

Credit Risk Management

Project Report

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INTRODUCTION

Set in the year 2009, we are Chase Bank' credit analysts and we have a portfolio, with 16 borrowers, to lend our money to. We are given the loan amount by each borrower and the maturity days attached to each borrower.

The following is the list of companies and their corresponding ticker in our portfolio.

| Serial No. | Borrower | Ticker | Amount | % |
|------------|--|--------|-------------------------|--------|
| 1 | Acxiom Corp | AXCM | 495,400,000.00 | 6.15% |
| 2 | AH Belo | AHC | 25,000,000.00 | 0.31% |
| 3 | Apollo Investment Corp | AINV | 1,179,000,000.00 | 14.64% |
| 4 | Cedar Fair LP | FUN | 64,070,000.00 | 0.80% |
| 5 | CIT Group Inc | CIT | 750,000,000.00 | 9.31% |
| 6 | FEI Co | FEIC | 100,000,000.00 | 1.24% |
| 7 | HSBC Finance Corp | HSBC | 1,800,000,000.00 | 22.35% |
| 8 | Lear Corp | LEA | 550,000,000.00 | 6.83% |
| 9 | Penn Virginia Corp, Penn Virginia Holding Corp | PVA | 300,000,000.00 | 3.72% |
| 10 | PhotronicsInc | PLAB | 130,000,000.00 | 1.61% |
| 11 | Rural/Metro Corp | RURL | 17,600,000.00 | 0.22% |
| 12 | Sinclair Broadcast Group | SBGI | 405,400,000.00 | 5.03% |
| 13 | Team Financial Inc | TFIN | 125,000,000.00 | 1.55% |
| 14 | Trimas Corp | TRS | 301,300,000.00 | 3.74% |
| 15 | United States Steel | X | 750,000,000.00 | 9.31% |
| 16 | Yellow Roadway Corp, YRC Worldwide Inc | YRCW | 1,062,000,000.00 | 13.18% |
| | TOTAL AMOUNT | | 8,054,770,000.00 | |

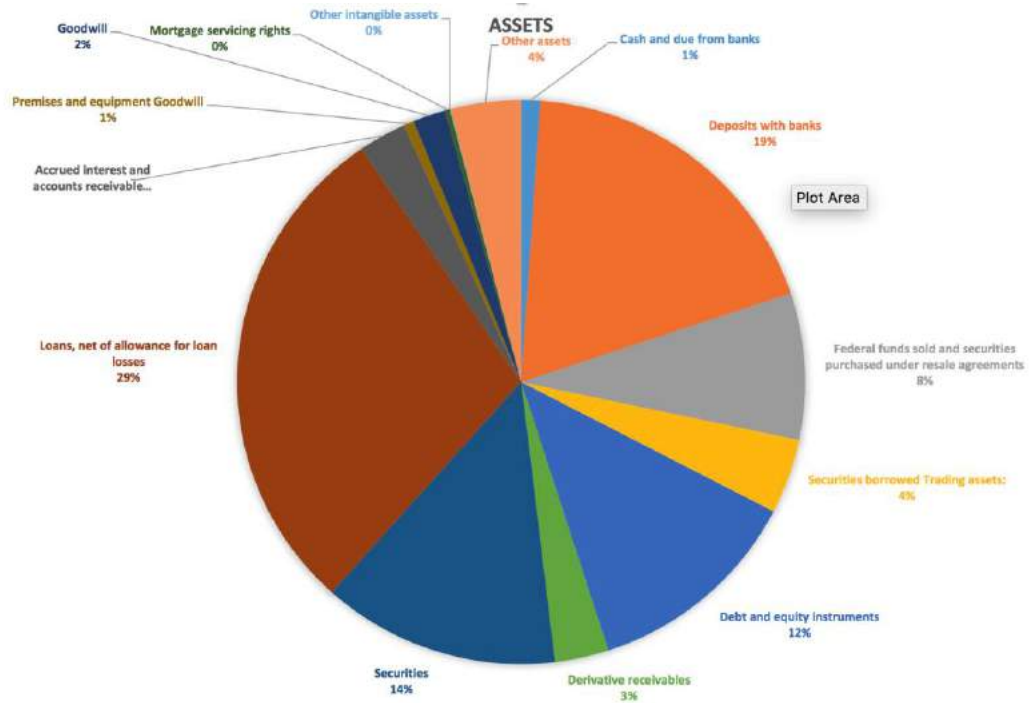
Overview of our Bank

I. Asset structure

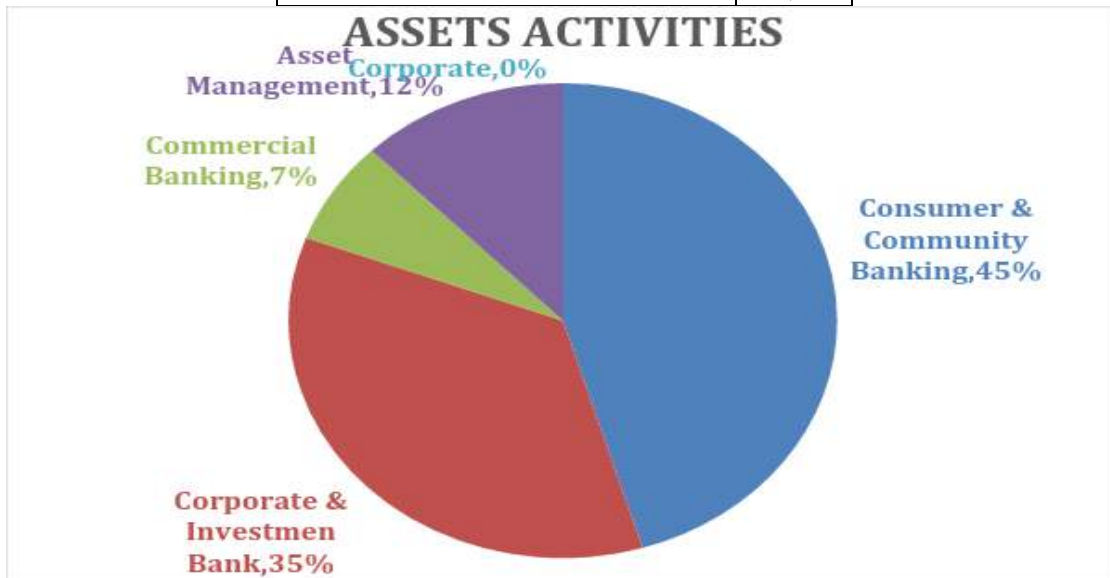
We are discussing what the main asset activities are and what is the percentage of them to total assets? Please comment on your banks' activities, e.g., more traditional banking or more security investment?

| | |
|---|-------------|
| Assets (in millions) | |
| Cash and due from banks | \$27,831 |
| Deposits with banks | \$484,477 |
| Federal funds sold and securities purchased under resale agreements | \$215,803 |
| Securities borrowed Trading assets: | \$110,435 |
| Debt and equity instruments | \$320,013 |
| Derivative receivables | \$78,975 |
| Securities | \$348,004 |
| Loans | \$757,336 |
| Allowance for loan losses | \$(14,185) |
| Loans, net of allowance for loan losses | \$743,151 |
| Accrued interest and accounts receivable | \$70,079 |
| Premises and equipment Goodwill | \$15,133 |
| Goodwill | \$47,647 |
| Mortgage servicing rights | \$7,436 |
| Other intangible assets | \$1,192 |
| Other assets | \$102,950 |
| Total assets | \$2,573,126 |

Asset Distribution Structure for the Bank



| | |
|------------------------------|----------|
| Consumer & Community Banking | \$44,368 |
| Corporate & Investment Bank | \$34,633 |
| Commercial Banking | \$6,882 |
| Asset Management | \$12,028 |
| Corporate | \$12 |
| Total Revenue | \$97,923 |



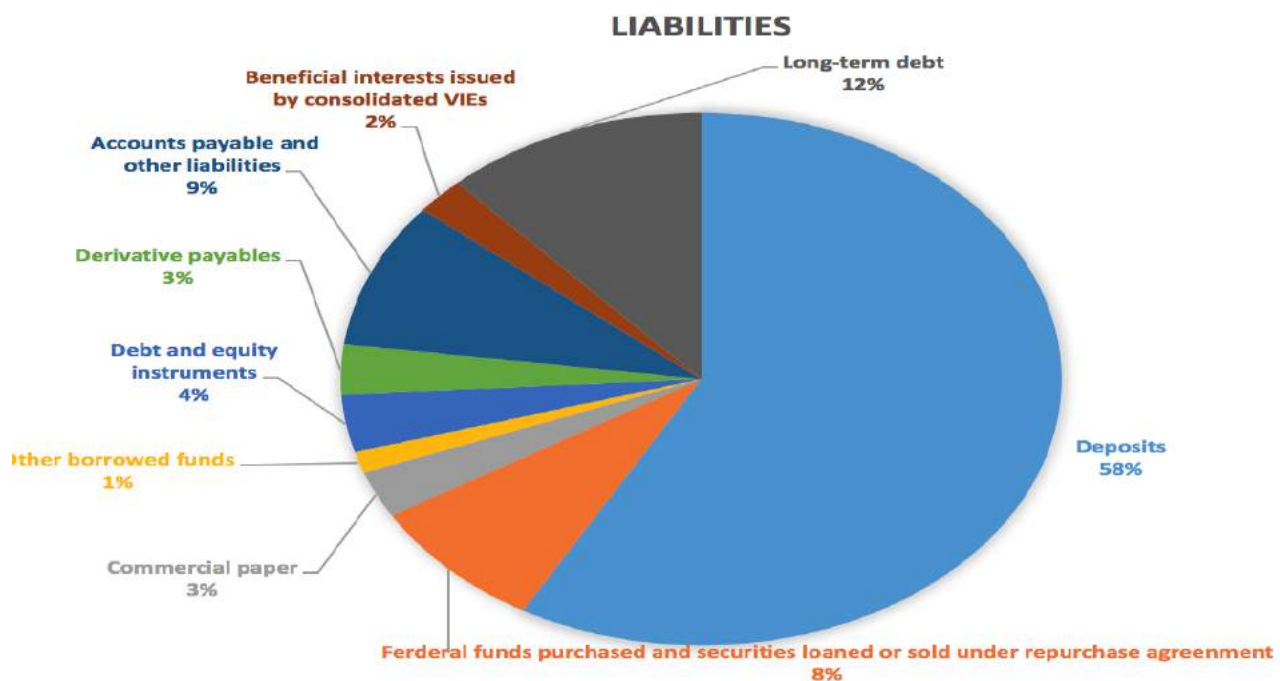
As the above graph shows, Consumer & Community Banking is J.P. Morgan's biggest segment. The bank is similar to its peers. Core banking activities contribute the biggest chunk of revenues at all four banks. Traditional banking activities are the biggest revenue source for J.P. Morgan.

II. Liability structure

We are discussing what the main funding sources are and what is the percentage of them to total debt? What are the implications of these funding sources on bank risk level?

| Liabilities(in million) | |
|--|-------------|
| Deposits | \$1,363,427 |
| Federal funds purchased and securities loaned or sold under repurchase agreement | \$192,101 |
| Commercial paper | \$66,344 |
| Other borrowed funds | \$30,222 |
| Debt and equity instruments | \$81,699 |
| Derivative payables | \$71,116 |
| Accounts payable and other liabilities | \$206,954 |
| Beneficial interests issued by consolidated VIEs | \$52,362 |
| Long-term debt | \$276,836 |
| Total liabilities | \$2,341,061 |

Liability Structure for the Bank



Deposits fund 58% of J.P. Morgan's (JPM) total assets. The deposit mix is diversified both by type and by line of business. Banks have to pay low or no interest on non-interest bearing deposits. On the other hand, interest cost is highest for time deposits.

