0.039	1.950485	0.007422	0.003299318	0.019995024	2.4434E-05

The correlation coefficients are presented in table 88:

Table 88 Correlation Coefficients (First Scenario)

Equity	Variables	Correlation Coefficient
Equity	Total Assets	1
Equity	Standard Deviation of Total Assets	0.999930151
Equity	Probability of default	-0.999709832
Equity	Capital to Assets Ratio	0.999931911
Equity	Standard Deviation of Debt	0.998018108

From table 88 it is obvious that there is a strong positive correlation between equity and each of standard deviation of total assets, capital to assets ratio and standard deviation of debt. A perfect positive correlation exists between equity and total assets and a strong negative correlation between equity and probability of default.

Since the correlation coefficients in the above table are all greater than 0.6119, then all the correlation coefficients are statistically significant.

Second Scenario: value of preferred shares added to market value of bank equity

Under the second scenario, as shown in the table below, the relationship between the variables is consistent as above. There is a positive correlation between equity and total assets, standard deviation of total assets, capital to assets ratio and standard deviation of debt. And there is a negative correlation between equity and probability of default.

Table 89 Equity Crashing of Byblos Bank (Second Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Assets	Probability of Default	Capital to Assets Ratio	Standard Deviation of Debt
0.1805	2.0317	0.0231	2.96E-05	0.088841876	6.7971E-07
0.171	2.022199	0.021987	3.07E-05	0.084561423	6.7147E-07
0.1615	2.0127	0.020863	3.18E-05	0.080240489	6.6121E-07
0.152	2.0032	0.019729	3.30E-05	0.075878605	6.4912E-07
0.1425	1.993699	0.018584	3.43E-05	0.071475187	6.3476E-07
0.133	1.9842	0.017428	3.56E-05	0.067029542	6.1794E-07
0.1235	1.9747	0.016261	3.69E-05	0.062541158	5.9864E-07
0.114	1.965199	0.015083	3.83E-05	0.058009383	5.7620E-07
0.1045	1.955699	0.013893	3.98E-05	0.05343357	5.5101E-07
0.095	1.9462	0.012692	4.13E-05	0.048813078	5.2280E-07
0.0855	1.936699	0.011479	4.29E-05	0.044147285	4.9085E-07
0.076	1.927199	0.010254	4.45E-05	0.039435472	4.5544E-07
0.0665	1.917699	0.009016	4.62E-05	0.034676968	4.1576E-07
0.057	1.9082	0.007767	4.79E-05	0.029871085	3.7182E-07

Table 90 presents the coefficient of correlation between the variable of Byblos bank:

Table 90 Correlation Coefficients (Second Scenario)

Equity	Variables	Correlation Coefficient
Equity	Total Assets	1
Equity	Standard Deviation of Total Assets	0.99987304
Equity	Probability of default	-0.997995443
Equity	Capital to Assets Ratio	0.999872642
Equity	Standard Deviation of Debt	0.9772663

Table 90 shows that there is a strong positive correlation between equity and each of standard deviation of total assets, capital to assets ratio and standard deviation of debt. A perfect positive correlation exists between equity and total assets and a strong negative correlation between equity and probability of default. Since the correlation coefficients in the above table are all greater than 0.6119, then all the correlation coefficients are statistically significant.

BEMO Bank

First Scenario: value of preferred shares added to deposits

Table 91 Equity Crashing of BEMO Bank (First Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	Probability of Default	Capital to Assets Ratio	Standard Deviation of Debt
0.0171	0.1884	0.028147	0.000380817	0.090764558	1.0641E-05
0.0162	0.1875	0.026794	0.000391059	0.086400214	1.0406E-05
0.0153	0.186599	0.025428	0.000401657	0.081993803	1.0146E-05
0.0144	0.1857	0.024048	0.000412427	0.077544618	9.8563E-06
0.0135	0.1848	0.022654	0.000423372	0.07305234	9.5349E-06
0.0126	0.183899	0.021248	0.000434887	0.06851572	9.1894E-06
0.0117	0.183	0.019829	0.000446867	0.063934557	8.8150E-06
0.0108	0.1821	0.018393	0.000458736	0.059308223	8.3972E-06
0.0099	0.1812	0.016945	0.000471181	0.054435871	7.9486E-06
0.009	0.1803	0.015482	0.000484116	0.049916927	7.4645E-06
0.0081	0.1794	0.014003	0.000497028	0.045150581	6.9344E-06
0.0072	0.1785	0.012511	0.000510659	0.040336215	6.3679E-06
0.0063	0.1776	0.011003	0.000524568	0.035473024	5.7548E-06
0.0054	0.1767	0.009483	0.000541245	0.030560318	5.1195E-06

Figures in table 91 show that there is a negative relationship between value of equity of BEMO bank and probability of default. The rest of the variables in the table have a positive relationship with the value of the equity. Correlation coefficients are presented below:

Table 92 Correlation Coefficients (First Scenario)

Equity	Variables	Correlation Coefficient
Equity	Total Assets	0.999999996
Equity	Standard Deviation of Total Assets	0.999845696
Equity	Probability of default	-0.998389939
Equity	Capital to Assets Ratio	0.999853928
Equity	Standard Deviation of Debt	0.989357805

There is a strong positive correlation between equity and each of total assets, standard deviation of total assets, capital to assets ratio and standard deviation of debt. A strong negative correlation exists between equity and probability of default. Since the correlation coefficients in the above table are all greater than 0.6119, then they are statistically significant.

Second Scenario: value of preferred shares added to market value of equity

Table 93 Equity Crashing of BEMO Bank (Second Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	Probability of Default	Capital to Assets Ratio	Standard Deviation of Debt
0.0095	0.1775	0.012845	9.52E-06	0.053521129	1.2197E-07
0.009	0.177	0.012204	9.77E-06	0.050847462	1.1889E-07
0.0085	0.1765	0.011558	1.00E-05	0.048158641	1.1548E-07
0.008	0.176	0.010909	1.03E-05	0.045454547	1.1182E-07
0.0075	0.1755	0.010256	1.05E-05	0.042735044	1.0785E-07
0.007	0.175	0.0096	1.08E-05	0.040000001	1.0356E-07
0.0065	0.174499	0.00894	1.11E-05	0.037249396	9.9128E-08
0.006	0.174	0.008276	1.14E-05	0.034482759	9.3972E-08
0.0055	0.1735	0.007608	1.17E-05	0.031700289	8.8632E-08
0.005	0.173	0.006937	1.20E-05	0.02890173	8.3046E-08
0.0045	0.1725	0.006264	1.24E-05	0.026086941	7.7614E-08
0.004	0.172	0.005596	1.32E-05	0.023255786	7.3798E-08
0.0035	0.1715	0.004898	1.29E-05	0.020408173	6.3261E-08
0.003	0.171	0.004211	1.32E-05	0.01754386	5.57539E-08

Based on the outputs of table 93, when the value of the preferred shares is added to equity, and when crashing occurs in the market, on one hand, there is a negative relationship between the equity of BEMO bank and its probability of default, on the other hand, the relationship between the equity of the bank and the rest of the variables is positive.

Correlation coefficients are presented in table 94:

Table 94 Correlation Coefficients (Second Scenario)

Equity	Variables	Correlation Coefficient
Equity	Total Assets	0.999999992
Equity	Standard Deviation of Total Assets	0.999947483
Equity	Probability of default	-0.99171896
Equity	Capital to Assets Ratio	0.999947286
Equity	Standard Deviation of Debt	0.990851218

The above table shows that there is a strong positive correlation between equity and each of total assets, standard deviation of total assets, capital to assets ratio and standard deviation of debt. A strong negative correlation exists between equity and probability of default.

Since the correlation coefficients in the above table are all greater than 0.6119, then all the correlation coefficients are statistically significant and the null hypothesis that the actual r is zero is rejected.

It's of no surprise or coincidence to have a strong positive correlation between the equity of a bank and its total assets, standard deviation of total assets, capital to assets ratio, and standard deviation of debt when crashing occurs. Additionally, it's rational to have a strong negative relationship between the equity of a bank and the probability of default.

The reason why there is a positive correlation between the equity and total assets is because when equity is crashed the liabilities of the bank are unaffected. Liabilities are the

deposits in the case of banks and when deposits are constant, the total assets move in parallel with the direction of equity to balance the fall in the equity. There is also a positive correlation between equity and standard deviation of total assets. The reason for this relationship can be referred to the Black-Scholes-Merton model's principle. When the standard deviation of total assets is high, the option price is also high. Since the equity of the bank is an option on the assets of the bank, as the standard deviation of the assets decrease, the option price, which is the equity, also decreases. The negative correlation between equity and the probability of default can be explained simply by saying that as the equity of the bank decreases, the risk that the bank will fail to honor its obligations increase. Equity is considered as a cushion against dues, and when it falls, the risk of default increases and this explains the negative correlation between equity and probability of default. The positive correlation between equity and capital to assets ratio is explained by the fact that when equity falls, total assets also fall and the reason is justified above. The capital is composed of Tier 1 and Tier 2 capital, which is the equity, and when this figure is crashed, total assets are also affected and hence the ratio of capital to total assets decrease too. Finally, the positive correlation between equity and standard deviation of debt is due to the variable standard deviation of total assets, when the latter falls, the standard deviation of debt also falls.

The sampled banks' correlation coefficients supported the expectations with no exception under the two scenarios. In addition to that, it's worth mentioning, that under the two scenarios of BLOM bank and Byblos Bank, and under the first scenario of Bank Audi, there is a perfect positive correlation between the equity of the banks and the total assets when crashing occurs and the reason for this is because when equity falls, the deposits are not affected and remain constant. Therefore, the fall in equity is balanced by the fall in total assets. Total assets of a bank

equals to the summation of total equity and liabilities, when equity falls and liabilities remain constant, total assets must also fall with the same amount to balance the equation and this justifies the perfect positive correlation between equity and total assets.

All of the above tables confirmed the expectations and since the output results were anticipated, the analysis of the variables is restricted on correlation coefficients.

Stress Testing by using the VaR methodology

The Bank for International Settlements in 1998 required the banks to calculate their capital requirements by adopting their own internal models such as VaR. Consequently, the adoption of VaR methodology to measure the risk of financial institutions gained an international acceptance. The importance of VaR is illustrated in the first part of this thesis.

Based on its importance, the VaR methodology is adopted in this thesis for stress testing of Lebanese banks. The aim is to answer the question “how much can the Lebanese banks lose on their trading portfolio?”

The stress testing by using the VaR methodology in this thesis is done when:

1. Stock market crash occur in Lebanon
2. Standard deviation of returns on equity is changed from its lower confidence limit to its upper limit

Basel II required the banks to calculate 10-day 99% VaR, whereas, Basel III discussions are based on 1-year 99.9%. Consequently, the VaR measures are based on Basel II and Basel III requirements.

The formula adopted in the 10-day 99% VaR calculation is presented below:

$$VAR_{99\%} = 2.33 \times \sigma_{Total\ Assets} \times Total\ Assets \times \sqrt{\frac{10}{244} - \%increase\ in\ Total\ Assets} \times Total\ Assets \times \frac{10}{244} \quad (19)$$

Where 2.33 is the z-value corresponding to the 99% confidence interval, the number 10 under the radical sign correspond to the length of time over which the market risk will be measured, and the 244 represents the average number of open days of the Beirut Stock Exchange. The % increase in total assets corresponds to the average growth rate of total assets which is calculated separately for each bank for the period between 2005 to 2009. The average growth rate of total assets of Bank Audi is 23.32%. It is 14.87% for BLOM Bank, 15.98% for Byblos Bank and 16.22% for BEMO Bank.

The formula adopted in the 1-year 99.9% VaR calculation is presented below:

$$VAR_{99.9\%} = 3.09 \times \sigma_{Total\ Assets} \times Total\ Assets - \%increase\ in\ Total\ Assets \times Total\ Assets \quad (20)$$

Where 3.09 is the z-value corresponding to the 99.9% confidence interval.

The results of the VaR analysis is analyzed when crashing is done for each bank under the two usual scenarios: when value of preferred shares is added to deposits and when the value of preferred shares is added to market value of equity.

Bank Audi

First scenario: value of preferred shares added to deposits

The VaR measures are presented in the table below:

Table 95 VaR Measures of Bank Audi (First Scenario)

Equity (in 10^{13} LBP)	Total Assets (in 10^{13} LBP)	Standard Deviation of Total Assets	1-yr 99.9% VaR (in 10^{13} LBP)	10-day 99% VaR (in 10^{13} LBP)
0.4085	4.090088	0.030971	-0.562585306	0.020652809
0.387	4.06859	0.029497	-0.578159333	0.017715454
0.3655	4.04709	0.028006	-0.593749828	0.014775533
0.344	4.025589	0.0265	-0.60932865	0.011837368
0.3225	4.004089	0.024978	-0.624905477	0.008899534
0.301	3.982591	0.023438	-0.64050191	0.005958759
0.2795	3.961091	0.021883	-0.656077008	0.003021189
0.258	3.93959	0.02031	-0.671664442	8.17091E-05
0.2365	3.91809	0.01872	-0.687248854	-0.002857283
0.215	3.896591	0.017112	-0.702838912	-0.005797111
0.19355	3.875091	0.015487	-0.718418698	-0.008735397
0.172	3.853593	0.013843	-0.734009196	-0.011675266
0.1505	3.832094	0.012181	-0.749594221	-0.014614326
0.129	3.810594	0.0105	-0.765181946	-0.017553824

The first figure under the column 10-day 99% VaR indicates that there is 1% probability that the assets of Bank Audi will decrease by 0.0206×10^{13} LBP or more over the next 10 days if crashing is done. If this value is compared to the equity, then it is obvious that the value of VaR is less than the value of the equity. Therefore, the conclusion is that Bank Audi's equity, even under crash, can absorb losses very easily.

It's important to mention that as the severity of the crashing lessens, the value of VaR is also decreasing until it reaches a negative VaR figure which indicates that the Bank has enough profits to withstand any losses.

Hence, at high levels of crashing the equity of the bank is larger than the expected losses. Therefore, the bank faces no problems. And at the lower levels of crashing, there's absolutely no problem because the negative value of VaR indicates that there is a chance of achieving profitability even when crashing occurs.