Of its remaining 42% non-deposit-funded assets, 8% of them are funded by common and preferred equity. And, other assets are funded by unsecured funding including long-term unsecured debt, commercial papers, and other borrowed funds.

Deposits are the most crucial source of funds for any bank. They're also the cheapest, which can affect the bank's overall funding costs. Banks with lower-cost deposits have a competitive advantage over other banks.

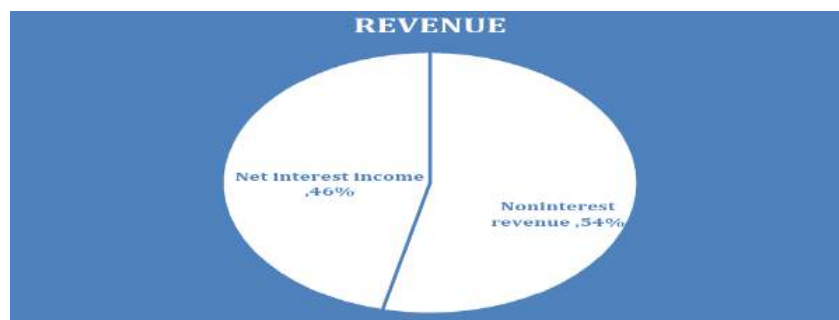
Banks also need some long-term funding sources such as debt and equity capital. A bank's credit rating affects the cost and availability of financing. Reductions in credit ratings could increase the cost of funds and decrease the number of investors willing to lend to the firm.

III. Main Income Sources

We are discussing what are the margins on interest vs. non-interest generating business?

| Revenue(in millions) | |
|--|----------|
| Investment banking fees | \$6,542 |
| Principal transactions(a) | \$10,531 |
| Lending- and deposit-related fees | \$5,801 |
| Asset management, administration and commissions | \$15,931 |
| Securities gains | \$77 |
| Mortgage fees and related income | \$3,563 |
| Card income | \$6,020 |
| Other income(b) | \$2,106 |
| Noninterest revenue | \$50,571 |
| Net interest income | \$43,634 |
| Total net revenue | \$94,205 |

Revenue Distribution Structure of the Bank



Main income source is noninterest revenue. Most of noninterest revenue came from assets management. Net interest margin is 2.1. Noninterest margin is 1.8.

IV. Performance Measures

We are discussing all the measures that are discussed in the annual report? How is your bank performance based on these measures?

Measures are net income, earnings per share, net revenue and ROE.

JPMorgan Chase reported record full-year 2014 net income of \$21.8 billion, and record earnings per share of \$5.29, on net revenue of \$94.2 billion. Net income increased by \$3.8 billion, or 21%, compared with net income of \$17.9 billion, or \$4.35 per share, in 2013. ROE for the year was 10%, compared with 9% for the prior year.

Core net interest income increased by \$543 million in 2014 to \$39.1 billion, and core average interest-earning assets increased by \$72.8 billion to \$1.5 trillion. The increase in net interest income in 2014 predominantly reflected higher yields on investment securities, the impact of lower interest expense, and higher average loan balances. The increase was partially offset by lower yields on loans due to the runoff of higher-yielding loans and new originations of lower-yielding loans. The increase in average interest-earning assets largely reflected the impact of higher average balance of deposits with banks. These changes in net interest income and interest-earning assets resulted in the core net interest yield decreasing by 9 basis points to 2.54% for 2014.

2. Capital Ratios

Capital Ratios of the Companies

| (in millions) | 2014 |
|--|--------------|
| Tier 1 common capital | \$105,284 |
| Total Tier 1 capital | \$132,971 |
| Risk-weighted assets | \$1,198,006 |
| Tier 1 capital ratio | 11.1% |
| Tier 2 capital | \$44,102 |
| Total Tier 1 capital | \$132,971 |
| Tier 2 capital | \$44,102 |
| Risk-weighted assets | \$1,198,006 |
| Total capital (Tier 1 and Tier 2) ratio | 14.8% |
| Total Tier 1 capital | \$132,971 |
| Total Consolidated Assets | \$1,933,767 |
| Tier 1 leverage ratio | 6.9% |

Discussing two main topics :

- i) Have these ratios met Fed's requirement and regulation?*
- ii) Have these ratios met Fed's requirement and regulation?*

In 2014, JPMorgan Chase's capital ratios were able to meet the standards established by the Federal Reserve. At 11% the Tier 1 capital ratio was significantly over the minimum 4% capital requirement established by the Federal Reserve; its total capital ratio was 14.8% which is also in excess of the Federal Reserve's requirement by 6.8% and its leverage ratio was 6.9% well over the 3% standard. Under the Federal Reserve all of Chase's capital ratios were considered to be well-capitalized in 2014.

3. Risks faced by the bank

Risk governance

The independent stature of the Risk organization is supported by a governance structure that provides for escalation of risk issues up to senior management and the Board of Directors.

The illustration of the governance structure and certain senior management level committees and forums that are primarily responsible for key risk-related functions.

The list of risk exposures of the Bank are mentioned in the next page :

List of risk exposures of the Companies

| Risk and key risk management metrics | | |
|--------------------------------------|---|---|
| Capital risk | The risk the Firm has an insufficient level and composition of capital to support the Firm's business activities and associated risks during normal economic environments ratio. | Metrics: Risk-based capital ratio, supplementary leverage |
| Compliance risk | The risk of fines or sanctions or of financial damage or loss due to the failure to comply with laws, rules, and regulations. | |
| Country risk | The risk that a sovereign event or action alters the value or terms of contractual obligations of obligors, counterparties and issuers or adversely affects markets related to a particular country. | Metrics: Default exposure at 0% recovery, Stress |
| Credit risk | The risk of loss arising from the default of a customer, client or counterparty. | Metrics: Total exposure; industry, geographic and customer concentrations; risk ratings; delinquencies; loss experience; stress |
| Fiduciary risk | The risk of a failure to exercise the applicable high standard of care, to act in the best interests of clients or to treat clients fairly, as required under applicable law or regulation. | |
| Legal risk | The risk of loss or imposition of damages, fines, penalties or other liability arising from failure to comply with a contractual obligation or to comply with laws or regulations to which the Firm is subject. | |
| Liquidity risk | The risk that the Firm will not have the appropriate amount, composition and tenor of funding and liquidity in support of its assets, and that the Firm will be unable to meet its contractual and contingent obligations through normal economic cycles and market stress events. | Metrics: LCR; Stress risk |
| Market risk | The risk of loss arising from potential adverse changes in the value of the Firm's assets and liabilities resulting from changes in market variables such as interest rates, foreign exchange rates, equity prices, commodity prices, implied volatilities or credit spreads. | Metrics: VaR, Stress, Sensitivities risk analysis |
| Model risk | The risk of the potential for adverse consequences from decisions based on incorrect or misused model outputs and reports. | Metrics: Model Status, Model Tier |
| Non-USD FX risk | The risk arising from capital investments, forecasted expense and revenue, investment securities portfolio or issuing debt in denominations other than the U.S. dollar. | Metrics: FX Net Open Position ("NOP") risk. |
| Operational risk | The risk of loss resulting from inadequate or failed processes or systems or due to risk external events that are neither market nor credit-related. | Metrics: Firm-specific loss experience; industry loss experience; business environment and internal control factors ("BEICF") |
| Principal risk | The risk of an adverse change in the value of privately-held financial assets and instruments, typically representing an ownership or junior capital position. These positions have unique risks due to their illiquidity or for which there is less observable market or valuation data. | Metrics: Carrying Value, Stress risk analysis |
| Reputation risk | The risk that an action, transaction, investment or event will reduce the trust that clients, shareholders, employees or the broader public has in the Firm's integrity or competence | |
| Structural interest rate risk | The risk resulting from the Firm's traditional banking activities (both on- and off-balance sheet positions) arising from the extension of loans and credit facilities, taking deposits and issuing debt (collectively referred to as "non-trading activities"), and also the impact from the CIO investment securities portfolio and other related CIO, Treasury activities. | Metrics: Earnings-at-risk |

PART 1: THE LOAN PORTFOLIO: RATIO ANALYSIS

Objective

- To analyze the financial soundness of each of the companies by calculating the Altman Z-scores of the companies using past year's data
- To qualitatively assess the creditworthiness of each of the companies, by using the 5Cs of credit quality
- To check if our portfolio is well diversified and distributed in various sectors and checking for the sector stock return correlations using past year's data.

Our Working

A) Calculating Altman Z-score of the companies

The Altman Z-score value for each of the companies gives us the probability that the company might go bankrupt within 2 years.

We calculate this value using both Manufacturing and Non-Manufacturing formulae.

Altman Z-score for manufacturing firms

$$Z_{\text{manufacturing}} = 1.2x_1 + 1.4x_2 + 3.3x_3 + 0.6x_4 + 0.99x_5$$

Altman Z-score for non-manufacturing firms:

$$Z_{\text{non-manufactured}} = 6.56x_1 + 3.26x_2 + 6.72x_3 + 1.05x_4$$

x_1 = Working Capital / Total Assets

x_2 = Retained Earnings / Total Assets

x_3 = Earnings Before Interest & Tax / Total Assets

x_4 = Market Value of Equity / Total Liabilities

x_5 = Sales / Total Assets¹

¹ x_5 was only considered for manufacturing companies

Altman Z-Score, as of December 2009.

| Companies | Liquidity ratio: Working Capital/ total assets | Profitability Ratio: Retained Earnings/ total assets | Efficiency Ratio : EBIT/ total assets | Insolvency Ratio : Market Cap/Total Liabilities | Asset Turnover Ratio : Sales/Total Assets* | Altman -Z Score |
|-----------|---|---|--|---|--|--------------------|
| | x1 | x2 | x3 | x4 | x5 | |
| ACXM | 17.14% | -18.81% | 2.17% | 131.01% | | 2.033 |
| AHC | 11.44% | -41.26% | 1.51% | 142.87% | 33.50% | 0.798 |
| AINV | 13.67% | -23.76% | 2.46% | 104.19% | | 1.382 |
| FUN | -3.27% | -3.82% | -0.92% | 31.22% | | -0.074 |
| CIT | 2.50% | 0.00% | 0.59% | 20.26% | | 0.416 |
| FEIC | 45.60% | 8.59% | 0.94% | 227.79% | 16.19% | 2.226 |
| LEA | 22.82% | -0.08% | 20.37% | 78.22% | 45.16% | 1.861 |
| PVA | 5.04% | 10.97% | -0.21% | 57.81% | 2.39% | 0.578 |
| PLAB | 13.49% | -4.96% | 0.65% | 110.61% | 14.27% | 0.919 |
| RURL | 12.77% | -95.83% | 4.68% | 39.23% | | -1.56 |
| SBGI | 1.45% | -51.45% | -4.16% | 17.95% | | -1.673 |
| TRS | 33.88% | -56.52% | 0.86% | 29.76% | 23.14% | 0.051 |
| X | 32.52% | 5.66% | -2.13% | 75.66% | 21.75% | 1.068 |
| YRCW | 28.32% | -46.65% | -3.00% | 1.76% | 34.63% | 0.155 |
| HSBC | -26.52% | 0.03% | -0.13% | 4.20% | | -1.704 |

*Only Considered for manufacturing companies.

Benchmark for Z-score Manufacturing:

$Z > 2.99$ - "Safe" Zone

$1.8 < Z < 2.99$ - "Grey" Zone

$Z < 1.80$ - "Distress" Zone

Benchmark for Z-score Non-Manufacturing:

If Z" is less than 0, then the firm is equated to default

By analyzing our results, there are several manufacturing companies that rely on the distress Zone.

AH Belo (AHC), PhotronicsInc (PLAB), and Trimas Corp (TRS) have a negative retained earnings (RE) over total assets (TA), which makes the z-score 0.798, 0.919, and 0.051 respectively.

Penn Virginia Corp (PVA) and United States Steel (X) had a z-score of 0.578, 1.068 primarily due to their negative profitability ratio (EBIT/total assets); however, they also had low liquidity ratio, and a low sales to total assets ratio. (YRCW) presented a negative retained earnings (RE) over total assets (TA) and a negative profitability ratio, which also makes it a distressed company.

By analyzing the other 7 non-manufacturing companies, there are 6 companies that are on the distress zone and 4 are below zero (FUN, RURL, SBGI, HSBC), which are equated to default.

FUN and HSBC presented a negative liquidity ratio, and a negative EBIT/TA ratio. RURL's retained earnings over total assets was -95%, which means RURL's deficit is equivalent to 95% of their assets. SBGI and presented negative retained earnings, negative EBIT/TA, and a low liquidity ratio.

CIT presented a z-score (0.416) below 1.80, due to low profitability ratio and no retained earnings. It is worth noting that this company got out of bankruptcy on December 2009.

5Cs of credit to qualitatively assess the credit

5Cs of credit to qualitatively assess the credit

| 5 Cs | What they indicate? | How are we assessing it? |
|-------------------|--|---|
| Capacity | Ability to pay back interest and principals | Interest coverage ratio / Debt to Equity Ratio |
| Collateral | A secondary source of repayment of the loan | Measuring collateral quantitatively by its value and its ease of liquidation, as perceived |
| Capital | Sufficient equity in the company provides a cushion to withstand a blip in the company's ability to generate cash flow | Debt to Equity Ratios (no higher than 2 to 3 times) ; Also, as a percentage of the total investment cost |
| Character | Management quality, people that can be trusted to honor their commitments in good times and bad | Checking the Credit history |
| Conditions | The competitive landscape of your company and the nature of your customer relationships | Loan's interest rate, principal amount and repayment length |

Summary of 5Cs assessment

According to 5Cs assessment requirement and details of portfolio's companies, we summarized all our portfolio companies' 5C approach into "good", "fair" and "bad" as follow:

5Cs for 8 of the Companies

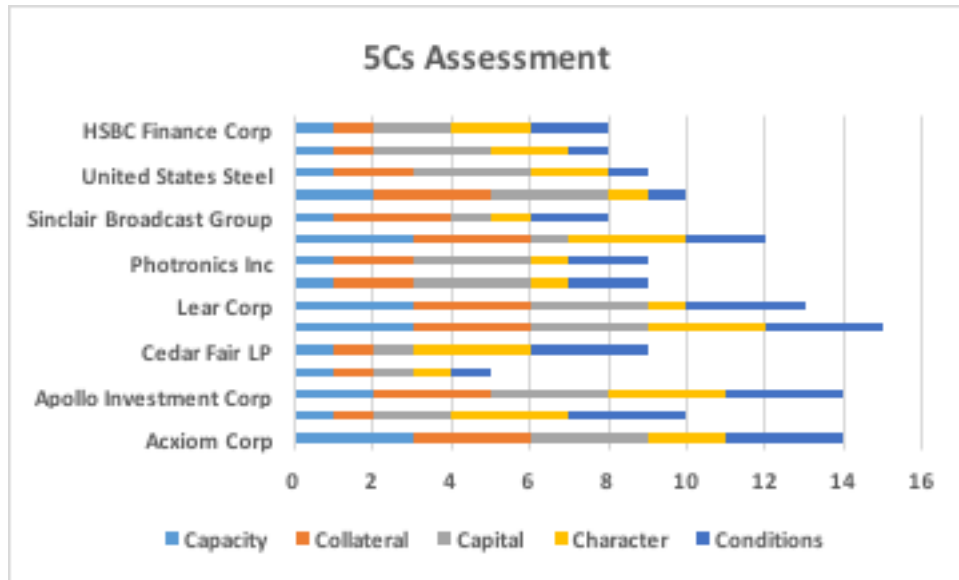
| | Capacity | Collateral | Capital | Character | Conditions |
|--|----------|------------|---------|-----------|------------|
| Acxiom Corp | good | good | good | fair | good |
| AH Belo | bad | bad | no data | good | good |
| Apollo Investment Corp | fair | good | good | good | good |
| CIT Group Inc | bad | bad | bad | bad | bad |
| Cedar Fair LP | bad | bad | bad | good | good |
| FEI Co | good | good | good | good | good |
| Lear Corp | good | good | good | bad | good |
| Penn Virginia Corp, Penn Virginia Holding Corp | bad | fair | good | bad | fair |
| Photronics Inc | bad | fair | good | fair | bad |
| Rural/Metro Corp | good | good | bad | good | fair |
| Sinclair Broadcast Group | bad | good | bad | bad | fair |
| Trimas Corp | fair | good | good | bad | bad |
| United States Steel | bad | fair | good | fair | bad |
| Yellow Roadway Corp | bad | bad | good | fair | bad |
| HSBC Finance Corp | bad | bad | fair | fair | fair |

Let "good" = 3, "fair" = 2, "bad" = 1, then we can get table like follow:

Numbering the 5Cs for all the Companies

| | Capacity | Collateral | Capital | Character | Conditions | sum |
|--|----------|------------|---------|-----------|------------|-----|
| Acxiom Corp | 3 | 3 | 3 | 2 | 3 | 14 |
| AH Belo | 1 | 1 | 2 | 3 | 3 | 10 |
| Apollo Investment Corp | 2 | 3 | 3 | 3 | 3 | 14 |
| CIT Group Inc | 1 | 1 | 1 | 1 | 1 | 5 |
| Cedar Fair LP | 1 | 1 | 1 | 3 | 3 | 9 |
| FEI Co | 3 | 3 | 3 | 3 | 3 | 15 |
| Lear Corp | 3 | 3 | 3 | 1 | 3 | 13 |
| Penn Virginia Corp, Penn Virginia Holding Corp | 1 | 2 | 3 | 1 | 2 | 9 |
| Photronics Inc | 1 | 2 | 3 | 1 | 2 | 9 |
| Rural/Metro Corp | 3 | 3 | 1 | 3 | 2 | 12 |
| Sinclair Broadcast Group | 1 | 3 | 1 | 1 | 2 | 8 |
| Trimas Corp | 2 | 3 | 3 | 1 | 1 | 10 |
| United States Steel | 1 | 2 | 3 | 2 | 1 | 9 |
| Yellow Roadway Corp | 1 | 1 | 3 | 2 | 1 | 8 |
| HSBC Finance Corp | 1 | 1 | 2 | 2 | 2 | 8 |

Chart of 5Cs for 8 of the Companies

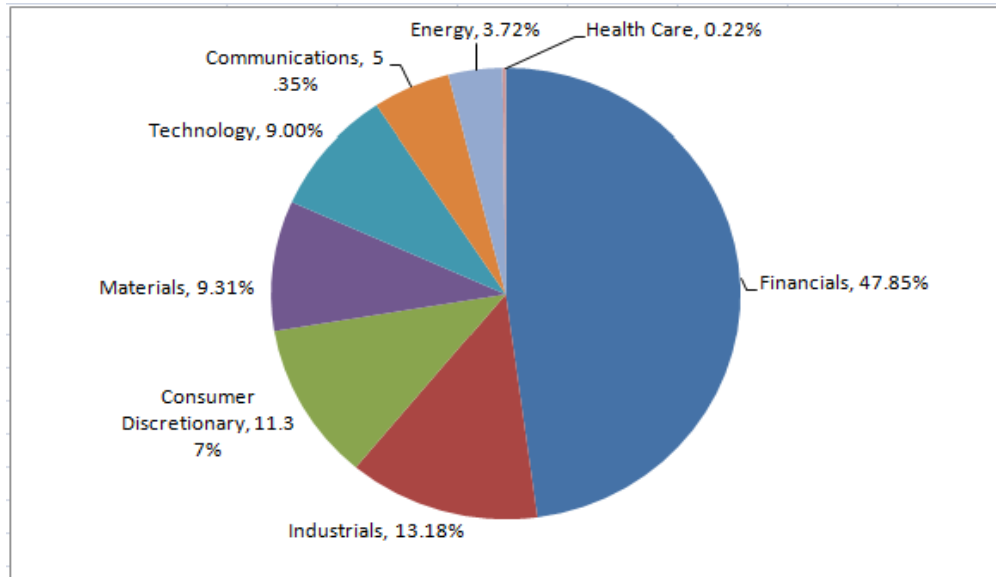


The red bar companies have characters that is extremely risky and the yellow bar companies are risky. However, the green bar companies are speculative but seem safer than the rest.

B) Distribution of sectors in the portfolio. Calculating the sector stock return correlations matrix using past year's data

Chase's total loan amount in 2009 was 8,054.77 billion dollars, the loan's period varied from 1 to 6 years. Almost 44% of the debt had to be paid in less than 3 years, 41% between 3 to 5 years, and the remaining 13% between 5 and 6 years.

Almost half of the loan of the portfolio was concentrated in the financial sector, 13% in industrials, 11% in consumer discretionary, and the remaining is distributed among the materials, technology, communications, and the energy sector.

Portfolio Distribution by Sector

Although 48% of the loan is concentrated in the financial sector, 22% is from HSBC and it has a one year duration. The other financial loans are distributed among other 3 companies and their durations range from 2 to 3.3 years.

The industrial sector (13%) is concentrated in only one company, YRCW, which numbers are highly risky.

The sector stock return correlation matrix was created from the companies of our portfolio. The firms were divided into sectors and the returns per stock was calculated. We average the returns per sector, and then we created an index per each sector.

Almost all the sectors are highly correlated. Since Materials and Industrials have a correlation of 0.999, our portfolio is less diversified and more exposed to default.

The healthcare sector is the least correlated, which can help diversify our portfolio; however, less than 0.5% is invested on this sector. Other sectors that help to diversify our portfolio are consumer discretionary and financials. This last sector is our largest concentration.