The 1-year 99.9% VaR figures indicate that the capital of Bank Audi can easily absorb shocks over a period of 1 year. If stock market crash occurs, Bank Audi will be able to withstand losses for a year. Therefore, since the bank's profitability is above the expected losses, crashing has no effect on the equity of Bank Audi.

To sum up, under the first scenario, the 10-day 99% and 1-year 99.9% VaR figures of Bank Audi reveal that the bank faces no problem if stock market crash occurs in Lebanon.

Second scenario: value of preferred shares added to market value of bank equity

Table 96 VaR Measures of Bank Audi (Second Scenario)

Equity (in 10^{13} LBP)	Total Assets (in 10^{13} LBP)	Standard Deviation of Total Assets	1-yr 99.9% VaR (in 10^{13} LBP)	10-day 99% VaR (in 10^{13} LBP)
0.418	4.080087	0.031769	-0.551148923	0.022138104
0.396	4.058088	0.030261	-0.567086794	0.019132159
0.374	4.036088	0.028736	-0.583031518	0.016125141
0.352	4.01409	0.027194	-0.598980061	0.013117592
0.33	3.99209	0.025635	-0.61492837	0.010110027
0.308	3.970089	0.024059	-0.630873106	0.007102981
0.286	3.94809	0.022465	-0.646823481	0.004095127
0.264	3.92609	0.020854	-0.662763214	0.001088871
0.242	3.90409	0.019224	-0.678713124	-0.001918938
0.22	3.882092	0.017576	-0.694657699	-0.004925881
0.198	3.860093	0.015908	-0.710616602	-0.007935037
0.176	3.838093	0.014222	-0.72656202	-0.010942161
0.154	3.816094	0.012516	-0.742514239	-0.013950297
0.132	3.794093	0.010791	-0.758456871	-0.016957021

In the second scenario, the first figure under the column 10-day 99% VaR indicates that there's 1% probability that the assets of Bank Audi will decrease by 0.0221×10^{13} LBP or more over the next 10 days if crashing is done. If this value is compared to the equity, it is obvious that the value of VaR is less than the value of equity. Therefore, Bank Audi's equity, even under crash, can absorb losses very easily.

It's important to mention that as the severity of the crashing lessens, the value of VaR is also decreasing until it reaches a negative VaR figure which indicates that the bank has enough profits to withstand any losses.

Hence, at high levels of crashing the equity of the bank is larger than the expected losses. Therefore, the bank faces no problems; and at the lower levels of crashing, there's absolutely no problem because the negative value of VaR indicates that there is a chance of achieving profitability even when crashing occurs.

The 1-year 99.9% VaR figures indicate that the capital of Bank Audi can easily absorb shocks over a period of 1 year. If stock market crash occurs, Bank Audi will be able to withstand losses for a year. Therefore, since the bank's profitability is above the expected losses, the conclusion is that crashing has no effect on the equity of Bank Audi.

The VaR results are similar for the two scenarios; therefore, the addition of the preferred shares whether to equity or deposits, is not resulting in any difference regarding the outcome of the VaR values. Bank Audi is capable to withstand stock market crash under the two scenarios.

BLOM Bank

First scenario: value of preferred shares added to deposits

The first figure under the column 10-day 99% VaR, in the below table, indicates that there's 1% probability that the assets of BLOM Bank will decrease by 0.0086×10^{13} LBP or more over the next 10 days if crashing is done. If this value is compared to the equity, then it is obvious that the value of VaR is less than the value of equity. Therefore, BLOM bank's equity, even under crash, can absorb losses very easily.

Table 97 VaR Measures of BLOM Bank (First Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.2565	3.1441	0.018764	-0.285217318	0.008667615
0.243	3.1306	0.017853	-0.292805272	0.007285136
0.2295	3.117099	0.016934	-0.300394179	0.005902495
0.216	3.103599	0.016007	-0.307983229	0.004519849
0.2025	3.090099	0.015072	-0.315571327	0.003137348
0.189	3.076599	0.014129	-0.323157471	0.001755145
0.1755	3.0631	0.013178	-0.330740768	0.000373394
0.162	3.049599	0.012218	-0.338329317	-0.001009192
0.1485	3.036099	0.011249	-0.345922315	-0.002392441
0.135	3.0226	0.010273	-0.353499965	-0.003773331
0.1215	3.0091	0.009287	-0.361089054	-0.005155983
0.108	2.995599	0.008292	-0.368679066	-0.006538793
0.0945	2.982099	0.007289	-0.376259903	-0.007920185
0.081	2.9686	0.006276	-0.383848918	-0.009302809

The numbers in the same column in the above table have the same explanations; and it's important to mention that as the value of the equity decreases the VaR figure is also decreasing indicating that BLOM bank is capable of absorbing the losses more and more. When the value of equity reaches 0.162, VaR figure is negative which indicates that BLOM Bank has enough profits to withstand any losses, and the crashing of its equity has no effect on its profitability.

The 1-year 99.9% VaR figures indicate that the capital of BLOM bank can easily absorb shocks over a period of 1 year. If stock market crash occurs, BLOM bank will be able to withstand losses for a year. Therefore, since the bank's profitability is above the expected losses, crashing will have no effect on the equity of BLOM bank.

BLOM Bank, under the first scenario and for 10-day 99% VaR and 1-year 99.9% VaR stress testing, faces no problem in withstanding possible stock market crash.

Second scenario: value of preferred shares added to market value of bank equity

Table 98 VaR Measures of BLOM Bank (Second Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.2755	3.136398	0.019325	-0.279081715	0.009476338
0.261	3.121898	0.018393	-0.286782174	0.008060081
0.2465	3.107398	0.017452	-0.294485532	0.00664338
0.232	3.092898	0.016502	-0.302190582	0.005226422
0.2175	3.078398	0.015544	-0.309886599	0.003810842
0.203	3.0639	0.014576	-0.317591652	0.002393917
0.1885	3.0494	0.0136	-0.325285142	0.000978723
0.174	3.0349	0.012613	-0.33299433	-0.000438867
0.1595	3.0204	0.011618	-0.340689736	-0.001854354
0.145	3.005898	0.010612	-0.348397919	-0.003271824
0.1305	2.991399	0.009597	-0.35609949	-0.004688234
0.116	2.976899	0.008575	-0.363774382	-0.006100589
0.1015	2.962399	0.007538	-0.371494999	-0.007519924
0.087	2.947899	0.006492	-0.379204671	-0.008937588

Under the second scenario, the figures differ slightly. Therefore, the above conclusions are valid for the second scenario as well.

The 1-year 99.9% VaR figures indicate that BLOM bank has absolutely no problem in absorbing stock market crashes.

The 10-day 99% VaR figures similarly show that BLOM bank's equity can absorb the crashing effects.

The 1-year 99.9% VaR figures and the 10-day 99% VaR figures of BLOM bank under the second scenario indicate that the bank has enough equity to absorb the crashing effects.

Byblos Bank

First scenario: value of preferred shares added to deposits

Table 99 VaR Measures of Byblos Bank (First Scenario)

Equity (in 10^{13} LBP)	Total Assets (in 10^{13} LBP)	Standard Deviation of Total Assets	1-year 99.9% VaR (in 10^{13} LBP)	10-day 99% VaR (in 10^{13} LBP)
0.1235	2.034964	0.022514	-0.183567694	0.008285507
0.117	2.028465	0.021398	-0.18997648	0.007191239
0.1105	2.021966	0.020275	-0.196384178	0.006097137
0.104	2.015468	0.019145	-0.202790467	0.005003268
0.0975	2.008968	0.018007	-0.209200831	0.003908741
0.091	2.002471	0.016862	-0.215609118	0.002814585
0.0845	1.995972	0.015709	-0.22202055	0.001719913
0.078	1.989474	0.014549	-0.22842882	0.000625741
0.0715	1.982975	0.013381	-0.234839408	-0.000468802
0.065	1.976477	0.012205	-0.241252066	-0.001563643
0.0585	1.96998	0.011021	-0.247666321	-0.00265871
0.052	1.963482	0.00983	-0.254075378	-0.003753002
0.0455	1.956983	0.00863	-0.260490897	-0.004848298
0.039	1.950485	0.007422	-0.266906573	-0.0059436

The first figure under the column 10-day 99% VaR indicates that there's 1% probability that the assets of Byblos Bank will decrease by 0.0082×10^{13} LBP or more over the next 10 days if crashing is done. If this value is compared to the equity, it is clear that the value of VaR is less than the value of equity. Therefore, Byblos bank's equity, even under crash, can absorb losses easily.

The relationship between the value of equity and 10-day 99% VaR figures of Byblos bank is similar to the relationship between these figures for the two banks analyzed so far, Bank Audi and BLOM bank. Hence, the same conclusion is valid as above and hence at high levels of crashing, the equity of Byblos bank is larger than the expected losses; therefore, the bank faces no problem; and at the lower levels of crashing, there's absolutely no problem because the negative value of VaR indicates that there is a chance of achieving profitability even when crashing occurs.

The 1-year 99.9% VaR figures indicate that the capital of Byblos bank can easily absorb shocks over a period of 1 year. If stock market crash occurs, Byblos bank will be able to withstand losses for a year. Therefore, since the bank's profitability is above the expected losses, crashing will have no effect on the equity of Byblos bank.

To sum up, under the first scenario, the 10-day 99% and 1-year 99.9% VaR figures of Byblos Bank reveal that the bank faces no problem if stock market crash occurs in Lebanon.

Second scenario: value of preferred shares added to market value of bank equity

Table 100 VaR Measures of Byblos Bank (Second Scenario)

Equity (in 10¹³ LBP)	Total Assets (in 10¹³ LBP)	Standard Deviation of Total Assets	1-year 99.9% VaR (in 10¹³ LBP)	10-day 99% VaR (in 10¹³ LBP)
0.1805	2.0317	0.0231	-0.179594379	0.008833806
0.171	2.022199	0.021987	-0.185709213	0.007730849
0.1615	2.0127	0.020863	-0.191827299	0.006627432
0.152	2.0032	0.019729	-0.197941202	0.005524635
0.1425	1.993699	0.018584	-0.204056191	0.004421654
0.133	1.9842	0.017428	-0.210171605	0.003318644
0.1235	1.9747	0.016261	-0.216286168	0.002215747
0.114	1.965199	0.015083	-0.2223989	0.00111311
0.1045	1.955699	0.013893	-0.228515099	9.96302E-06
0.095	1.9462	0.012692	-0.234627704	-0.001092618
0.0855	1.936699	0.011479	-0.240741371	-0.002195397
0.076	1.927199	0.010254	-0.246855404	-0.003298214
0.0665	1.917699	0.009016	-0.25297455	-0.004401811
0.057	1.9082	0.007767	-0.25908601	-0.005504217

Addition of the preferred shares to the market value of bank equity doesn't result in different conclusions regarding the crashing effects. The 10-day 99% VaR figures show that Byblos bank has no problem in absorbing the losses due to crashing. As the value of the equity decreases and standard deviation of total assets fall, the VaR figure is also decreasing indicating that Byblos bank is capable of absorbing the losses more and more. When the value of equity reaches 0.095, the VaR figure becomes negative indicating that Byblos Bank has enough profits

to withstand any losses below this value, and the crashing of its equity has no effect on its profitability.

The 1-year 99.9% VaR figures indicate that the capital of Byblos bank can easily absorb shocks over a period of 1 year. If stock market crash occurs, Byblos bank will be able to withstand losses for a year.

To sum up, under the second scenario as well, the 10-day 99% and 1-year 99.9% VaR figures of Byblos Bank reveal that the bank faces no problem if stock market crash occurs in Lebanon.

BEMO Bank

First scenario: value of preferred shares added to deposits

BEMO bank, similar to the other sampled banks, faces no problem in case of stock market crash. The first figure under the column 10-day 99% VaR in table 101 indicates that when crashing occurs there is 1% probability that the assets of BEMO Bank will decrease by 0.0012×10^{13} LBP or more over the next 10 days. Comparing this value to the equity, value of VaR is less than the value of equity. Hence, BEMO Bank's equity, even under crash, can absorb losses very easily.

The 1-year 99.9% VaR figures indicate that the capital of BEMO bank can easily absorb shocks over a period of 1 year. If stock market crash occurs, the bank will be able to withstand losses for a year.

Table 101 VaR Measures of BEMO Bank (First Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.0171	0.1884	0.028147	-0.014171457	0.001248995
0.0162	0.1875	0.026794	-0.014887653	0.001123365
0.0153	0.186599	0.025428	-0.015603736	0.000997735
0.0144	0.1857	0.024048	-0.016320422	0.000872049
0.0135	0.1848	0.022654	-0.017037343	0.000746308
0.0126	0.183899	0.021248	-0.017753234	0.000620707
0.0117	0.183	0.019829	-0.018468848	0.000495185
0.0108	0.1821	0.018393	-0.019186039	0.000369403
0.0099	0.1812	0.016945	-0.019901962	0.000243816
0.009	0.1803	0.015482	-0.020618188	0.000118181
0.0081	0.1794	0.014003	-0.021335146	-7.56446E-06
0.0072	0.1785	0.012511	-0.022051049	-0.000133149
0.0063	0.1776	0.011003	-0.022767433	-0.000258808
0.0054	0.1767	0.009483	-0.023481982	-0.000384186

To sum up, under the first scenario, the 10-day 99% and 1-year 99.9% VaR figures of BEMO Bank reveal that the bank faces no problem if stock market crash occurs in Lebanon.