Figure 2. Correlation Matrix

| | <i>Materials</i> | <i>Technology</i> | <i>Industrials</i> | <i>Healthcare</i> | <i>Financials</i> | <i>Energy</i> | <i>Consumer Discretion</i> | <i>Communicatio.</i> |
|----------------------------|------------------|-------------------|--------------------|-------------------|-------------------|---------------|----------------------------|----------------------|
| <i>Materials</i> | 1.0000 | | | | | | | |
| <i>Technology</i> | 0.8846 | 1.0000 | | | | | | |
| <i>Industrials</i> | 0.9999 | 0.8849 | 1.0000 | | | | | |
| <i>Healthcare</i> | 0.2194 | 0.5202 | 0.2196 | 1.0000 | | | | |
| <i>Financials</i> | 0.8693 | 0.8571 | 0.8693 | 0.4655 | 1.0000 | | | |
| <i>Energy</i> | 0.9318 | 0.8005 | 0.9315 | 0.1677 | 0.8942 | 1.0000 | | |
| <i>Consumer Discretion</i> | 0.9507 | 0.9079 | 0.9510 | 0.3632 | 0.9318 | 0.9051 | 1.0000 | |
| <i>Communication</i> | 0.9285 | 0.9184 | 0.9288 | 0.4022 | 0.8566 | 0.8180 | 0.9199 | 1.0000 |

Conclusions

- All z-scores are below the safety zone. Only 3 out of 16 are on the grey zone, and the other 13 rely on the distress zone.
- Chase's portfolio is strongly concentrated on companies from the financial sector, which are struggling the most in this period; however, half of this loan's amount is for less than a year.
- YRCM is highly leverage and its credit rating is nearly on default.
- The correlation among sectors is high; however, healthcare and financials have less correlation with other industries.

PART 2: MODELING PROBABILITY OF DEFAULT

Objective

- The probabilities of default for these companies will be estimated using three different approaches,
 1. Reduced form intensity based models
 2. Merton's structural KMV approach
 3. Agency rating model.
- Develop and test hybrid models by shocking the parameters of the model. Sensitivity analysis.

Our Working

I. Reduced form intensity based models

In the reduced model, we generated the probability of default: using the 5 year CDS spread of each company, and assuming a 40% recovery rate:

$$PD = CDS / (1 - Recovery Rate)$$

Reduced model Results

| Name | CDS spread or (Avg yield - risk free rate) | Recovery rate | Default Intensity of this bond |
|--------------------------|--|---------------|--------------------------------|
| AH Belo | 0.0203 | 40% | 3.383% |
| Sinclair Broadcast Group | 0.0297 | 40% | 4.950% |
| Cedar Fair LP | 0.0324 | 40% | 5.400% |
| Trimas Corp | 0.0287 | 40% | 4.783% |
| Penn Virginia Corp | 0.0182 | 40% | 3.033% |
| Apollo Investment Corp | 0.0146 | 40% | 2.433% |
| HSBC Finance Corp | 0.0068 | 40% | 1.133% |
| Yellow Roadway Corp | 0.1126 | 40% | 18.767% |
| United States Steel | 0.0204 | 40% | 3.400% |
| Axiom Corp | 0.0143 | 40% | 2.383% |
| FEI Co | 0.0087 | 40% | 1.450% |
| Photronics Inc | 0.02 | 40% | 3.333% |

II. Merton's Model

The Merton's Distance to Default model is used to estimate the PD by analyzing the capital structure of a company. This model considers the value of the firm a stochastic variable. When the asset value is below debt by the time of maturity, it would be bankrupt.

The function of Merton's model derive from option pricing model Black-Scholes-Merton formula. The functions as follow:

Distance to default:

$$D2 = \ln(V0) - \ln(D) + \left(r - \frac{\sigma v^2}{2}\right) \left(\frac{T}{\sigma\sqrt{T}}\right)$$

Probability of default:

$$N(-d2)$$

In this model we assumed the default point from the KMV model, assuming the following parameters:

- Equity volatility: Implied volatility of 12-month expiration put.
- Discount Factor: 12 month swap rate.
- Equity Debt: Short term debt plus half the long term debt (KMV default point).
- Maturity: 1 year.
- We ignore firms which have negative and zero value of equity value and debt.

Considering only the companies with enough data and running an optimization model (solver in excel) we got the Merton's Distance to default model result as follows:

Merton's Model Results

| Company | Value of company's assets | Volatility of Assets | Value of company's Equity | Debt | Risk Free rate | Volatility of equity | E0 calculated | Equity vol | d1 | (d2) | Prob of default N(-d2) |
|---------|---------------------------|----------------------|---------------------------|------------|----------------|----------------------|---------------|------------|-------|-------|------------------------|
| SBGI | 860.47 | 28.21% | 190.92 | 704.97 | 0.90% | 103.05% | 190.92 | 1.03 | 0.88 | 0.60 | 27.51% |
| HSBC | 676,138.70 | 9.36% | 198,766.88 | 481,689.00 | 0.90% | 31.85% | 198766.73 | 0.32 | 3.76 | 3.67 | 0.01% |
| YRCW | 561.94 | 37.58% | 50.39 | 665.02 | 0.90% | 170.42% | 50.39 | 1.70 | -0.24 | -0.61 | 72.98% |
| X | 9,600.58 | 39.61% | 7,901.45 | 1,714.50 | 0.90% | 48.13% | 7901.44 | 0.48 | 4.57 | 4.17 | 0.00% |
| ACXM | 1,342.55 | 50.18% | 1,061.76 | 283.41 | 0.90% | 63.43% | 1061.76 | 0.63 | 3.37 | 2.87 | 0.21% |
| FEIC | 988.91 | 54.35% | 880.30 | 109.60 | 0.90% | 61.06% | 880.30 | 0.61 | 4.34 | 3.79 | 0.01% |
| PLAB | 300.13 | 90.62% | 236.65 | 66.37 | 0.90% | 113.01% | 236.65 | 1.13 | 2.13 | 1.22 | 11.08% |

III Credit Rating Model

Considering the previous 20 years of the company's S&P ratings, we calculated the probability of default:

Credit Ratings model

| Name | PD average |
|--------------------------|------------|
| Sinclair Broadcast Group | 7.18% |
| Cedar Fair LP | 2.76% |
| Lear Corp | 6.96% |
| Trimas Corp | 2.76% |
| Penn Virginia Corp | 1.24% |
| Apollo Investment Corp | 0.23% |
| CIT Group Inc | 0.28% |
| HSBC Finance Corp | 0.11% |
| Rural/Metro Corp | 7.17% |
| Yellow Roadway Corp | 27.81% |
| United States Steel | 0.92% |
| Acxiom Corp | 0.88% |
| FEI Co | 2.76% |
| Photronics Inc | 1.58% |

Hybrid Models

Since not all the information from our all companies were available, we only considered the companies that have completed data for all the three models in order to calculate our Hybrid Models.

Companies considered for the Hybrid Models

| Name | PD reduced form | PD Merton's Model | Credit Rating |
|--------------------------|-----------------|-------------------|---------------|
| Yellow Roadway Corp | 18.77% | 72.98% | 27.81% |
| Sinclair Broadcast Group | 4.95% | 27.51% | 11.62% |
| United States Steel | 3.40% | 0.00% | 0.74% |
| Photronics Inc | 3.33% | 11.08% | 11.62% |
| Acxiom Corp | 2.38% | 0.21% | 0.99% |
| FEI Co | 1.45% | 0.01% | 2.76% |
| HSBC Finance Corp | 1.13% | 0.01% | 0.11% |

In this project, we considered 3 hybrid models:

Hybrid model 1: Equally weighted the reduced form, Merton's model and credit rating models.

Hybrid model 2: 50% Reduced + 30% Merton's + 20% Credit Rating

Hybrid model 3: 50% Reduced + 20% Merton's + 30% Credit Rating

The three models have highly correlation. Therefore, combining these three approaches will give us similar results; however, increasing the weight of a certain model, will make it more sensible to different parameters.

Correlation Models

| | PD reduced form | PD Merton's Model | Credit Rating |
|-----------------------|-----------------|-------------------|---------------|
| <i>Reduced Form</i> | 1 | | |
| <i>Merton's Model</i> | 0.9711 | 1.0000 | |
| <i>Credit Rating</i> | 0.9241 | 0.9678 | 1 |

The probabilities of default for the different hybrid models were:

PDs for Hybrid models

| Company | Model 1 | Model 2 | Model 3 |
|---------|---------|---------|---------|
| FEIC | 1.41% | 1.28% | 1.55% |
| X | 1.38% | 1.85% | 1.92% |
| HSBC | 0.42% | 0.59% | 0.60% |
| ACXM | 1.19% | 1.45% | 1.53% |
| PLAB | 8.68% | 7.32% | 7.37% |
| SBGI | 14.69% | 13.05% | 11.46% |
| YRCW | 39.85% | 36.84% | 32.32% |

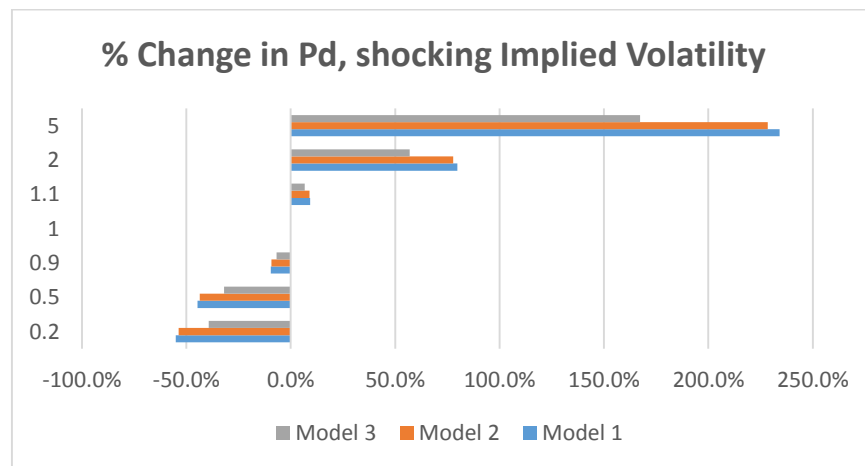
Sensitivity analysis

In order to estimate how each parameter, used to calculate the PDs, affected our model, we only moved one parameter at a time, living all else equal. We estimated the probabilities of default and average them equally to calculate a different PD per hybrid model.

- Implied Volatility

We analyzed our data if the implied volatility decreased by .2, 0.5, and 0.9 times the original value or if it increased by 1.1, 2, and 5 times its original value:

Changes in Implied Volatility

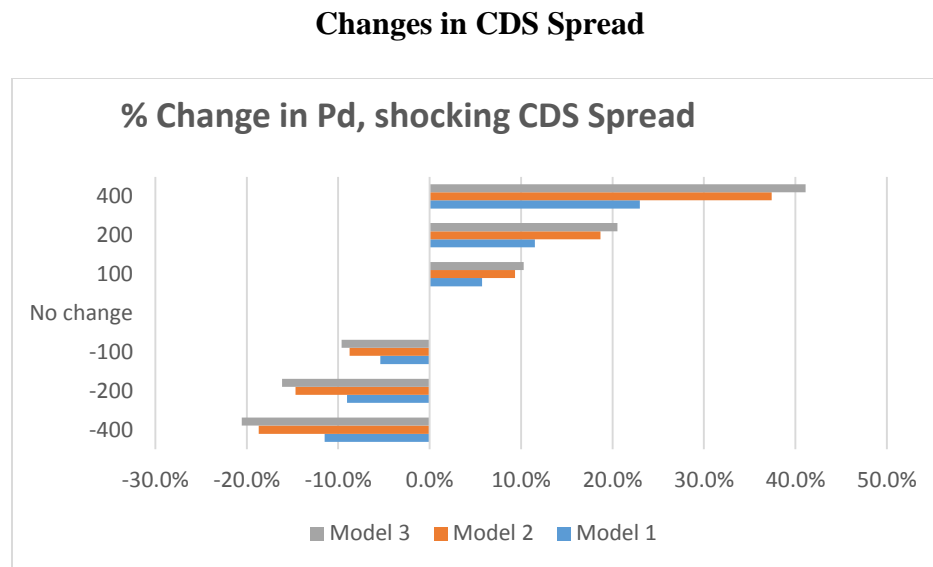


If the implied volatility decreased, the probabilities of default decreased for all our models; However, the models that were more sensible to these changes were the models that had more weight on the Merton's model (Model 1 and Model 2).

- CDS spread

We changed the CDS spread, leaving everything else constant, to analyze the probabilities of default. We made positive shocks by decreasing the CDS in 400 basis points (bps), 200 bps, 100 bps and for negative shocks we increased it by 100, 200, and 400 bps. If we decreased the CDS spread and it has less than zero, we considered a 0 CDS spread.

With this shock, the reduced form model is the one affected. But overall, Model 3 was the most affected by these CDS spread changes. If we increased the spread by a 400 bps, the pd of Model 3 increased more than 40%, and if the spread decreased by 400 bps it decreased only by 20%.

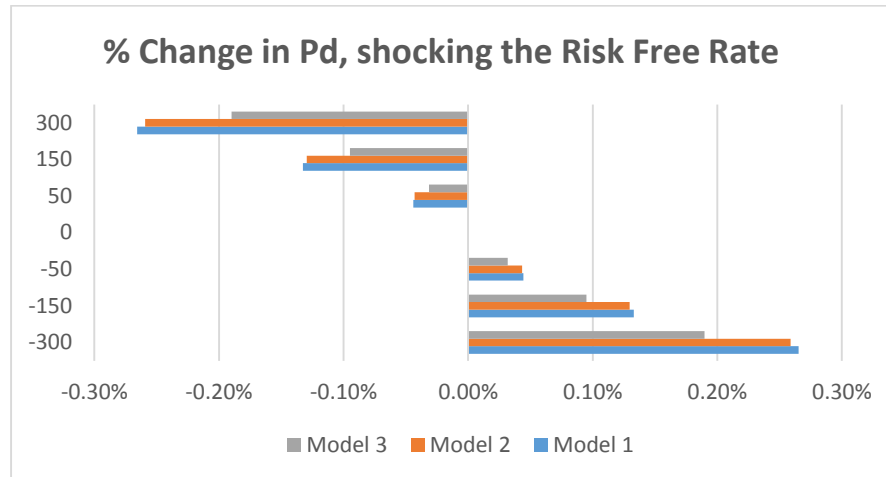


- Risk Free Rate

Keeping all input constraints constant except the risk free rate. For the positive shocks, we increased the rate in 50, 150 and 300 basis points, and for the negative shocks we decreased in 50, 150 and 300 basis points. We considered 0.90% Risk Free rate as the stable value.

Although the most affected model was model 1, the risk free rate doesn't have a significant movement on all the probabilities of default. If we increased the rate by 300 bps, the pd in model 1 decreased by 0.27%. If we decreased it, the PD in model 1 increased by 0.27%.

Changes in Risk Free Rate



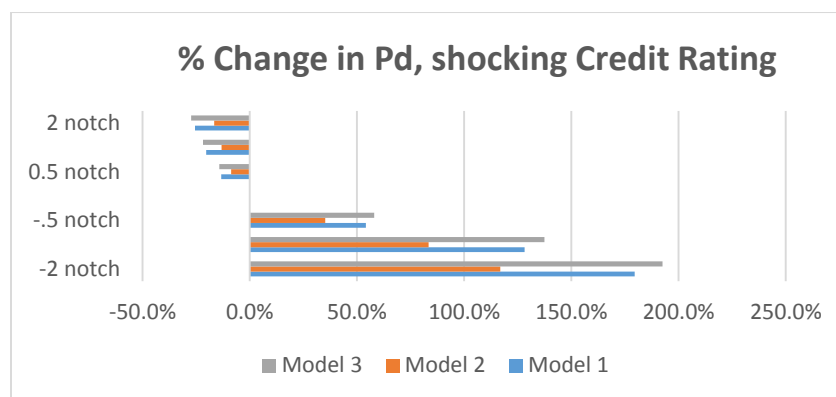
- Rating Notch

For the movements in credit rating, we identified the value attached to each Rating were 3 levels of shocks applied to the model on both positive and negative ends of the spectrum. The shocks were given in increments of 0.50 notches on both ends. We considered the 2009 rating value of the companies as our 'No Change' Rating Notch value.

Model 1 and 3 were the most affected negatively. Since some of the companies were rated in C or B-, when we decreased the rating by several notches, the companies fell in default. Therefore, having two notches down, the pd of our portfolio increased more than 150% using model 1 and 3.

On the other hand, if we increased the credit ratings on our companies, the default probabilities didn't have the same large movement, but it did decreased the PD by more than 13% just by changing half a notch (model 1 and 3).

Changes in Rating Notch

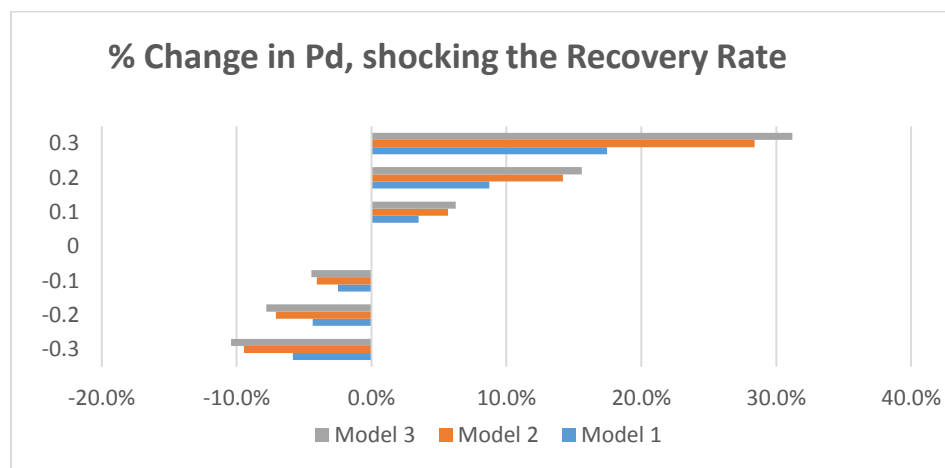


- Recovery Rate

For the sensitivity analysis changing the recovery rate(RR), we always considered 40% when there is no movement. The positive and negative changes were increments and decrements of 0.1. Therefore, the recovery rate range spanned from 0.1 to 0.7 and the 0.4 value being the 'No Change' value.

Model 2 and 3 were the most affected by these movements. It is important noting that if we increased the recovery rate, the PD increased even that we are recovering more of our money. This is caused because the reduced form ignores the relationship between default intensity and recovery rate, which is a weakness on this model.

Changes in Recovery Rate

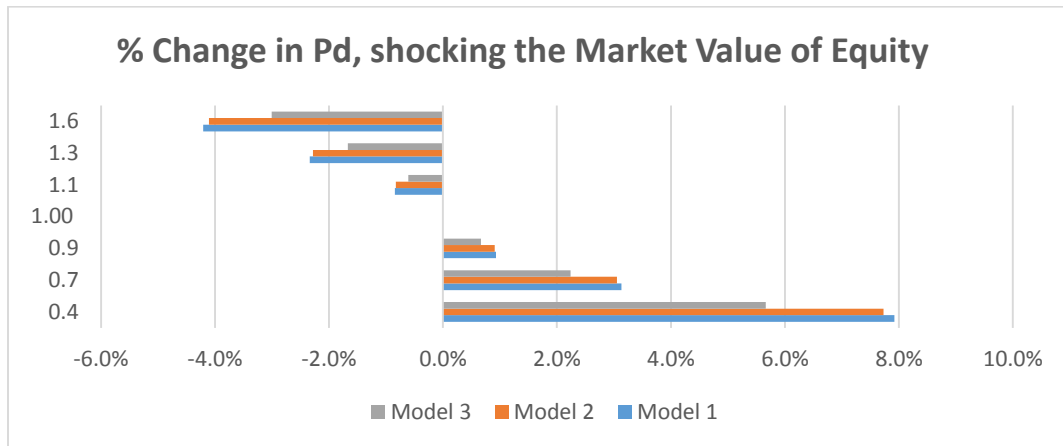


- Market Value of Equity

The Market Value of Equity is calculated as a product between the Market Price of a company's stock and the total number of shares outstanding. On this sensitivity analysis, we changed the whole market price, we didn't move the stock price or the number of shares separately. Ceteris paribus, we increased and decreased the Market Value by 10%, 30% and 60%.

Model 1 and 2 were the most affected models. For decreases of 60% in Value of Equity, the pd increased more than 7.5% in both models. However, if increased the Market value the pd decreased by 4%. Therefore, a decreased in the Market value of Equity will have a higher impact on the portfolio's probability of default.

Changes in Market Value of Equity



Conclusion

We see that each parameter has an impact on the Probability of Default calculation. Credit Rating and implied volatility have significant impact on the default probabilities. If we decreased by 1 notch the companies' credit rating, the PD could increase more than 100%. A CDS spread change can also move more than 50% our default probability.

Since the reduced model considers the recovery rate independent from the default intensity, the results on the probabilities are estranged. If the recovery rate increases, the default probability increases.

Based on this movements, we can understand how the probabilities of default could be affected if certain parameters changed. We now continue on conducting a regulatory capital analysis and severe stress testing.

PART 3 : REGULATORY CAPITAL ANALYSIS

Objective

To analyze the regulatory capital structure of the company and the sectors they belong to using 3 different approaches:

- a) Standard Approach
- b) Foundation IRB approach
- c) Advanced IRB approach

Our Working

I.Standard Approach

In the Standard Approach, we obtained the credit rating for our portfolio from S&P ratings:

Based on these ratings and on the standard approach weighting table (Figure 1.), we calculated risk-weighted asset based.

| Company | Loan Amounts (2009) | Credit Rating |
|---------|---------------------|---------------|
| SBGI | 405,400,000 | B- |
| AHC | 25,000,000 | N/A |
| LEA | 550,000,000 | D |
| TRS | 301,300,000 | B+ |
| FUN | 64,070,000 | B+ |
| PVA | 300,000,000 | BB- |
| HSBC | 1,800,000,000 | A |
| CIT | 750,000,000 | D |
| AINV | 1,179,000,000 | BBB |
| TFIN | 125,000,000 | N/A |
| RURL | 17,600,000 | B+ |
| YRCW | 1,062,000,000 | CCC |
| X | 750,000,000 | BB+ |
| ACXM | 495,400,000 | BB |
| FEIC | 100,000,000 | B+ |
| PLAB | 130,000,000 | B- |

Figure 1. Weights based on a Standard Approach

| Rating | AAA to AA- | A+ to A- | BBB+ to BBB- | BB+ to BB- | B+ to B- | Below B- | Unrated |
|------------|------------|----------|--------------|------------|----------|----------|---------|
| Country | 0% | 20% | 50% | 100% | 100% | 150% | 100% |
| Banks | 20% | 50% | 50% | 100% | 100% | 150% | 50% |
| Corporates | 20% | 50% | 100% | 100% | 150% | 150% | 100% |