Second scenario: value of preferred shares added to market value of bank equity

Table 102 VaR Measures of BEMO Bank (Second Scenario)

Equity (in 10 ¹³ LBP)	Total Assets (in 10 ¹³ LBP)	Standard Deviation of Total Assets	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.0095	0.1775	0.012845	-0.021744323	-0.000104439
0.009	0.177	0.012204	-0.022033653	-0.000157662
0.0085	0.1765	0.011558	-0.02232373	-0.000210998
0.008	0.176	0.010909	-0.022613442	-0.00026428
0.0075	0.1755	0.010256	-0.022903318	-0.000317586
0.007	0.175	0.0096	-0.023192798	-0.000370832
0.0065	0.174499	0.00894	-0.023482274	-0.000424095
0.006	0.174	0.008276	-0.02377213	-0.00047738
0.0055	0.1735	0.007608	-0.024061944	-0.000530676
0.005	0.173	0.006937	-0.024351298	-0.000583903
0.0045	0.1725	0.006264	-0.024639644	-0.000636975
0.004	0.172	0.005596	-0.024923253	-0.000689325
0.0035	0.1715	0.004898	-0.025220697	-0.000743786
0.003	0.171	0.004211	-0.025510171	-0.000797031

The addition of the preferred shares to the market value of bank equity results in negative 10-day 99% VaR figures. This indicates that using the 10-day 99% VaR methodology or the 1-year 99.9% VaR methodology will have no effect on the equity of BEMO bank and hence the bank will be able to absorb the crashing shocks easily.

To sum up, under the second scenario, the 10-day 99% and 1-year 99.9% VaR figures of BEMO Bank reveal that the bank faces no problem if stock market crash occurs in Lebanon. Under this scenario, the bank's ability to withstand stock market crashes is even stronger.

The next section presents the stress testing by using the VaR methodology under normal circumstances, that is, when there is no crashing. The stress testing is done by changing the standard deviation of each bank from its lower confidence limit to its upper limit. As previously, the stress testing is done under the two usual scenarios.

Bank Audi

First scenario: value of preferred shares added to deposits

The first figure under the column 10-day 99% VaR, in table 103, indicates that there's 1% probability that the assets of Bank Audi will decrease by 0.0093×10^{13} LBP or more over the next 10 days if the standard deviation of equity is at its lowest limit. Comparing this value to the equity, which is a fixed input in this analysis, it is clear the value of VaR is less than the value of equity. Hence, Bank Audi's equity, when the standard deviation of its equity is at its lowest limit, can absorb losses very easily.

By referring to the table below, as the standard deviation of equity is increased from its lower limit to its upper limit, the 10-day 99% VaR values are also increasing, indicating that as

the deviation is increased, the assets of the bank will decrease by more percentage, which is rational. However, all the way through, the figures of VaR are always less than the value of the equity. Therefore, Bank Audi faces no problem if the standard deviation of its equity is changed.

Table 103 VaR Measures of Bank Audi (First Scenario)

Equity (in 10 ¹³ LBP)	Standard Deviation of Equity	Standard Deviation of Total Assets	Total Assets (in 10 ¹³ LBP)	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.43	0.24	0.0251	4.111598	-0.640134076	0.009375094
0.43	0.25	0.026146	4.111598	-0.626844816	0.011403726
0.43	0.26	0.027192	4.111598	-0.613555555	0.013432358
0.43	0.27	0.028238	4.111597	-0.600266149	0.015460987
0.43	0.28	0.029285	4.111596	-0.586964044	0.017491554
0.43	0.29	0.030333	4.111595	-0.573649241	0.019524059
0.43	0.3	0.031381	4.111592	-0.560334172	0.021556553
0.43	0.31	0.03243	4.111588	-0.547006284	0.023590978
0.43	0.32	0.033482	4.111582	-0.533640049	0.025631204
0.43	0.33	0.034535	4.111574	-0.520260894	0.027673351
0.43	0.34	0.03559	4.111563	-0.506856012	0.029719347
0.43	0.35	0.036649	4.111547	-0.493399784	0.03177305
0.43	0.36	0.03771	4.111527	-0.479917783	0.033830584
0.43	0.37	0.038776	4.111501	-0.466371711	0.035897742
0.43	0.38	0.039847	4.111469	-0.452761627	0.037974515
0.43	0.39	0.040923	4.111429	-0.439087378	0.040060875
0.43	0.4	0.042004	4.11138	-0.425348944	0.042156798
0.43	0.41	0.043092	4.111322	-0.411521008	0.044266149
0.43	0.42	0.044187	4.111252	-0.397603374	0.046388881
0.43	0.43	0.04529	4.11117	-0.383583467	0.048526912

The 1-year 99.9% VaR figures indicate that the capital of Bank Audi can easily absorb variations in its equity value over a period of 1 year. If variations occur, Bank Audi will be able to withstand losses for a year. Therefore, since the bank's profitability is above the expected losses, changes in the standard deviation of equity will have no effect on its performance.

The stress testing results of Bank Audi is summed up under the first scenario by concluding that the bank is capable of absorbing losses if its standard deviation of equity is changed from its lower limit to upper limit. This conclusion is reached by referring to the 1-year 99.9% VaR figures and the 10-day 99% VaR figures.

Second scenario: value of preferred shares added to market value of bank equity

Table 104 VaR Measures of Bank Audi (Second Scenario)

Equity (in 10 ¹³ LBP)	Standard Deviation of Equity	Standard Deviation of Total Assets	Total Assets (in 10 ¹³ LBP)	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.44	0.22	0.023597	4.102099	-0.657706433	0.006445222
0.44	0.23	0.024671	4.1021	-0.644093118	0.008523348
0.44	0.24	0.025743	4.102099	-0.630504841	0.0105976
0.44	0.25	0.026816	4.102098	-0.616903894	0.012673786
0.44	0.26	0.027889	4.102098	-0.603303101	0.014749974
0.44	0.27	0.028962	4.102097	-0.589702164	0.016826159
0.44	0.28	0.030036	4.102096	-0.576088558	0.018904277
0.44	0.29	0.03111	4.102095	-0.562474959	0.020982394
0.44	0.3	0.032185	4.102092	-0.548848424	0.023062434
0.44	0.31	0.033261	4.102088	-0.535209102	0.0251444
0.44	0.32	0.034339	4.102082	-0.521544202	0.027230218
0.44	0.33	0.035419	4.102074	-0.507853744	0.029319885
0.44	0.34	0.036502	4.102062	-0.494124831	0.031415319
0.44	0.35	0.037587	4.102047	-0.480370296	0.033514586
0.44	0.36	0.038676	4.102027	-0.466564592	0.035621533
0.44	0.37	0.039769	4.102001	-0.45270766	0.037736145
0.44	0.38	0.040866	4.101968	-0.438799454	0.039858401
0.44	0.39	0.041969	4.101928	-0.424814697	0.04199216
0.44	0.4	0.043078	4.101878	-0.410753162	0.044137379
0.44	0.41	0.044194	4.101819	-0.396602377	0.046295988

Under the second scenario, and from the table above, adding the value of preferred shares to the market value of bank equity will not affect the performance of Bank Audi if its standard deviation of returns on equity is changed from its lower limit to its upper limit.

The 10-day-99% VaR figures are all greater than the value of bank's equity indicating that losses could be absorbed by the equity. The same conclusion is valid under the 1-year-99.9% stress testing. Additionally, the 1-year-99.9% VaR figures are all negative, which is a strong evidence of bank's ability to withstand losses for a period of 1 year.

The results of the second scenario are similar to the results of the first scenario. Therefore, Bank Audi has enough profits to absorb losses if its standard deviation of equity is changed from its lower limit to upper limit based on the two VaR figures.

BLOM Bank

First scenario: value of preferred shares added to deposits

Table 105 VaR Measures of BLOM Bank (First Scenario)

Equity	Standard Deviation of Equity	Standard Deviation of Total Assets	Total Assets	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.27	0.18	0.015391	3.157598	-0.319352076	0.003681005
0.27	0.19	0.016247	3.1576	-0.3110003	0.004955953
0.27	0.2	0.017102	3.1576	-0.302658079	0.00622941
0.27	0.21	0.017957	3.1576	-0.294315857	0.007502867
0.27	0.22	0.018812	3.1576	-0.285973636	0.008776324
0.27	0.23	0.019667	3.157599	-0.277631327	0.010049778
0.27	0.24	0.020522	3.157599	-0.269289108	0.011323234
0.27	0.25	0.021377	3.157598	-0.260946807	0.012596687
0.27	0.26	0.022233	3.157598	-0.252594834	0.013871632
0.27	0.27	0.023088	3.157598	-0.244252618	0.015145088
0.27	0.28	0.023944	3.157597	-0.23590057	0.016420028
0.27	0.29	0.024801	3.157596	-0.227538771	0.017696457
0.27	0.3	0.025658	3.157594	-0.219176907	0.018972879
0.27	0.31	0.026517	3.157592	-0.21079554	0.020252279

The first figure under the column 10-day 99% VaR, in table 105, indicates that there's 1% probability that the assets of BLOM Bank will decrease by 0.0036×10^{13} LBP or more over

the next 10 days if the standard deviation of its equity is changed. Comparing this value to the equity, it is obvious that the value of VaR is less than the value of equity by far. Hence, BLOM bank's equity can absorb losses very easily. This is valid for all the figures of the same column.

The 1-year 99.9% VaR figures indicate that the capital of BLOM bank can easily absorb variations in its standard deviation of equity over a period of 1 year. The negative figures indicate that the bank is not losing and the expected losses are below its profitability.

The stress testing results of BLOM Bank under the first scenario show that the bank is capable of absorbing losses if its standard deviation of equity is changed from its lower limit to upper limit. This conclusion is reached by referring to the 1-year 99.9% VaR figures and the 10-day 99% VaR figures.

Second scenario: value of preferred shares added to market value of bank equity

Table 106 VaR Measures of BLOM Bank (Second Scenario)

Equity (in 10 ¹³ LBP)	Standard Deviation of Equity	Standard Deviation of Total Assets	Total Assets (in 10 ¹³ LBP)	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.29	0.16	0.014726	3.150898	-0.325149077	0.00268483
0.29	0.17	0.015646	3.1509	-0.316191904	0.004052194
0.29	0.18	0.016567	3.1509	-0.30722479	0.005421042
0.29	0.19	0.017487	3.1509	-0.298267411	0.006788404
0.29	0.2	0.018407	3.1509	-0.289310033	0.008155765
0.29	0.21	0.019328	3.1509	-0.280342918	0.009524613
0.29	0.22	0.020248	3.1509	-0.271385539	0.010891975
0.29	0.23	0.021169	3.1509	-0.262418424	0.012260823
0.29	0.24	0.022089	3.150899	-0.253460965	0.013628181
0.29	0.25	0.02301	3.150899	-0.244493854	0.014997029
0.29	0.26	0.02393	3.150898	-0.235536403	0.016364385
0.29	0.27	0.024851	3.150898	-0.226569294	0.017733232
0.29	0.28	0.025773	3.150897	-0.21759238	0.019103559

Under the second scenario, only the figures differ slightly; therefore, the above conclusions are valid for the second scenario as well.

The 1-year 99.9% VaR figures indicate that BLOM bank has absolutely no problem in absorbing losses if standard deviation of its equity is changed.

The 10-day 99% VaR figures show that the expected losses are always below the bank's equity; therefore, the bank's equity is strong enough to withstand the losses.

Byblos Bank

First scenario: value of preferred shares added to deposits

Table 107 VaR Measures of Byblos Bank (First Scenario)

Equity (in 10 ¹³ LBP)	Standard Deviation of Equity	Standard Deviation of Total Assets	Total Assets (in 10 ¹³ LBP)	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.13	0.31	0.019749	2.041496	-0.201599161	0.005649511
0.13	0.32	0.020389	2.041493	-0.197561608	0.006265798
0.13	0.33	0.021032	2.041489	-0.193505048	0.006884968
0.13	0.34	0.021676	2.041485	-0.189442195	0.0075051
0.13	0.35	0.022322	2.041479	-0.185366561	0.008127146
0.13	0.36	0.022971	2.041472	-0.181271937	0.008752074
0.13	0.37	0.023622	2.041462	-0.177164464	0.00937891
0.13	0.38	0.024277	2.04145	-0.17303163	0.010009581
0.13	0.39	0.024936	2.041435	-0.168873364	0.010644081
0.13	0.4	0.025598	2.041418	-0.164696074	0.011281449
0.13	0.41	0.026265	2.041396	-0.160486921	0.011923593
0.13	0.42	0.026937	2.041371	-0.156246089	0.012570518
0.13	0.43	0.027614	2.041342	-0.151973525	0.013222216
0.13	0.44	0.028297	2.041307	-0.147662802	0.013879632
0.13	0.45	0.028986	2.041268	-0.143314101	0.014542774
0.13	0.46	0.029681	2.041222	-0.138927245	0.015211616

The first figure under the column 10-day 99% VaR, in the above table, indicates that there's 1% probability that the assets of Byblos Bank will decrease by 0.0056×10^{13} LBP or more

over the next 10 days if standard deviation of equity at its lowest limit. Comparing this value to the equity, it is obvious that the value of VaR is less than the value of equity. Therefore, Byblos bank's equity, even if variation occurs, can absorb losses very easily.

The above conclusion is valid for all the values of standard deviation of equity. As long as the value of the equity is above the VaR figure, Byblos bank faces no problem in absorbing losses.

The 1-year 99.9% VaR figures indicate that the capital of Byblos bank can easily absorb variations in standard deviation of equity over a period of 1 year. The negative figures indicate that the bank's equity is strong enough to withstand losses.

The stress testing results of Byblos Bank under the first scenario prove that the bank is capable of absorbing losses if its standard deviation of equity is changed from its lower limit to upper limit. This conclusion is reached by referring to the 1-year 99.9% VaR figures and the 10-day 99% VaR figures.

Second scenario: value of preferred shares added to market value of bank equity

Table 108 VaR Measures of Byblos Bank (Second Scenario)

Equity (in 10 ¹³ LBP)	Standard Deviation of Equity	Standard Deviation of Total Assets	Total Assets (in 10 ¹³ LBP)	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.19	0.21	0.019547	2.041199	-0.202843908	0.005454199
0.19	0.22	0.020478	2.0412	-0.196971903	0.00635059
0.19	0.23	0.021409	2.0412	-0.1910998	0.007246978
0.19	0.24	0.02234	2.0412	-0.185227696	0.008143367
0.19	0.25	0.023271	2.041199	-0.179355504	0.009039751
0.19	0.26	0.024202	2.041199	-0.173483403	0.009936139
0.19	0.27	0.025134	2.041198	-0.167604913	0.010833484
0.19	0.28	0.026065	2.041198	-0.161732815	0.011729872
0.19	0.29	0.026998	2.041197	-0.155848026	0.012628179
0.19	0.3	0.027931	2.041196	-0.149963243	0.013526485
0.19	0.31	0.028865	2.041194	-0.144072088	0.014425746

Addition of the preferred shares to the market value of bank equity doesn't result in different conclusions regarding changing the standard deviation of equity. The 10-day 99% VaR figures show that that Byblos bank's equity can act as a buffer in case of changes in the standard deviation of its equity. The value of the equity is far beyond the 10-day-99% VaR figures indicating bank's ability to absorb possible losses.