Risk weight asset by company:

| Company | Credit Rating | Risk Weights | Risk Weighted Asset |
|---------|---------------|--------------|---------------------|
| SBGI | B- | 150% | 608,100,000.00 |
| AHC | - | 100% | 25,000,000.00 |

| | | | |
|------|-----|------|------------------|
| LEA | D | 150% | 825,000,000.00 |
| TRS | B+ | 150% | 451,950,000.00 |
| FUN | B+ | 150% | 96,105,000.00 |
| PVA | BB- | 100% | 300,000,000.00 |
| HSBC | A | 50% | 900,000,000.00 |
| CIT | D | 150% | 1,125,000,000.00 |
| AINV | BBB | 50% | 589,500,000.00 |
| TFIN | - | 50% | 62,500,000.00 |
| RURL | B+ | 150% | 26,400,000.00 |
| YRCW | CCC | 150% | 1,593,000,000.00 |
| X | BB+ | 100% | 750,000,000.00 |
| ACXM | BB | 100% | 495,400,000.00 |
| FEIC | B+ | 150% | 150,000,000.00 |
| PLAB | B- | 150% | 195,000,000.00 |

Grouped by Industry and considering 8% as the minimum required capital ratio, we calculated the economic capital needed to allocate per industry. The total economic capital for our portfolio is 655.44 million dollars.

| Industry | Risk Weight Asset | Economic capital |
|------------------------|----------------------|--------------------|
| Communications | 633,100,000 | 50,648,000 |
| Consumer Discretionary | 1,373,055,000 | 109,844,400 |
| Energy | 300,000,000 | 24,000,000 |
| Financials | 2,677,000,000 | 214,160,000 |
| Health Care | 26,400,000 | 2,112,000 |
| Industrials | 1,593,000,000 | 127,440,000 |
| Materials | 750,000,000 | 60,000,000 |
| Technology | 840,400,000 | 67,232,000 |
| TOTAL | 8,192,955,000 | 655,436,400 |

$$E_{port} = \sqrt{\sum_{i=1}^n E_i^2 + \sum_{i=1}^n \sum_{j=1}^n 2r_{ij} E_i E_j}$$

We calculated the hybrid model, assuming the correlation ρ_{ij} from the industries of our portfolio in figure 2. And the new Economic capital is 628.13 million dls.

Figure 2. Industry Correlation (using stock returns)

| | <i>Materials</i> | <i>Technology</i> | <i>Industrials</i> | <i>Health Care</i> | <i>Fin</i> | <i>Energy</i> | <i>Consumer Discretion</i> | <i>Communications</i> |
|----------------------|------------------|-------------------|--------------------|------------------------|------------|---------------|--------------------------------|-----------------------|
| <i>Materials</i> | 1 | | | | | | | |
| <i>Technology</i> | 0.8846 | 1 | | | | | | |
| <i>Industrials</i> | 0.9999 | 0.8848 | 1 | | | | | |
| <i>Healthcare</i> | 0.2193 | 0.5202 | 0.2196 | 1 | | | | |
| <i>Financials</i> | 0.8693 | 0.8571 | 0.8693 | 0.4655 | 1 | | | |
| <i>Energy</i> | 0.9318 | 0.8004 | 0.9315 | 0.1676 | 0.8941 | 1 | | |
| <i>Consumer-Dis</i> | 0.9507 | 0.9078 | 0.9509 | 0.3631 | 0.9317 | 0.9051 | 1 | |
| <i>Communication</i> | 0.9284 | 0.9184 | 0.9287 | 0.4021 | 0.8566 | 0.8180 | 0.9199 | 1 |

Adding the correlations to calculate the economic capital between industries (hybrid model) reduces by almost 30 million dollars the amount that the bank must retain as economic capital, which means that our portfolio is diversified between industries.

If the correlation between two industries is low, they don't relate from one another (e.g. if one industry defaults the other industry is not likely to default), it will decrease the economic capital needed from the bank. In our portfolio. On the other hand, if the correlation is almost one they must maintain the total economic capital per industries (e.g. if one industry defaults, the other industry is likely to default).

II. Foundation Internal Rating Based (IRB) approach

Under the Foundation IRB approach banks estimate only PD and the Basel II guidelines determine the other variables for the formula and we have followed the same guidelines

We calculated the WCDR for each company in our portfolio using the PD from the credit rating model and rho. We used the Credit Rating model in particular because we had data for all the companies here.

| Borrower | Credit Rating PD | Rho | WCDR |
|-----------------|-------------------------|-------------|-------------|
| ACXM | 0.8790% | 0.197323022 | 13.179% |
| AINV | 0.2340% | 0.226750223 | 11.460% |
| FUN | 2.7595% | 0.150196975 | 30.278% |
| CIT | 0.2760% | 0.224531843 | 12.506% |
| FEIC | 2.7595% | 0.150196975 | 30.278% |
| HSBC | 0.1065% | 0.233777154 | 7.288% |
| LEA | 6.9625% | 0.123692271 | 42.769% |

| | | | |
|------|----------|-------------|---------|
| PVA | 1.2375% | 0.184634075 | 23.675% |
| PLAB | 1.5820% | 0.174406941 | 25.601% |
| RURL | 7.1660% | 0.123335064 | 43.323% |
| SBGI | 7.1790% | 0.123313456 | 43.358% |
| TRS | 2.7595% | 0.150196975 | 30.278% |
| X | 0.9160% | 0.195905697 | 21.327% |
| YRCW | 27.8135% | 0.12000011 | 77.220% |

With the assumption of 60% LGD we calculated economic capital as follows:

| Credit rating PD | | | | | | | | | |
|------------------|------------------|-----------------|------------------|------------------|-------------|---------|-------------|-------------|------------------|
| Borrower | Loan amount | Maturity (days) | Maturity (years) | Credit Rating PD | rho | WCDR | b | MA | Economic Capital |
| ACXM | 120,000,000.00 | 1583 | 4.3370 | 0.8790% | 0.197323022 | 13.179% | 0.142775323 | 1.606282586 | 14,224,697.62 |
| ACXM | 375,400,000.00 | 1948 | 5.3370 | 0.8790% | 0.197323022 | 13.179% | 0.142775323 | 1.787968254 | 49,532,918.55 |
| AINV | 1,154,000,000.00 | 1209 | 3.3123 | 0.2340% | 0.226750223 | 11.460% | 0.202820136 | 1.674054605 | 130,123,714.37 |
| AINV | 25,000,000.00 | 1209 | 3.3123 | 0.2340% | 0.226750223 | 11.460% | 0.202820136 | 1.674054605 | 2,818,971.28 |
| FUN | 64,070,000.00 | 1843 | 5.0493 | 2.7595% | 0.150196975 | 30.278% | 0.099342726 | 1.472710525 | 15,579,282.37 |
| CIT | 750,000,000.00 | 694 | 1.9014 | 0.2760% | 0.224531843 | 12.506% | 0.19475672 | 1.24799624 | 68,681,749.38 |
| FEIC | 100,000,000.00 | 1826 | 5.0027 | 2.7595% | 0.150196975 | 30.278% | 0.099342726 | 1.467273394 | 24,226,260.18 |
| HSBC | 1,800,000,000.00 | 364 | 0.9973 | 0.1065% | 0.233777154 | 7.288% | 0.243519623 | 0.998948865 | 77,481,721.85 |
| LEA | 550,000,000.00 | 1096 | 3.0027 | 6.9625% | 0.123692271 | 42.769% | 0.069954176 | 1.1565243 | 136,656,509.39 |
| PVA | 300,000,000.00 | 1096 | 3.0027 | 1.2375% | 0.184634075 | 23.675% | 0.128965721 | 1.320233486 | 53,320,427.84 |
| PLAB | 130,000,000.00 | 608 | 1.6658 | 1.5820% | 0.174406941 | 25.601% | 0.119483733 | 1.096916649 | 20,550,159.00 |
| RURL | 17,600,000.00 | 730 | 2.0000 | 7.1660% | 0.123335064 | 43.323% | 0.069121858 | 1.077117628 | 4,112,588.86 |
| SBGI | 330,000,000.00 | 2191 | 6.0027 | 7.1790% | 0.123313456 | 43.358% | 0.06906966 | 1.385474411 | 99,247,252.69 |
| SBGI | 75,400,000.00 | 1524 | 4.1753 | 7.1790% | 0.123313456 | 43.358% | 0.06906966 | 1.244668588 | 20,371,880.51 |
| TRS | 70,000,000.00 | 1460 | 4.0000 | 2.7595% | 0.150196975 | 30.278% | 0.099342726 | 1.350215172 | 15,605,452.22 |
| TRS | 226,300,000.00 | 2190 | 6.0000 | 2.7595% | 0.150196975 | 30.278% | 0.099342726 | 1.583691954 | 59,173,955.20 |
| TRS | 5,000,000.00 | 1460 | 4.0000 | 2.7595% | 0.150196975 | 30.278% | 0.099342726 | 1.350215172 | 1,114,675.16 |
| X | 750,000,000.00 | 1064 | 2.9151 | 0.9160% | 0.195905697 | 21.327% | 0.141073527 | 1.342680104 | 123,323,838.39 |
| YRCW | 112,000,000.00 | 1221 | 3.3452 | 27.8135% | 0.12000011 | 77.220% | 0.035577185 | 1.08813944 | 36,127,504.83 |
| YRCW | 950,000,000.00 | 1221 | 3.3452 | 27.8135% | 0.12000011 | 77.220% | 0.035577185 | 1.08813944 | 306,438,657.03 |

$$\text{Capital} = \text{EAD} * \text{LGD} * (\text{WCDR} - \text{PD}) * \text{MA}$$

Where,

$$\text{MA} = (1 + (M - 2.5) * b) / (1 - 1.5 * b) \text{ Where, } M = \text{effective maturity} \mid b = [0.11852 - 0.05478 * \ln(\text{PD})]^2$$

The risk - weighted assets are 12.5 times the Capital so that Capital = 8% of RWA

EAD is the loan amount and the other values are calculated in the previous step.

We then grouped all the companies by industry and summed the risk-weighted asset for all borrowers in the same industry as shown below:

| Industry | Risk Weight Asset | Economic capital |
|------------------------|-------------------|------------------|
| Communications | 1,495,239,164.93 | 119,619,133.19 |
| Consumer discretionary | 2,851,623,429.21 | 228,129,874.34 |
| Energy | 666,505,347.96 | 53,320,427.84 |
| Financials | 3,488,826,961.07 | 279,106,156.89 |
| Health care | 51,407,360.81 | 4,112,588.86 |
| Industrials | 4,282,077,023.30 | 342,566,161.86 |
| Materials | 1,541,547,979.87 | 123,323,838.39 |
| Technology | 1,356,675,442.02 | 108,534,035.36 |

The table below shows the correlation between different industries using stock returns:

| | <i>Materials</i> | <i>Technology</i> | <i>Industrials</i> | <i>Healthcare</i> | <i>Financials</i> | <i>Energy</i> | <i>Consumer Discretion</i> | <i>Communications</i> |
|---------------|------------------|-------------------|--------------------|-------------------|-------------------|---------------|----------------------------|-----------------------|
| Materials | 1 | | | | | | | |
| Technology | 0.88462537 | 1 | | | | | | |
| Industrials | 0.9999402 | 0.88487786 | 1 | | | | | |
| Healthcare | 0.21935425 | 0.52024086 | 0.2196157 | 1 | | | | |
| Financials | 0.86931089 | 0.85713549 | 0.8693002 | 0.4655368 | 1 | | | |
| Energy | 0.93180195 | 0.80046082 | 0.9315407 | 0.1676719 | 0.894176 | 1 | | |
| Consumer-Disc | 0.95072388 | 0.90787291 | 0.9509675 | 0.3631837 | 0.931785 | 0.90510 | 1 | |
| Communication | 0.92848391 | 0.91842377 | 0.9287622 | 0.4021733 | 0.856625 | 0.81801 | 0.91993860 | 1 |

The hybrid model was used to aggregate economic capital across different industries and the results were as follows:

$$E_{port} = \sqrt{\sum_{i=1}^n E_i^2 + \sum_{i=1}^n \sum_{j=1}^n 2r_{ij} E_i E_j}$$

We calculated the hybrid model, assuming the correlation r_{ij} from Figure 2. And the new Economic capital is 1,209.165 million dls.

With the hybrid model, the economic capital decreased by almost 50 million.

Adding the correlations to calculate the economic capital between industries (hybrid model) reduces by almost 50 million dollars the amount that the bank must retain as economic capital, which means that our portfolio is diversified between industries.

If the correlation between two industries is low, they don't relate from one another (e.g. if one industry defaults the other industry is not likely to default), it will decrease the economic capital needed from the bank. In our portfolio. On the other hand, if the correlation is almost one they must maintain the total economic capital per industries (e.g. if one industry defaults, the other industry is likely to default)

III. Advanced Internal Rating Based (IRB) approach

Under A-IRB banks we used quantitative models to estimate EAD (exposure at default), PD (probability of default), LGD (loss given default) and other parameters required to calculate the RWA (risk-weighted asset). The total required capital is a fixed percentage of the estimated RWA.

- A) Using PD calculated in Part II for your portfolio companies. To choose the PD, you can choose hybrid PD model, or the model that gives you the most available information.

| Borrower | Credit Rating PD |
|----------|------------------|
| ACXM | 0.8790% |
| AINV | 0.2340% |
| FUN | 2.7595% |
| CIT | 0.2760% |
| FEIC | 2.7595% |
| HSBC | 0.1065% |
| LEA | 6.9625% |
| PVA | 1.2375% |
| PLAB | 1.5820% |
| RURL | 7.1660% |
| SBGI | 7.1790% |
| TRS | 2.7595% |

- B) We are estimating the 1-year default rate distribution for each rating group using historical default rate for the specific rating following MLE approach

For Rating A

| | |
|-----|----------|
| rho | 0.733937 |
| PD | 0.121456 |

For Rating B

| | |
|-----|----------|
| rho | 0.600237 |
| PD | 0.131144 |

For Rating BB

| | |
|-----|----------|
| rho | 0.700237 |
| PD | 0.131144 |

For Rating BBB

| | |
|-----|----------|
| rho | 0.695013 |
| PD | 0.00948 |

For Rating C

| | |
|-----|----------|
| rho | 0.17034 |
| PD | 0.276235 |

C) Based on your loan type, identify recovery rate recovery rate

| Company | Recovery Rate | Loan type |
|---------|---------------|-----------|
| ACXM | 0.371 | Unsecured |
| AINV | 0.375 | Secured |
| FUN | 0.371 | Unsecured |
| CIT | 0.375 | Secured |
| FEIC | 0.371 | Unsecured |
| HSBC | 0.371 | Unsecured |
| LEA | 0.375 | Secured |
| PVA | 0.375 | Secured |
| PLAB | 0.371 | Unsecured |
| RURL | 0.371 | Unsecured |
| SBGI | 0.375 | Secured |
| TRS | 0.371 | Unsecured |
| X | 0.375 | Secured |
| YRCW | 0.375 | Secured |

D) Calculating economic capital needed using estimated PD, rho, WCDR, and recovery rate

| Company | Capital |
|---------|-------------|
| ACXM | 346949388 |
| AINV | 396873463.3 |
| FUN | 44334847.64 |
| CIT | 208667435.6 |
| FEIC | 68942042.91 |
| HSBC | 231213850.5 |
| LEA | 340536128.1 |
| PVA | 178405238.8 |
| PLAB | 69224947.07 |
| RURL | 10228656.26 |
| SBGI | 295463330.3 |
| TRS | 215976096.1 |
| X | 410046967.6 |
| YRCW | 358610213.4 |

E) Grouping by industry and sum up the risk-weighted asset for all borrowers in the same industry

| Industry | Risk Weight Asset | Economic capital |
|------------------------|-------------------|------------------|
| communications | 3693291628 | 295463330.3 |
| consumer discretionary | 7510588399 | 600847071.9 |
| energy | 2230065485 | 178405238.8 |
| Financials | 10459434368 | 836754749.4 |
| health care | 127858203.3 | 10228656.26 |
| industrials | 4482627668 | 358610213.4 |
| materials | 5125587095 | 410046967.6 |
| technology | 6063954725 | 485116378 |

F) Calculating correlation between different industries using stock returns (done in Part I)

| | Materials | Technology | Industrials | Healthcare | Financials | Energy | Consumer Discretion | Communications |
|---------------------|-------------|-------------|-------------|-------------|-------------|-------------|---------------------|----------------|
| Materials | 1 | | | | | | | |
| Technology | 0.884625371 | 1 | | | | | | |
| Industrials | 0.999940274 | 0.884877864 | 1 | | | | | |
| Healthcare | 0.219354252 | 0.520240863 | 0.21961577 | 1 | | | | |
| Financials | 0.869310898 | 0.857135495 | 0.86930022 | 0.465536884 | 1 | | | |
| Energy | 0.931801954 | 0.800460825 | 0.931540732 | 0.16767191 | 0.894176288 | 1 | | |
| Consumer Discretion | 0.950723885 | 0.907872914 | 0.950967523 | 0.363183778 | 0.931785852 | 0.905101576 | 1 | |
| Communications | 0.928483915 | 0.918423774 | 0.928762204 | 0.402173356 | 0.856626105 | 0.818011869 | 0.919938606 | 1 |

G) Using hybrid model to aggregate economic capital across different industries

| Industry | Risk Weight Asset | Economic capital | Economic capital ^2 |
|------------------------|-------------------|------------------|---------------------|
| communications | 3693291628 | 295463330.3 | 8.72986E+16 |
| consumer discretionary | 7510588399 | 600847071.9 | 3.61017E+17 |
| energy | 2230065485 | 178405238.8 | 3.18284E+16 |
| Financials | 10459434368 | 836754749.4 | 7.00159E+17 |
| health care | 127858203.3 | 10228656.26 | 1.04625E+14 |
| industrials | 4482627668 | 358610213.4 | 1.28601E+17 |
| materials | 5125587095 | 410046967.6 | 1.68139E+17 |
| technology | 6063954725 | 485116378 | 2.35338E+17 |

| | Standard Approach | Hybrid Model (Across Industries) |
|-------|-------------------|----------------------------------|
| Total | 3175472606 | 3037374953.04016 |

$$E_{port} = \sqrt{\sum_{i=1}^n E_i^2 + \sum_{i=1}^n \sum_{j=1}^n 2r_{ij} E_i E_j}$$

We calculated the hybrid model, assuming the correlation r_{ij} from Figure 2. And the new Economic capital is 3037.3749 million dls.

With the hybrid model, the economic capital decreased by almost 140 million.

H) The benefit of industry diversification from our calculation

Adding the correlations to calculate the economic capital between industries (hybrid model) reduces by almost 140 million dollars the amount that the bank must retain as economic capital, which means that our portfolio is diversified between industries.

If the correlation between two industries is low, they don't relate from one another (e.g. if one industry defaults the other industry is not likely to default), it will decrease the economic capital needed from the bank. In our portfolio. On the other hand, if the correlation is almost one they must maintain the total economic capital per industries (e.g. if one industry defaults, the other industry is likely to default).

PART 4 : SCENARIO ANALYSIS AND STRESS TESTING

Objective

- Report the average PD of your portfolio over the nine quarters. 10 points
- Calculate economic capital for the nine quarters and evaluate your bank's capital adequacy on tier 1 capital, assuming there is no change to the retained earnings. 10 points
- Summarize the key CCAR results for your bank in the recent years (from 2012 to 2015). You can obtain this information from CCAR or bank annual reports

Our Working

- 1) Report the average PD of your portfolio over the nine quarters.

In order to stress our data we used FED CCAR supervisory scenarios to model our PD's for the next 8 quarters. We consider the CCAR scenarios from 2016 and we forecasted different parameters (Implied Volatility, CDS spread, Swap Rate, Market Capital and Rating Letters) for the next 8 quarters after Q4 2009.

For the first 3 quarters we considered severely adverse scenarios, followed by 3 quarters of adverse scenarios, and 2 quarters back to baseline scenarios. Since we didn't have enough data for all our companies, we only considered 7 companies from our portfolio to calculate the probabilities of default.

Scenario for Implied Volatility

We used the VIX Index and the companies' betas to scale the implied volatility:

| | SBGI | HSBC | YRCW | X | ACXM | FEIC | PLAB |
|----------------|-------------|-------------|-------------|----------|-------------|-------------|-------------|
| Q4 2009 | 103.047 | 31.849 | 170.419 | 48.132 | 63.432 | 61.06 | 113.013 |
| Q1 2010 | 135.785 | 29.3196 | 586.011 | 116.421 | 65.2643 | 59.5173 | 47.939 |
| Q2 2010 | 162.265 | 35.0375 | 700.293 | 139.125 | 77.992 | 71.1242 | 57.2879 |
| Q3 2010 | 133.232 | 28.7685 | 574.995 | 114.232 | 64.0375 | 58.3985 | 47.0378 |
| Q4 2010 | 137.222 | 29.6301 | 592.215 | 117.654 | 65.9553 | 60.1475 | 48.4466 |
| Q1 2011 | 148.636 | 32.0946 | 641.474 | 127.44 | 71.4413 | 65.1503 | 52.4762 |
| Q2 2011 | 139.44 | 30.109 | 601.787 | 119.555 | 67.0213 | 61.1196 | 49.2296 |
| Q3 2011 | 154.083 | 33.2707 | 664.98 | 132.11 | 74.0592 | 67.5377 | 54.3991 |
| Q4 2011 | 151.158 | 32.6392 | 652.359 | 129.602 | 72.6536 | 66.2559 | 53.3667 |

Scenario for CDS Spread

| | SBGI | HSBC | YRCW | X | ACXM | FEIC | PLAB |
|----------------|-------------|-------------|-------------|----------|-------------|-------------|-------------|
| Q4 2009 | 297 | 68 | 1126 | 204 | 143 | 87 | 200 |
| Q1 2010 | 359.5263 | 82.315789 | 1363.053 | 246.9474 | 173.1053 | 105.3158 | 242.1053 |
| Q2 2010 | 309.913 | 70.956522 | 1174.957 | 212.8696 | 149.2174 | 90.78261 | 208.6957 |
| Q3 2010 | 309.375 | 70.833333 | 1172.917 | 212.5 | 148.9583 | 90.625 | 208.3333 |
| Q4 2010 | 275 | 62.962963 | 1042.593 | 188.8889 | 132.4074 | 80.55556 | 185.1852 |
| Q1 2011 | 308.88 | 70.72 | 1171.04 | 212.16 | 148.72 | 90.48 | 208 |
| Q2 2011 | 285.5769 | 65.384615 | 1082.692 | 196.1538 | 137.5 | 83.65385 | 192.3077 |
| Q3 2011 | 279.5294 | 64 | 1059.765 | 192 | 134.5882 | 81.88235 | 188.2353 |
| Q4 2011 | 297 | 68 | 1126 | 204 | 143 | 87 | 200 |

Scenario Swap Rate

We repeated this process for eight more quarters and three scenarios.