The 1-year 99.9% VaR figures support more the above conclusion especially with the appearance of negative figures which indicate that the bank has the potential to make profits even if the standard deviation of its equity is changed from its lower limit to the upper limit.

BEMO Bank

First scenario: value of preferred shares added to deposits

Table 109 VaR Measures of BEMO Bank (First Scenario)

Equity (in 10 ¹³ LBP)	Standard Deviation of Equity	Standard Deviation of Total Assets	Total Assets (in 10 ¹³ LBP)	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.018	0.25	0.024724	0.1901	-0.016310032	0.000953327
0.018	0.26	0.025713	0.1901	-0.015729084	0.00104201
0.018	0.27	0.026702	0.1901	-0.015148137	0.001130693
0.018	0.28	0.027693	0.1901	-0.014566014	0.001219555
0.018	0.29	0.028683	0.1901	-0.01398448	0.001308328
0.018	0.3	0.029675	0.190099	-0.013401699	0.001397272
0.018	0.31	0.030668	0.190099	-0.012818405	0.001486313
0.018	0.32	0.031662	0.190099	-0.012234524	0.001575444
0.018	0.33	0.032658	0.190098	-0.011649406	0.001664745
0.018	0.34	0.033657	0.190098	-0.011062591	0.001754324
0.018	0.35	0.034658	0.190097	-0.010474545	0.001844072
0.018	0.36	0.035662	0.190096	-0.009884744	0.001934088
0.018	0.37	0.036671	0.190095	-0.009292012	0.002024552
0.018	0.38	0.037684	0.190094	-0.008696937	0.002115373

The first figure under the column 10-day 99% VaR, in the above table, indicates that there's 1% probability that the assets of BEMO Bank will decrease by 0.0009×10^{13} LBP or more over the next 10 days if the standard deviation of equity is at its lowest limit. Comparing this value to the equity, which is a fixed input in this analysis, it is obvious that the value of VaR is less than the value of equity. Therefore, BEMO Bank's equity, when the standard deviation of its equity is at its lowest limit, can absorb losses very easily.

Referring to the above table, as the standard deviation of equity is increased from its lower limit to its upper limit, the 10-day 99% VaR values are also increasing, indicating that as the deviation is increased the assets of the bank will decrease by more percentage, which is rational. However, all the way through, the figures of VaR are always less than the value of the equity. Therefore, BEMO Bank faces no problem if the standard deviation of its equity is changed.

The 1-year 99.9% VaR figures indicate that the capital of BEMO Bank can easily absorb variations in its equity value over a period of 1 year. If variations occur, the bank will be able to withstand losses for a year. Therefore, since the bank's profitability is above the expected losses, changes in the standard deviation of equity will not affect the performance of BEMO bank.

The stress testing results of BEMO bank under the first scenario show that the bank is capable of absorbing losses if its standard deviation of equity is changed from its lower limit to upper limit. This conclusion is reached by referring to the 1-year 99.9% VaR figures and the 10-day 99% VaR figures.

Second scenario: value of preferred shares added to market value of bank equity

Table 110 VaR Measures of BEMO Bank (Second Scenario)

Equity (in 10 ¹³ LBP)	Standard Deviation of Equity	Standard Deviation of Total Assets	Total Assets (in 10 ¹³ LBP)	1-year 99.9% VaR (in 10 ¹³ LBP)	10-day 99% VaR (in 10 ¹³ LBP)
0.01	0.19	0.010674	0.178	-0.022999668	-0.000287014
0.01	0.2	0.011236	0.178	-0.022690556	-0.000239827
0.01	0.21	0.011797	0.178	-0.022381995	-0.000192725
0.01	0.22	0.012359	0.178	-0.022072884	-0.000145538
0.01	0.23	0.012921	0.178	-0.021763773	-9.83519E-05
0.01	0.24	0.013483	0.178	-0.021454661	-5.11655E-05
0.01	0.25	0.014045	0.178	-0.02114555	-3.97904E-06
0.01	0.26	0.014607	0.178	-0.020836439	4.32074E-05
0.01	0.27	0.015169	0.178	-0.020527328	9.03939E-05
0.01	0.28	0.015732	0.178	-0.020217666	0.000137664
0.01	0.29	0.016295	0.178	-0.019908005	0.000184935
0.01	0.3	0.016859	0.178	-0.019597794	0.000232289

Under the second scenario, and from the table above, negative figures of VaR for 1-year 99.9% and for 10-day 99% is observed. Therefore, adding the value of the preferred shares to the market value of bank equity of BEMO bank is resulting in better figures regarding the VaR. Hence, if the standard deviation of the bank's equity is changed from its lower limit to its upper limit, the bank has no problem in withstanding the possible losses.

In the next section, the summary of the findings of the three general stress tests is presented.

Summary of Findings

The Black-Scholes-Merton model is the theoretical model adopted in this thesis to perform stress testing on four Lebanese banks. The banks are the following: Bank Audi, BLOM Bank, Byblos Bank and BEMO Bank.

Three general stress testing procedures are performed for each bank:

1. Stress testing to changes in the equity variance
 - A model is adopted and the outputs of the model are analyzed by a regression analysis
2. Stress testing to crashes in equity prices that occur unexpectedly
 - A model is adopted and the outputs of the model are correlated with equity
3. Stress testing by using the VaR methodology
 - A model is adopted and the outputs on standard deviation of total assets are obtained and VaR values are calculated based on the variances.

The stress testing is performed for each bank under the two scenarios. The first is when the value of the preferred shares is added to the deposits and the second when the value of the preferred shares is added to the market value of bank equity.

The findings for all the banks are summarized below:

1. Stress testing to changes in the equity variance

First Scenario: value of preferred shares added to deposits

The regression analysis of the dependant variables: capital to assets ratio, total assets, probability of default, market debt, and standard deviation of debt on the independent variables,

standard deviation of returns on equity and its square, for the sampled banks revealed the same results:

- The relation between the dependent variables and the independent variables is significant
- A high percentage of each of the dependent variables is explained by the variation in the independent variables
- The whole regression model is significant
- Heteroskedasticity is absent in the regression model
- A square of the independent variable is observed for each regression which proved that the banks have minimum capital to assets ratio, probability of default and standard deviation of debt and a maximum of total assets and market debt at a fixed value of standard deviation of returns on equity. This value lies within the confidence interval of each bank

Second Scenario: value of preferred shares added to market value of bank equity

The regression analysis of the dependant variables: capital to assets ratio, total assets, probability of default, market debt, and standard deviation of debt on the independent variables: standard deviation of returns on equity and its square, for the sampled banks revealed different results for each:

- There's a significant relation between the dependent variables and the independent variable for all the banks except for two cases. First, the regression of the variable probability of default of Bank Audi revealed that it has an insignificant relation with the independent variable. The same is applicable to the variable total assets of BEMO Bank.

- A high percentage of each of the dependent variables is explained by the variation in the independent variable for Bank Audi and BLOM Bank. This is valid for Byblos Bank too except for one variable: standard deviation of debt. Finally, the same exception is valid for two variables of BEMO Bank: capital to assets ratio and market debt.
- The whole regression model is significant for all the banks
- Heteroskedasticity is absent from the regression models of Bank Audi. BLOM Bank faces heteroskedasticity problem with respect to three variables: capital to assets ratio, total assets and market debt. Byblos Bank faces the same problem with its standard deviation of debt and BEMO Bank has heteroskedasticity problem with its capital to assets ratio and market debt.
- The square of the independent variable in each regression proved that the banks have minimum capital to assets ratio, probability of default and standard deviation of debt and a maximum of total assets and market debt at a value of standard deviation of returns on equity. This value lies within the confidence interval of each bank. BEMO Bank is an exception with respect to its total assets variable which revealed that the bank has minimum total assets and this was attributed to sampling error.

2. Stock Market Crash

Prior to stress testing to crashes in equity prices, the significance of the correlation between equity and each of total assets, capital to assets ratio, standard deviation of total assets and standard deviation of debt is tested when stock market crash occurs in Lebanon. The four sampled banks had the same results.

First Scenario: value of preferred shares added to deposits

There is a strong positive correlation between equity and total assets, capital to assets ratio, standard deviation of total assets and standard deviation of debt and a strong negative correlation between equity and probability of default. It's important to mention that Bank Audi, BLOM Bank and BEMO Bank had perfect positive correlation between their equity values and total assets.

Second Scenario: value of preferred shares added to market value of bank equity

There is a strong positive correlation between equity and total assets, capital to assets ratio, standard deviation of total assets and standard deviation of debt and a strong negative correlation between equity and probability of default. It's important to mention that BLOM Bank and BEMO Bank had perfect positive correlation between their equity values and total assets.

The positive correlation between the equity and total assets under the two scenarios is because when equity is crashed the liabilities of the bank are unaffected and the total assets move in parallel with the direction of equity to balance the fall in the equity. The positive correlation between equity and standard deviation of total assets can be justified by referring to the Black-Scholes-Merton model's principle. When the standard deviation of total assets is high, the option price is also high. Since the equity of the bank is an option on the assets of the bank, as the standard deviation of the assets decrease, the option price, which is the equity, also decreases. The negative correlation between equity and the probability of default can be explained simply by saying that as the equity of the bank decreases, the risk that the bank will fail to honor its obligations increase. The positive correlation between equity and capital to assets ratio is

explained by the fact that when equity falls, total assets also fall and the reason is justified above. The capital is composed of Tier 1 and Tier 2 capital, which is the equity, and when this figure is crashed, total assets are also affected and hence the ratio of capital to total assets decrease too. Finally, the positive correlation between equity and standard deviation of debt is the result of the positive correlation between equity and standard deviation of total assets.

3. Stress testing by using the VaR methodology when:

- a. Stock market crash occur in Lebanon
- b. Standard deviation of returns on equity is changed from lower limit to upper limit

Based on Basel recommendations, the 10-day 99% VaR and 1-year 99.9% VaR measures are adopted to stress test the sampled banks under each scenario and for the two cases mentioned above. The findings of the first case are summarized below:

a. Stock market crash occur in Lebanon

The outcome of the two scenarios is presented together since both revealed the same results.

- The 10-day 99% VaR figures for all the sampled banks revealed that the banks' equity is strong enough to absorb losses when stock market crashes occur in Lebanon.
- The 1-year 99.9% VaR figures for all the sampled banks revealed that the banks' capital can easily absorb shocks over a period of one year. The banks' profitability is above the expected losses and hence crashing will have no effect on the equity of the banks.

b. Standard deviation of returns on equity is changed from lower limit to upper limit

The stress testing of a sample of Lebanese banks by changing the standard deviation of returns on equity from its lower confidence limit to upper confidence limit revealed the same results under the two scenarios.

- The 10-day 99% VaR figures for all the sampled banks revealed that the banks' equity is strong enough to absorb losses.
- The 1-year 99.9% VaR figures for all the sampled banks revealed that the banks' capital can easily absorb the losses over a period of one year. The banks' profitability is above the expected losses and hence if standard deviation of returns on equity is changed within the values of the confidence interval for each bank, the banks will face no problems in absorbing the losses.

Conclusion

This study provides a thorough insight of how to perform stress testing of banks by applying the Black-Scholes-Merton option pricing model. The study will also assist in predicting if the amount of capital is sufficient to withstand unexpected market crashes, and it will prepare the Lebanese banks for the Basel III new tougher capital requirements.

Limitations

Although this study was carefully performed and has reached its aims, there were some unavoidable limitations and shortcomings which are essential to mention. One of the limitations of this study is that it is based on only one year, the year 2009. Second, the Black-Scholes-Merton option pricing model which is the model adopted in this study is applicable only to banks which are listed on the Beirut Stock Exchange. Third, the growth rate of total assets calculated is

higher than 15% for all the banks. This rate is calculated for each bank for the period between 2005 to 2009. This high percentage affected the VaR figures and provided better results; however, it is likely that such a high growth rate may not materialize in the future. Fourth, two banks are excluded from the study although these banks have their shares listed on the Beirut Stock Exchange. Fifth, the study couldn't cover all the liquidity, solvency, and profitability ratios required by the Basel rules and regulations. The study focused mainly on capital to assets ratio. Finally, the literature review is of a concern of this study. Although the Basel rules and regulations are covered in the first part of the thesis; however, no literature was available regarding how stress testing is performed in the banks. Additionally, there is no study of adopting an option pricing model and stress testing the banks which is considered to be the originality of this study.

Recommendations

Regarding the maturity of the model and to solve one of the study's limitations, it is highly recommended to expand this study by referring to data before year 2009 and perform a comparative analysis between the results obtained. The research could also be developed by referring to years after 2009.

Taking into consideration that the Basel rules and regulations are considered to be the backbone of the financial system, it is suggested to take into consideration all the requirements of the Basel rules and regulations and perform tests to make sure if the Lebanese banks' ratios are compatible with the international standards.

Regarding the Black-Scholes-Merton option pricing model, its applicability is dependent on the banks which are listed on the Beirut Stock Exchange and taking into consideration that the

capital market in Lebanon is not well developed, it is suggested to further develop the capital market in order to apply the model on more number of banks.

Scatter Diagrams

Bank Asst1

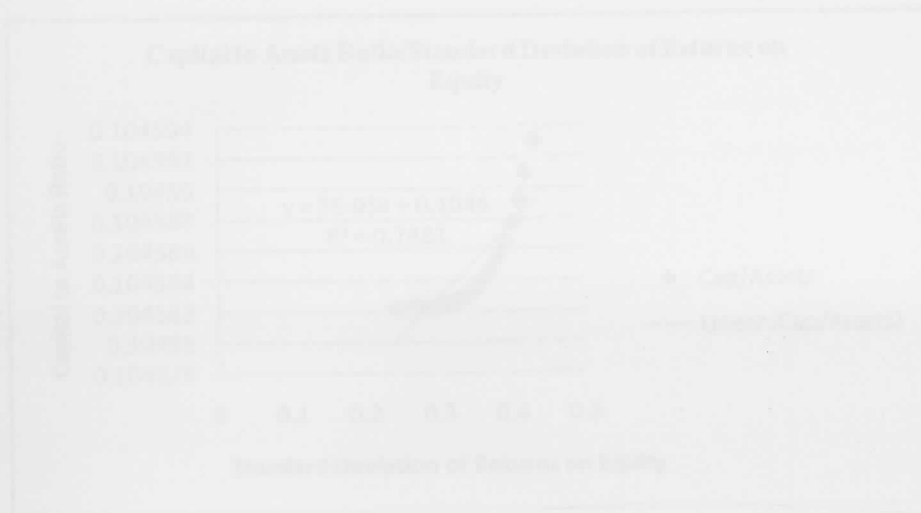


Figure 1a

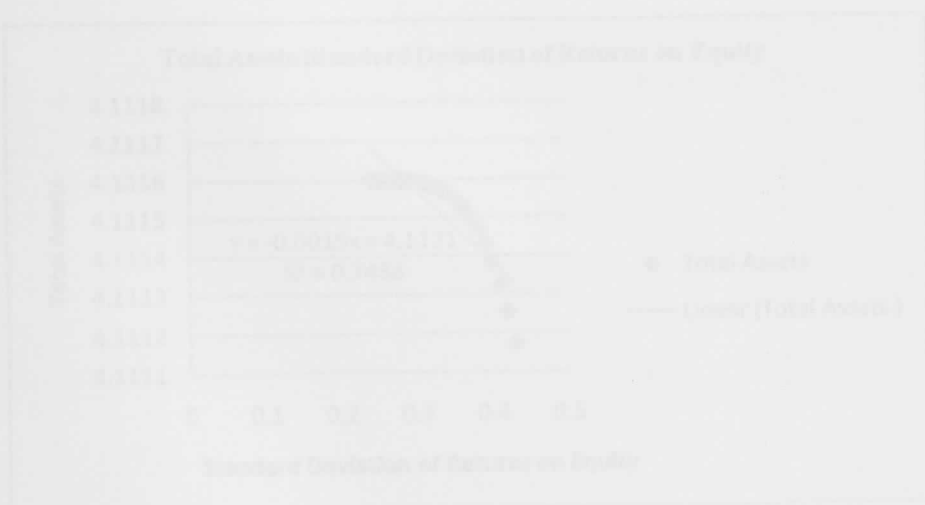


Figure 1b

Appendix 1 Scatter Diagrams

Bank Audi

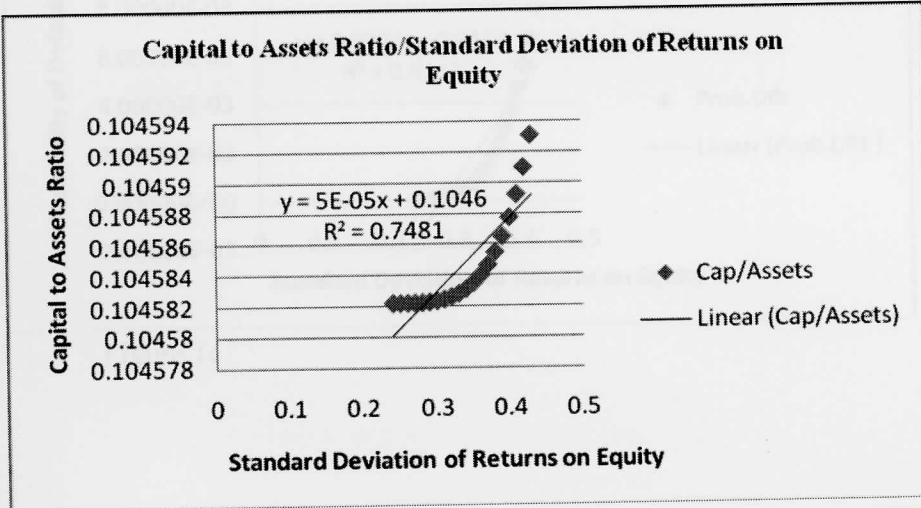


Figure 1a

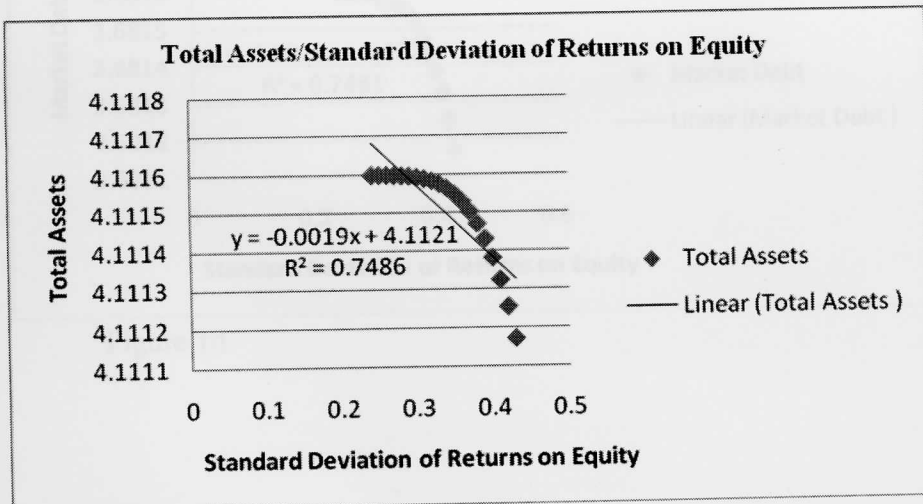


Figure 1b

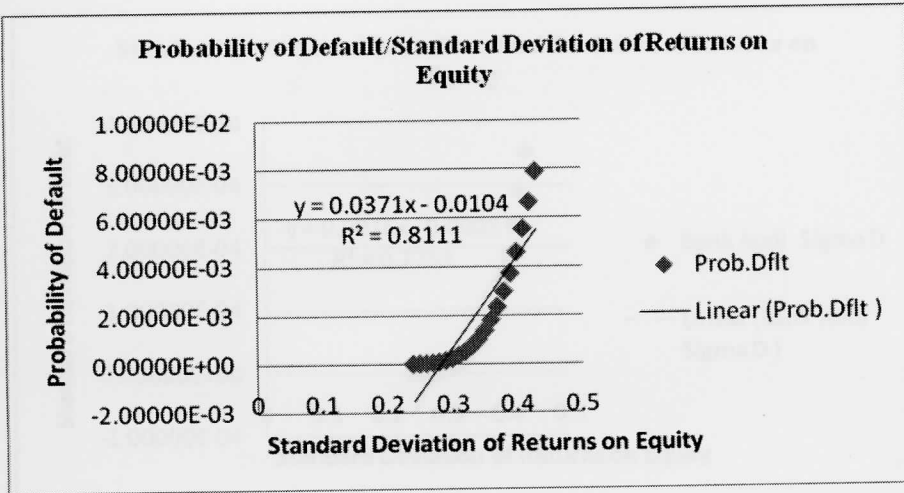


Figure 1c

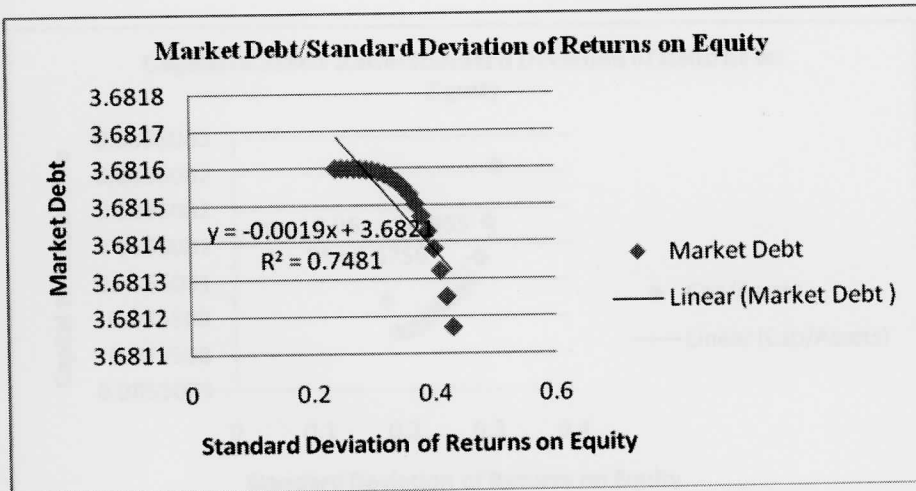


Figure 1d

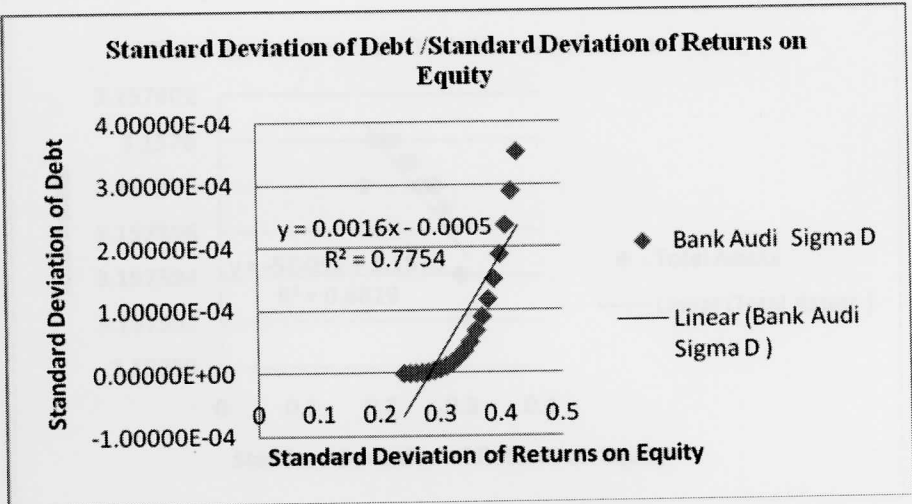


Figure 1e

BLOM Bank

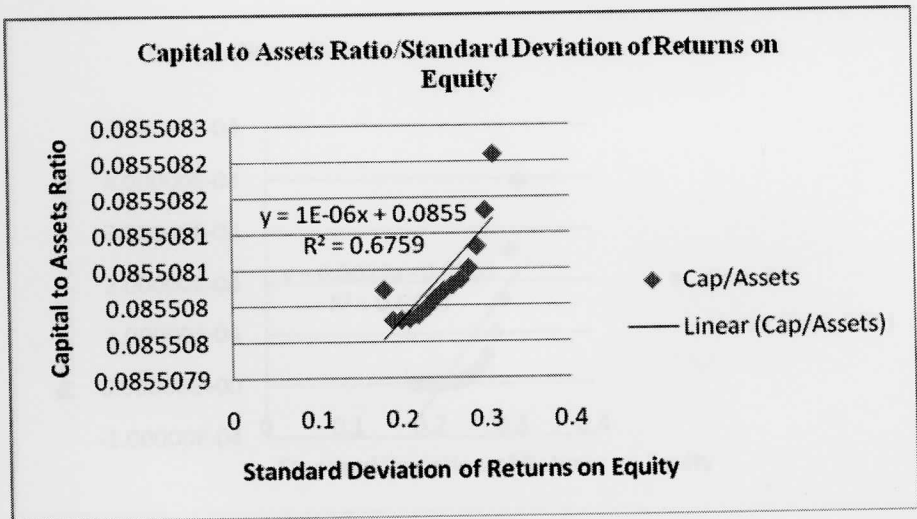


Figure 1f

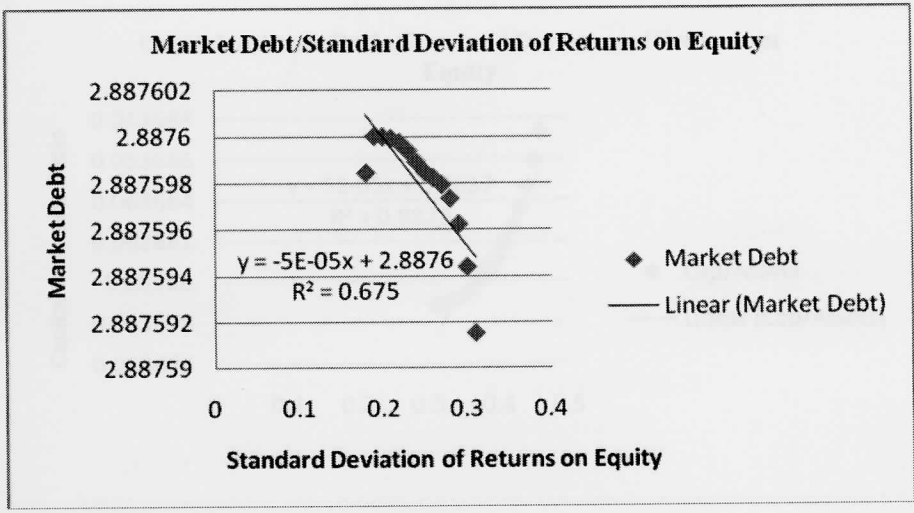


Figure 1i

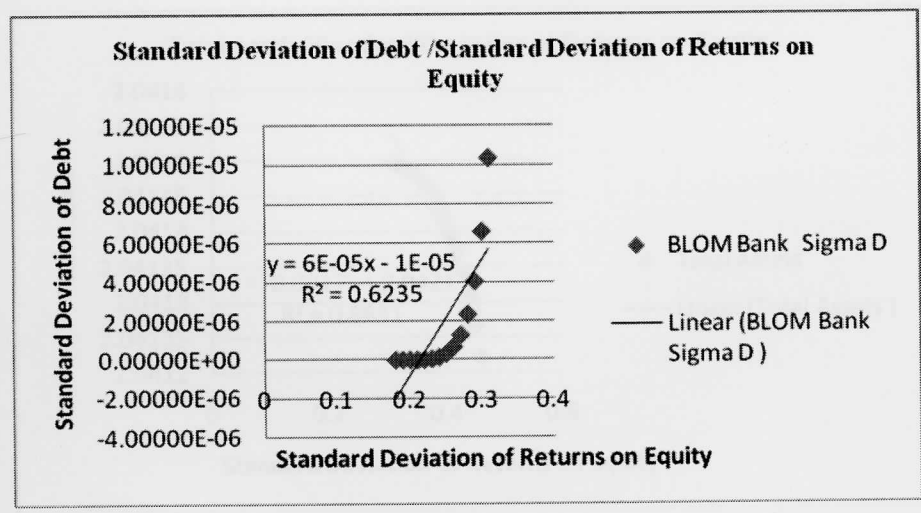


Figure 1j

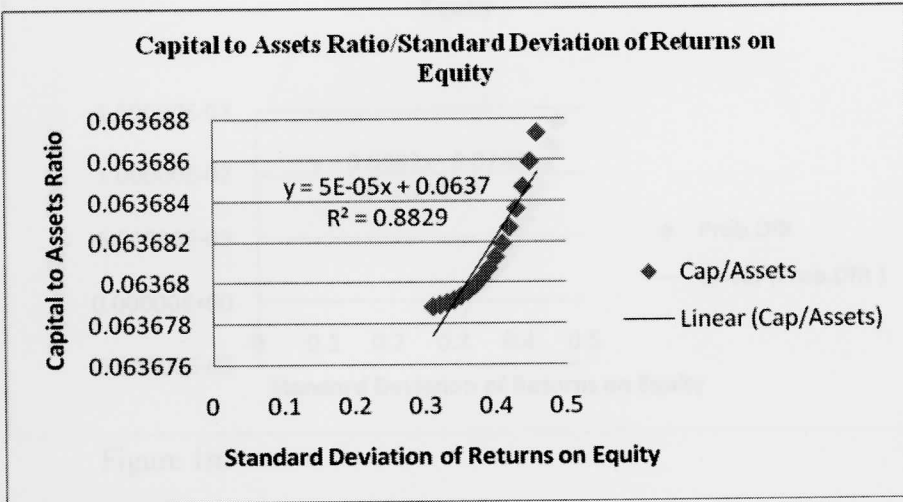


Figure 1k

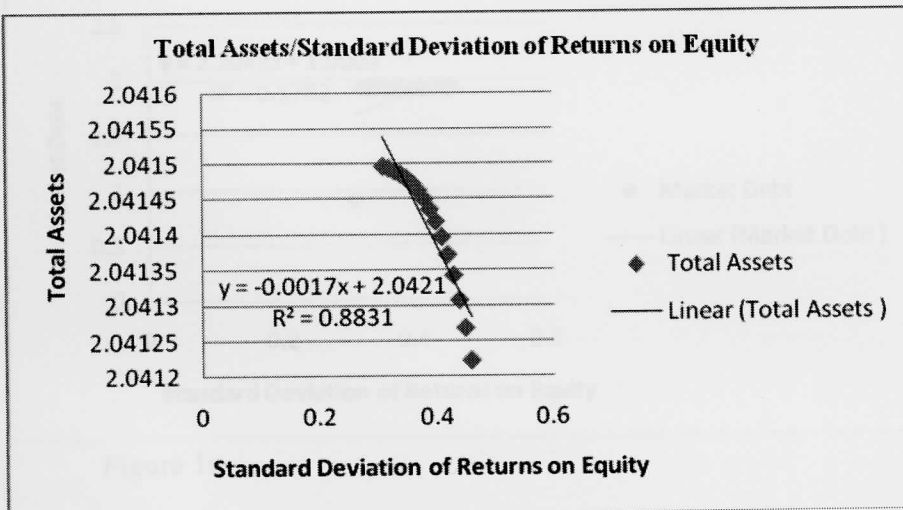


Figure 1l

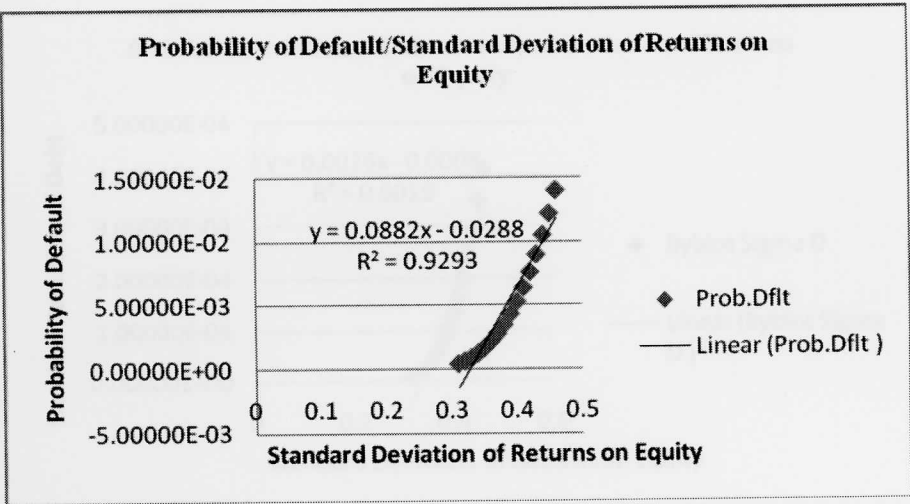


Figure 1m

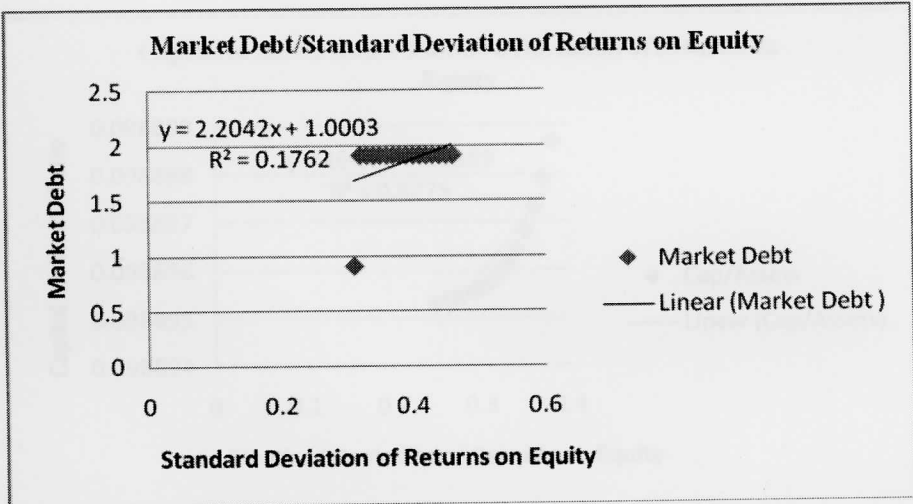


Figure 1n

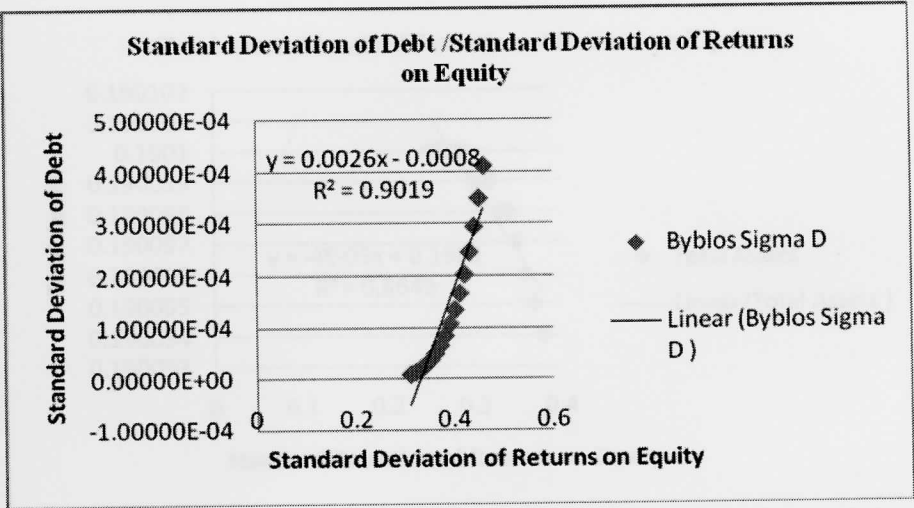


Figure 1o

BEMO Bank

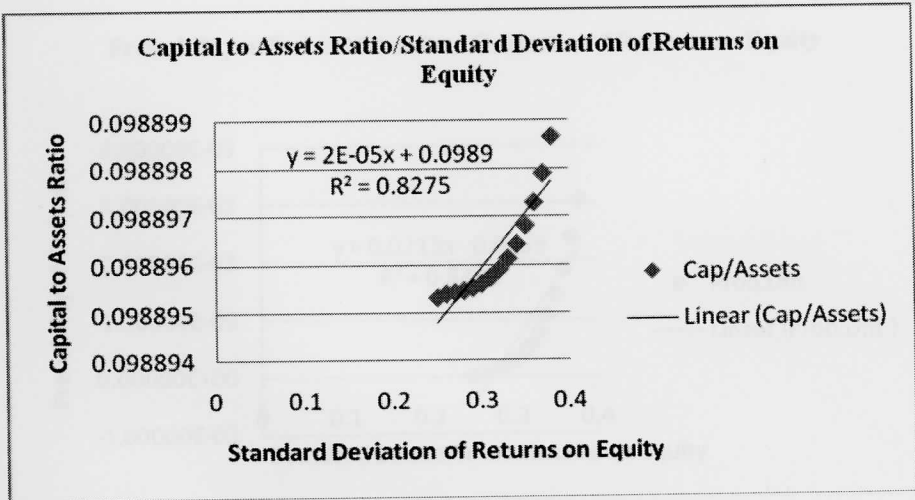


Figure 1p

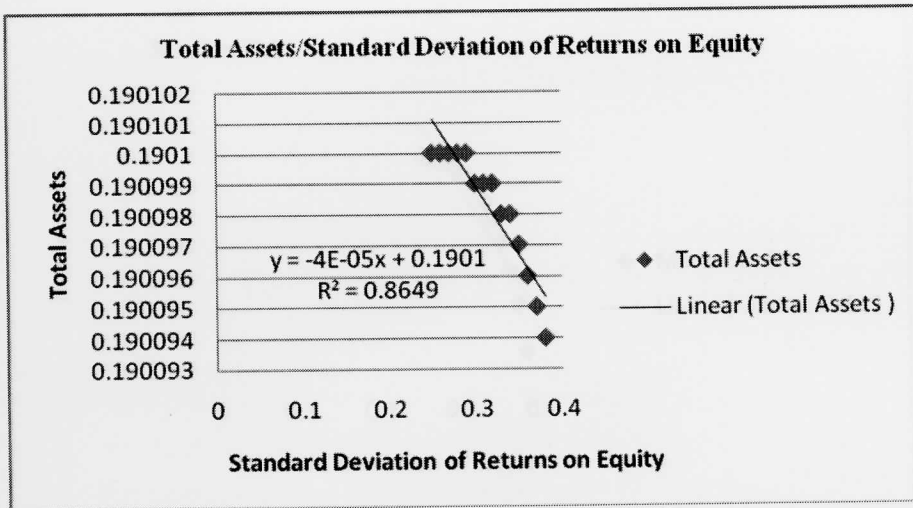


Figure 1q

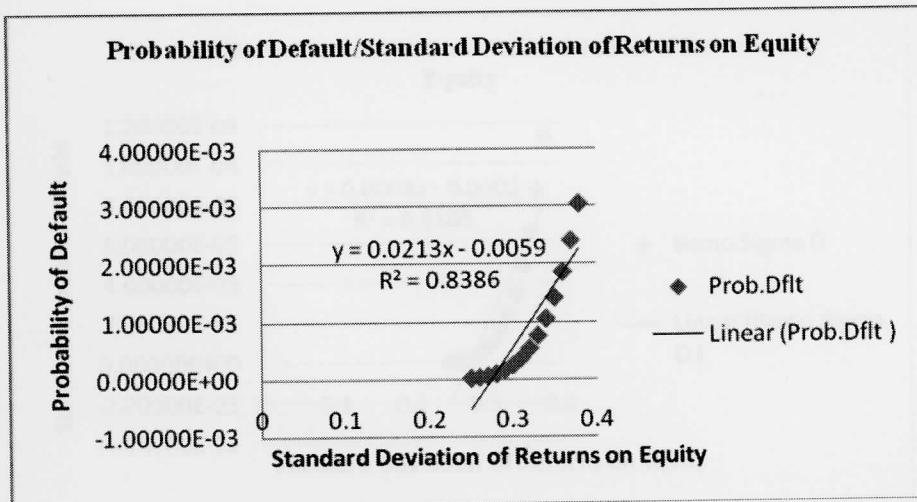


Figure 1r

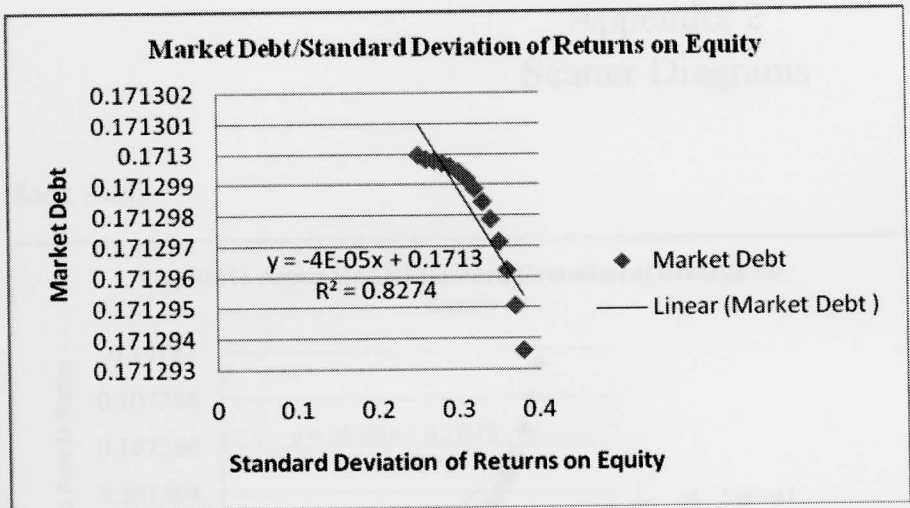


Figure 1s

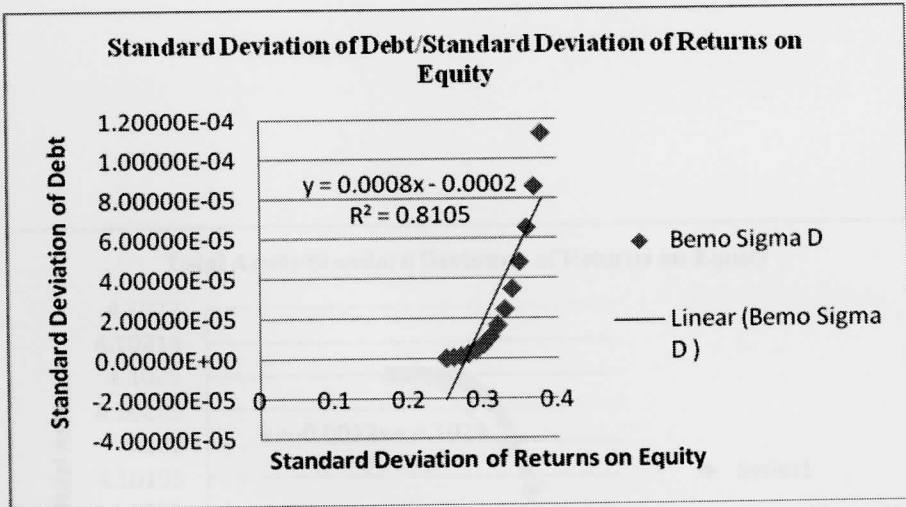


Figure 1t

Appendix 2 Scatter Diagrams

Bank Audi

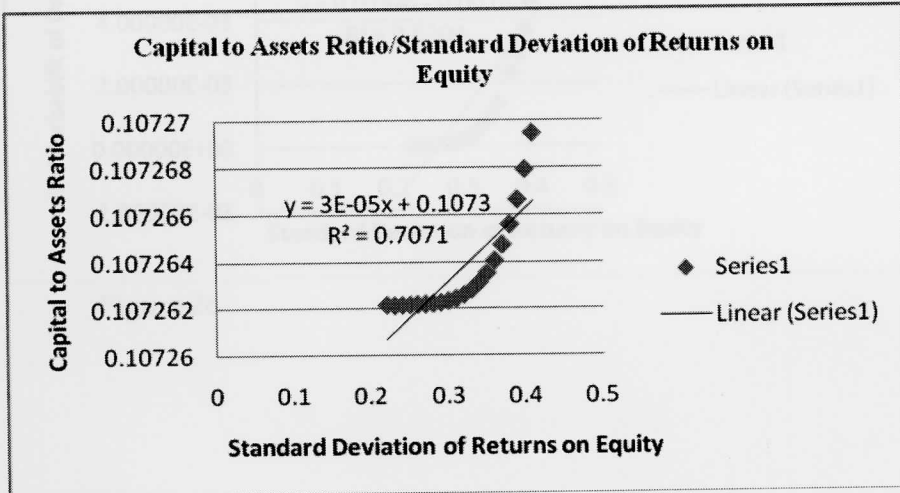


Figure 2a

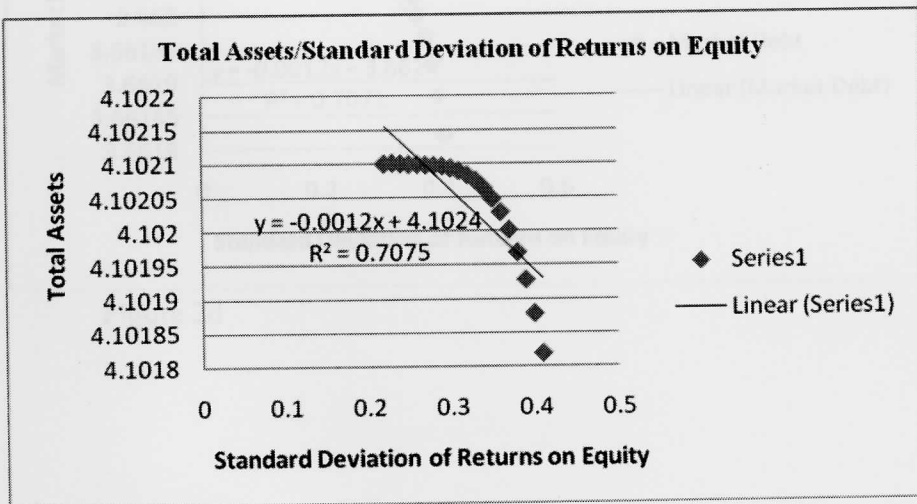


Figure 2b

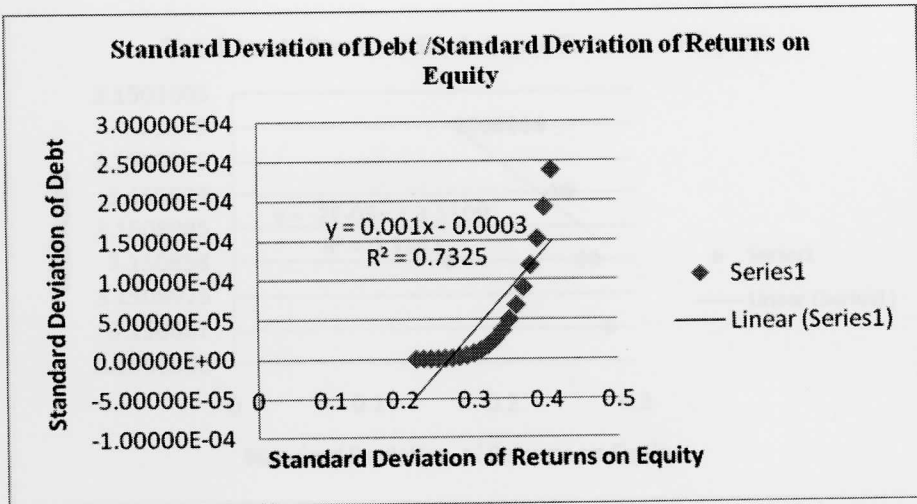


Figure 2e

BLOM Bank

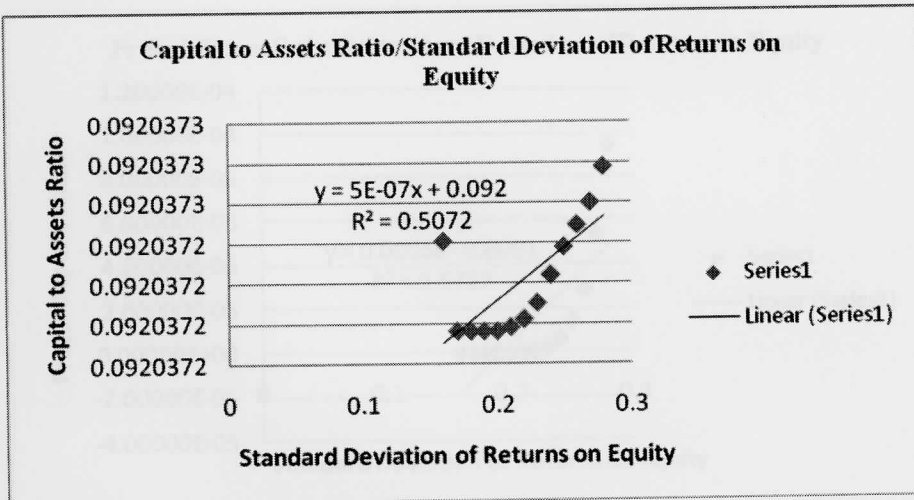


Figure 2f

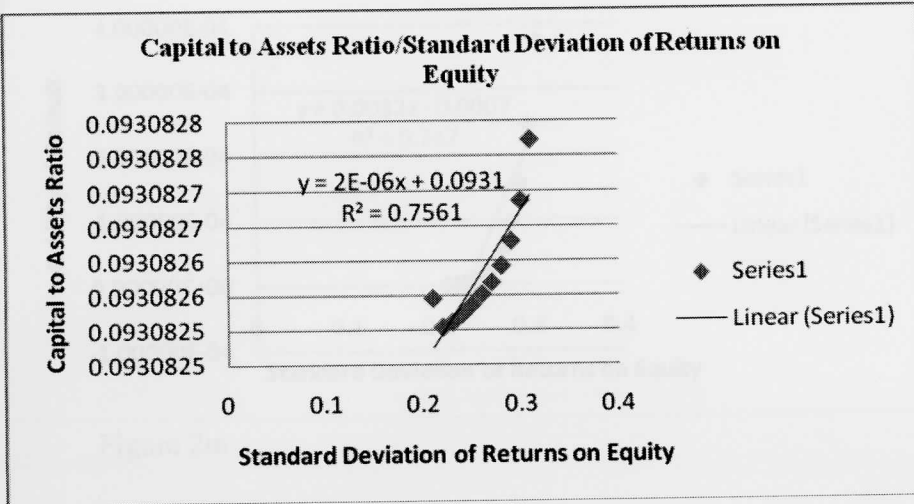


Figure 2k

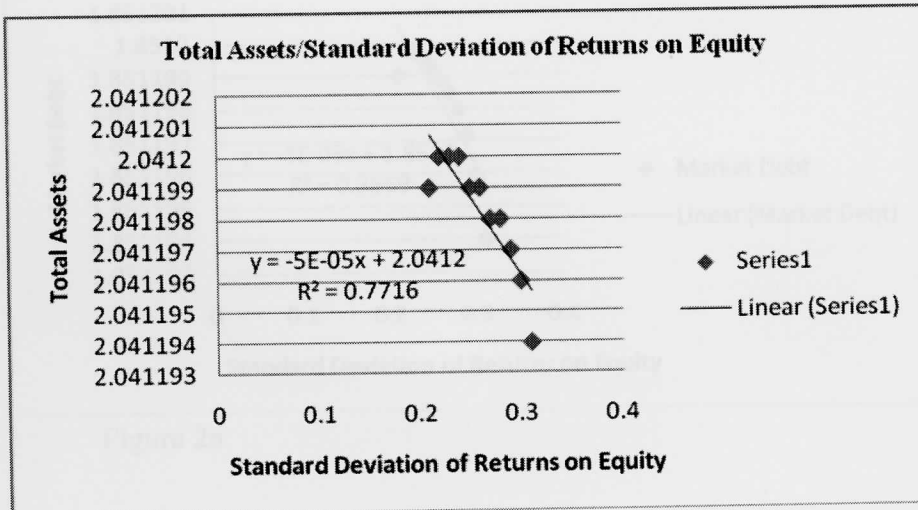


Figure 2l

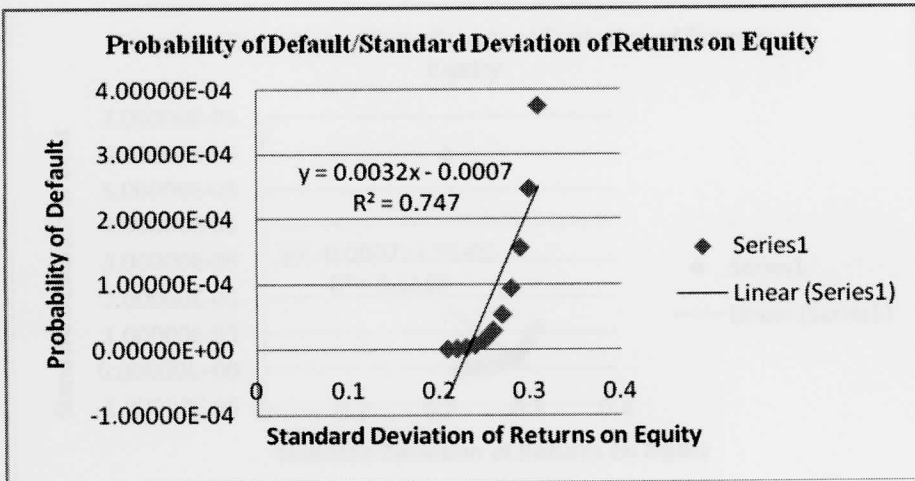


Figure 2m

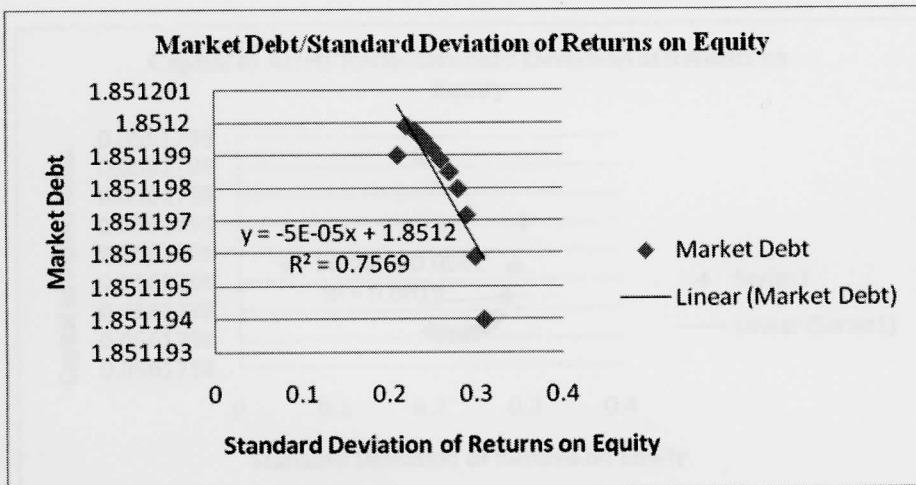


Figure 2n

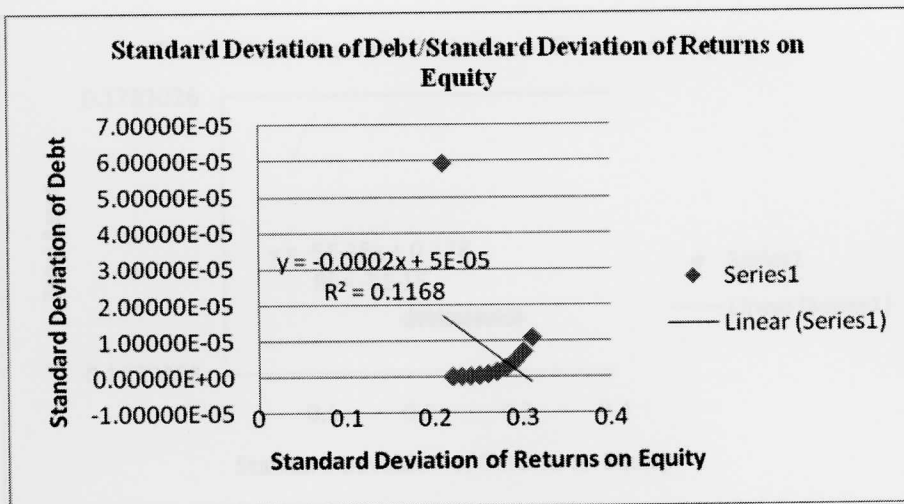


Figure 2o

BEMO Bank

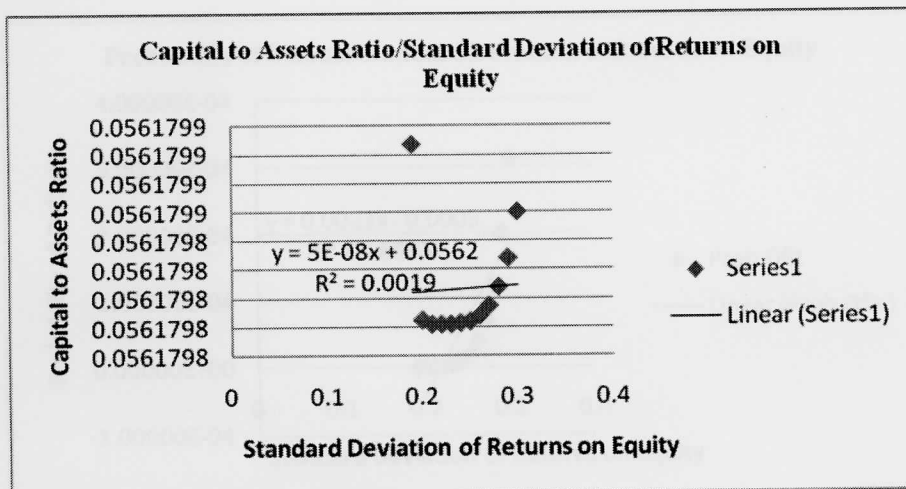


Figure 2p

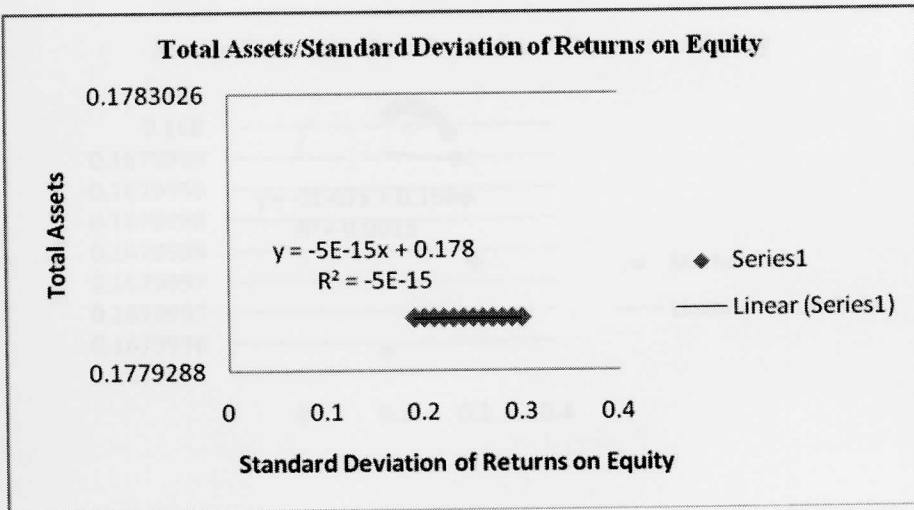


Figure 2q

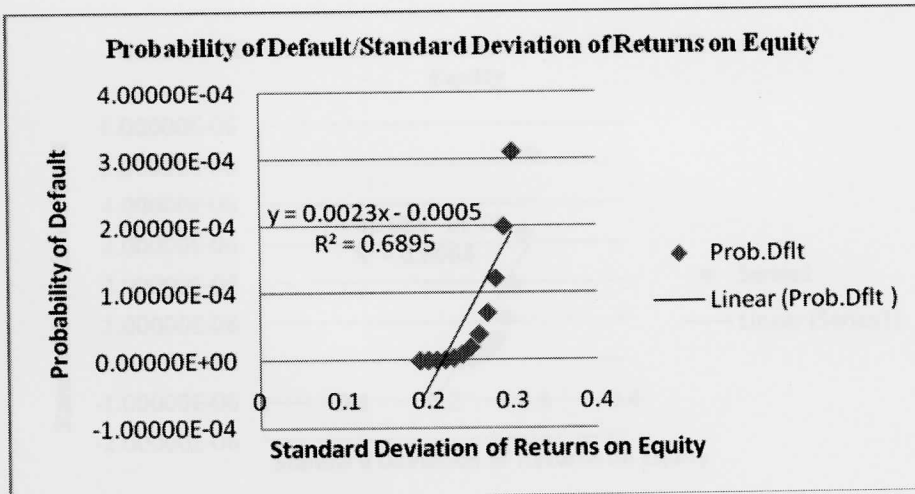


Figure 2r

Appendix 3

Critical r Derivation

$$t_{\text{critical}} = \frac{r_c \sqrt{n-2}}{\sqrt{1-r_c^2}}$$

Where, r_c is the correlation coefficient (r critical) and n is the number of observations

Taking the square of both sides, we have:

$$t_c^2 = \frac{(n-2)r_c^2}{(1-r_c^2)}$$

We cross multiply and we have:

$$t_c^2 - r_c^2 t_c^2 = (n-2)r_c^2$$

$$t_c^2 = (n-2)r_c^2 + r_c^2 t_c^2$$

$$t_c^2 = r_c^2 [n-2 + t_c^2]$$

$$r_c^2 = \frac{t_c^2}{n-2 + t_c^2}$$

$$r_c = \sqrt{\frac{t_c^2}{n-2 + t_c^2}} = \frac{t_c}{\sqrt{n-2 + t_c^2}}$$

Bibliography

About BIS. (n.d.). *Bank for International Settlements*. Retrieved from <http://www.bis.org/about/index.htm>

Amendment to the Capital Accord to Incorporate Market Risks. (2005). *Bank for International Settlements*. Retrieved from www.bis.org

Awad, A. (2004). "Lebanon's Preparations and Related Issues from Basel II Assessing Progress and Roadmap. *Advanced Risk Management: Assessing, Managing and Supervising Financial Risk*. Retrieved from <http://info.worldbank.org/etools/docs/library/.../lebanon%5B1%5D.ppt>

Awad, A. (2006). "Obstacles Encountered by an Emerging Economy in Implementing Basel II: The Lebanese Experience." Conference Presentation. 19 Oct. 2006.

Bank Audi SAL- Delisting of Shares. (2005) *Investigate*. Retrieved from <http://www.investigate.co.uk/article.aspx?id=2005021414000057721>

Bank for International Settlements. (2009). Retrieved from <http://www.bis.org/publ/bcbs158.htm>

Basel II-a Guide to Capital Adequacy Standards for Lending. (n.d.). *Council of Mortgage Lenders*. Retrieved from <http://www.cml.org.uk/cml/policy/issues/748>

Basel III (2011). *Lexicon Financial Times*. Retrieved from <http://lexicon.ft.com/Term?term=Basel-III>

Baz, F. C. (2010). *Bilanbanques 2010*. Beirut: Bankdata Financial Services WLL

BDL Basic Circular (2000). Retrieved from Banque Du Liban: <http://www.bdl.gov.lb/circ/circpdf/77.pdf>

BDL Basic Circular (2001). Retrieved from Banque Du Liban:

<http://www.bdl.gov.lb/circ/circpdf/81.pdf>

BDL Basic Circular (2006). Retrieved from Banque Du Liban:

<http://www.bdl.gov.lb/circ/circpdf/104.pdf>

BDL Basic Circular (2006). Retrieved from Banque Du Liban:

<http://www.bdl.gov.lb/circ/circpdf/106.pdf>

BDL Basic Circular (2007). Retrieved from Banque Du Liban:

<http://www.bdl.gov.lb/circ/circpdf/108.pdf>

BDL Basic Circular (2008). Retrieved from Banque Du Liban:

<http://www.bdl.gov.lb/circ/circpdf/119.pdf>

BDL Basic Circular (2009). Retrieved from Banque Du Liban:

<http://www.bdl.gov.lb/circ/circpdf/121.pdf>

Bertelsmann S. (2009) BTI 2010- Lebanon Country Report. Gutersloh : Bertelsmann Stiftung

Bosley, C. (2011). Basel to update midyear on banks' coco usage." *Thomson Reuters*.

CEPS Task Force Report.(2008) *Basel II implementation in the midst of turbulence*. Retrieved from <http://www.ceps.eu/book/basel-ii-implementation-midst-turbulence>

Davis, B. (2010) Banks Could Struggle with New Rules. *The Wall Street Journal*.

El Harati, H.H. (2003). *The new basel capital accord: presentation and implications*. Retrieved from American University of Beirut MA thesis.

Emmons, W. R., Lskavyan, V., & Yeager, T. J. (2005). Basel II will trickle down to community bankers, consumers. *Regional Economist*. Retrieved from <http://www.highbeam.com/doc/1P3-822335281.html>

Experience with Basel Core Principle Assessments. (2000). *International Monetary Fund*. Retrieved from <http://www.imf.org/external/np/mae/bcore/exp.htm>

FFA Private Bank. (2009). *Activity and performance of the lebanese banking sector 2008*. Retrieved from <http://www.ffaprivatebank.com/NewsDetails.aspx?ID=515&MID=351&PID=322>

FFA Private Bank. (2010) *The lebanese banking Sector 2009*. Retrieved from www.ffaprivatebank.com/pdf/The-Lebanese-banking-sector-2009.pdf

Hendricks, D. (1996). Evaluation of value-at-risk models using historical data.(methods for estimating market risk). *Federal Reserve Bank of New York Economic Policy Review*. Retrieved from <http://www.highbeam.com>

History of the Basel Committee and Its Membership (2009). *Bank for International Settlements*. Retrieved from <http://www.bis.org/bcbs/index.htm>

Hull, J.C. (2010). *Risk management and financial institutions*. United States of America: Prentice Hall.

International Regulatory Framework for Banks (Basel III). (n.d.). *Bank for International settlements*. Retrieved from <http://www.bis.org/bcbs/basel3.htm>

Jenkins, P. (2010). Barclays chief praises ‘substance’ of basel”. *The Financial Times*.

Jorion, P. (1997). *Value at risk: the new benchmark for controlling market risk*. California: IRWIN

Lucchetti, A. & Philbin, B. (2010). Morgan stanley may wait on smith barney. *The Wall Street Journal*. Retrieved from <http://online.wsj.com/article/SB10001424052748703506904575592633195828658.html>

Masters, B. & Baer J. (2010). US banks face \$100 billion basel III shortfall. *The Financial Times*. Retrieved from <http://www.ft.com/intl/cms/s/0/42d42de2-f593-11df-99d6-00144feab49a.html>

Mohanty, S. K. (2008). Basel II: challenges and risks.(Accord on the International Convergence of Capital Measurement and Capital Standards, 1988). *Academy of Banking Studies Journal*. Retrieved from <http://www.highbeam.com>

Murphy, M. & Masters B. (2010). Basel rules spark mitigation drives. *The Financial Times*. Retrieved from <http://www.ft.com/intl/cms/s/0/5c7f52e2-f10d-11df-bb17-00144feab49a.html>

Neaime, S. & Shahin W. (n.d.). Basel II and market risk of selected european commercial banks: a Var analysis.

Pillar 3 (Market Discipline)- Supporting Document to the New Basel Capital Accord.(2001). *Bank for International Settlements*. Retrieved from www.bis.org/publ/bcbcsca10.pdf

Principles for Sound Stress Testing Practices and Supervision. (2009). *Bank for International Settlement*.

Qiblawi, T. (2010). Sader: Lebanese banks can meet basel III conditions. *The Daily Star*. Retrieved from <http://www.dailystar.com.lb/Business/Lebanon/Oct/26/Salameh-Lebanese-banks-can-meet-Basel-III-requirements.ashx>

Regulating Swiss Banks: First Mover. (2010). *The Economist*. Retrieved from <http://www.economist.com/node/17202233>.

Saunders, A. (1994). *Financial institutions management: a modern perspective*. Irwin McGraw Hill Companies

Simonian, H. (2010). Swiss finish for big banks wins over some converts. *The Financial Times*.

Smith, G. T. (2010). Banks falling short of basel requirements. *The Wall Street Journal*. Retrieved from <http://online.wsj.com/article/SB10001424052748703395204576023140257369716.html>

Staffs of the International Monetary Fund and the World Bank. (2005) Retrieved from <http://www.imf.org/external/np/pp/eng/2005/072205.htm#s3>

The Basel iii Accord (2011). *Basel III Compliance Professionals Association (BiiiCPA)*. Retrieved from <http://www.basel-iii-accord.com/>

The Federal Reserve Board (1999). *Differences in capital and accounting standards among the federal banking and thrift agencies*. Retrieved from <http://www.federalreserve.gov/boarddocs/rptcongress/differences/default.htm>

Torbey: Lebanon Gradually Applying Basel III Guidelines. (2010). *The Daily Star*. Retrieved from <http://www.dailystar.com.lb/Business/Lebanon/Dec/04/Torbey-Lebanon-gradually-applying-Basel-III-guidelines.ashx>

U.S. Department of State (2011). *2011 investment climate statement-Lebanon*. Retrieved from <http://www.state.gov/e/eeb/rls/othr/ics/2011/157309.htm>

Zaki, F.A. (1995). Capital on tap. (Lebanese banking industry)(industry overview). *The Banker*. Retrieved from <http://www.highbeam.com>