We used the 3 month treasury rate to scale the one year swap rate.

Annualized 3-month treasury rate= $(1+\text{rate})^4 - 1$

| | SBGI | HSBC | YRCW | X | ACXM | FEIC | PLAB |
|----------------|-------------|-------------|-------------|----------|-------------|-------------|-------------|
| Q4 2009 | 0.90% | 0.90% | 0.90% | 0.90% | 0.90% | 0.90% | 0.90% |
| Q1 2010 | 0.40% | 0.40% | 0.40% | 0.40% | 0.40% | 0.40% | 0.40% |
| Q2 2010 | 0.40% | 0.40% | 0.40% | 0.40% | 0.40% | 0.40% | 0.40% |
| Q3 2010 | 0.40% | 0.40% | 0.40% | 0.40% | 0.40% | 0.40% | 0.40% |
| Q4 2010 | 10.81% | 10.81% | 10.81% | 10.81% | 10.81% | 10.81% | 10.81% |
| Q1 2011 | 12.99% | 12.99% | 12.99% | 12.99% | 12.99% | 12.99% | 12.99% |
| Q2 2011 | 15.20% | 15.20% | 15.20% | 15.20% | 15.20% | 15.20% | 15.20% |
| Q3 2011 | 8.67% | 8.67% | 8.67% | 8.67% | 8.67% | 8.67% | 8.67% |
| Q4 2011 | 9.95% | 9.95% | 9.95% | 9.95% | 9.95% | 9.95% | 9.95% |

Scenario for Market Capital

We used the Dow Jones Industrial Index and the companies' betas to scale the total market value of our companies.

| | SBGI | HSBC | YRCW | X | ACXM | FEIC | PLAB |
|----------------|-------------|-------------|-------------|----------|-------------|-------------|-------------|
| Q4 2009 | 190.92 | 198767 | 50.39 | 7901.45 | 1061.76 | 880.3 | 236.65 |
| Q1 2010 | 203.34 | 147896 | 140.05 | 15447.3 | 882.97 | 693.53 | 81.14 |
| Q2 2010 | 227.26 | 165297 | 156.52 | 17264.8 | 986.85 | 775.13 | 90.68 |
| Q3 2010 | 239.92 | 174502 | 165.24 | 18226.3 | 1041.81 | 818.29 | 95.73 |
| Q4 2010 | 266.83 | 194076 | 183.77 | 20270.7 | 1158.67 | 910.08 | 106.47 |
| Q1 2011 | 269.82 | 196251 | 185.83 | 20497.9 | 1171.66 | 920.28 | 107.67 |
| Q2 2011 | 273.32 | 198794 | 188.24 | 20763.5 | 1186.84 | 932.21 | 109.06 |
| Q3 2011 | 282.42 | 205415 | 194.51 | 21455 | 1226.36 | 963.25 | 112.69 |
| Q4 2011 | 282.44 | 205432 | 194.53 | 21456.8 | 1226.47 | 963.33 | 112.7 |

Scenario for Credit Ratings

We analyzed the next 8 quarter from 2009 Q4. For the 2010 Q1, Q2 and Q3 we considered the Severely adverse scenario. For 2020Q1 the nominal GDP and the real GDP were negative, and the spread between BBB corporate bond yield and 3-month yield got wider, and the DJI went from 17133.5 to 12498. Therefore we considered downgrading all our companies for half a notch. For 2010Q2 the scenarios remained negative, so we decided to leave the ratings down half notch. For 2010Q3 the scenarios continued to be bad, the GDP more negative, the spreads got wider and the DJI more negative, and we downgraded another half notch. The next 2 quarters, everything started to stabilized, so we decided to maintain our credit ratings half notch down the actual rates. For Q2 2011 we upgraded it half a notch, so it was equal to the actual ratings. And for the last 2 quarters, there is a better scenario. Therefore, we increased for half a notch the ratings.

| | SBGI | HSBC | YRCW | X | ACXM | FEIC | PLAB |
|----------------|-------------|-------------|-------------|----------|-------------|-------------|-------------|
| Q4 2009 | B- | A | CCC | BB+ | BB | B+ | B- |
| Q1 2010 | CCC | A- | D | BB | BB- | B | CCC |
| Q2 2010 | CCC | A- | D | BB | BB- | B | CCC |
| Q3 2010 | D | BBB+ | D | BB- | B+ | B- | D |
| Q4 2010 | CCC | A- | D | BB | BB- | B | CCC |
| Q1 2011 | CCC | A- | D | BB | BB- | B | CCC |
| Q2 2011 | B- | A | CCC | BB+ | BB | B+ | B- |
| Q3 2011 | B | A+ | B- | BBB- | BB+ | BB- | B |
| Q4 2011 | B | A+ | B- | BBB- | BB+ | BB- | B |

Therefore, using each quarter's scenario, the probabilities of default were calculated. In order to capture all the movements from the different scenarios, we used a hybrid model to calculate the PD (averaging the 3 models: Reduced form, Merton's Model, and Credit Rating).

| Scenario Used: | | Average from the Reduced form, Merton's Model, and Credit Rating Model |
|--------------------------------------|----------------|---|
| | Q4 2009 | 9.66% |
| Severely adverse scenario | Q1 2010 | 17.25% |
| | Q2 2010 | 17.99% |
| | Q3 2010 | 23.91% |
| | Q4 2010 | 16.58% |
| Adverse scenario | Q1 2011 | 17.17% |
| | Q2 2011 | 11.44% |
| | Q3 2011 | 10.70% |
| baseline scenario | Q4 2011 | 10.68% |

Estimating the loss distribution by approach 2: Given the Loss = PD * LGD * EAD

The total loan amount from the 7 analyzed companies was 4,742.8 million, and considering a 60% loss given default.

The Loss per quarter was:

| | Loss |
|----------------|---------------|
| Q4 2009 | 274,892,688.0 |
| Q1 2010 | 490,879,800.0 |
| Q2 2010 | 511,937,832.0 |
| Q3 2010 | 680,402,088.0 |
| Q4 2010 | 471,813,744.0 |

| | |
|----------------|---------------|
| Q1 2011 | 488,603,256.0 |
| Q2 2011 | 325,545,792.0 |
| Q3 2011 | 304,487,760.0 |
| Q4 2011 | 303,918,624.0 |

Economic Capital

We calculated Economic Capital for each quarter using the Internal Rating Based Approach.

Where, **Capital = EAD×LGD ×(WCDR-PD)×MA**

| Q4 2009 | | | | | | | |
|---------|-----|---------------------|--------|--------|-------------------|--------------|------------------|
| Company | LGD | EAD = Loan Exposure | PD | WCDR | Maturity in years | MA | Economic Capital |
| FEIC | 0.6 | 100,000,000.00 | 1.41% | 16.40% | 5.002739726 | 1.609043959 | 14475403.99 |
| X | 0.6 | 750,000,000.00 | 1.38% | 16.25% | 2.915068493 | 1.293794227 | 86573846.87 |
| HSBC | 0.6 | 1,800,000,000.00 | 0.42% | 8.84% | 0.997260274 | 0.9993499676 | 90845735.7 |
| ACXM | 0.6 | 375,000,000.00 | 1.19% | 15.21% | 5.336986301 | 1.703801218 | 53743497.36 |
| ACXM | 0.6 | 120,000,000.00 | 1.19% | 15.21% | 4.336986301 | 1.541522353 | 15559900.13 |
| PLAB | 0.6 | 130,000,000.00 | 8.68% | 38.12% | 1.665753425 | 1.046897696 | 24042617.39 |
| SBGI | 0.6 | 330,000,000.00 | 14.69% | 50.89% | 6.002739726 | 1.270369776 | 91063908.18 |
| SBGI | 0.6 | 75,400,000.00 | 14.69% | 50.89% | 4.175342466 | 1.171609294 | 19189176.89 |
| YRCW | 0.6 | 112,000,000.00 | 39.85% | 80.70% | 3.345205479 | 1.069910427 | 29371111.98 |
| YRCW | 0.6 | 950,000,000.00 | 39.85% | 80.70% | 3.345205479 | 1.069910427 | 249129967.7 |

| Q1 2010 | | | | | | | |
|---------|-----|---------------------|--------|--------|-------------------|----------|------------------|
| Company | LGD | EAD = Loan Exposure | PD | WCDR | Maturity in years | MA | Economic Capital |
| FEIC | 0.6 | 100,000,000.00 | 3.05% | 22.69% | 4.753 | 1.420440 | 16,737,124.47 |
| X | 0.6 | 750,000,000.00 | 3.31% | 23.50% | 2.665 | 1.180317 | 107,253,508.75 |
| HSBC | 0.6 | 1,800,000,000.00 | 0.54% | 10.21% | 0.747 | 0.945180 | 98,667,098.90 |
| ACXM | 0.6 | 375,000,000.00 | 1.52% | 16.95% | 5.087 | 1.604201 | 55,683,601.04 |
| ACXM | 0.6 | 120,000,000.00 | 1.52% | 16.95% | 4.087 | 1.456365 | 16,176,663.52 |
| PLAB | 0.6 | 130,000,000.00 | 10.68% | 42.78% | 1.416 | 1.026464 | 25,699,919.93 |
| SBGI | 0.6 | 330,000,000.00 | 27.41% | 69.18% | 5.753 | 1.180227 | 97,617,913.57 |
| SBGI | 0.6 | 75,400,000.00 | 27.41% | 69.18% | 3.925 | 1.110931 | 20,994,638.47 |
| YRCW | 0.6 | 112,000,000.00 | 74.22% | 96.67% | 3.095 | 1.039170 | 15,676,475.11 |
| YRCW | 0.6 | 950,000,000.00 | 74.22% | 96.67% | 3.095 | 1.039170 | 132,970,101.37 |

| Q2 2010 | | | | | | | |
|---------|-----|---------------------|--------|--------|-------------------|----------|------------------|
| Company | LGD | EAD = Loan Exposure | PD | WCDR | Maturity in years | MA | Economic Capital |
| FEIC | 0.6 | 100,000,000.00 | 3.01% | 22.56% | 4.503 | 1.394576 | 16,359,181.49 |
| X | 0.6 | 750,000,000.00 | 5.09% | 28.70% | 2.415 | 1.127413 | 119,789,549.86 |
| HSBC | 0.6 | 1,800,000,000.00 | 0.50% | 9.77% | 0.497 | 0.887905 | 88,929,685.74 |
| ACXM | 0.6 | 375,000,000.00 | 1.75% | 17.99% | 4.837 | 1.537120 | 56,180,070.22 |
| ACXM | 0.6 | 120,000,000.00 | 1.75% | 17.99% | 3.837 | 1.397135 | 16,340,408.09 |
| PLAB | 0.6 | 130,000,000.00 | 10.68% | 42.78% | 1.166 | 1.010551 | 25,301,488.72 |
| SBGI | 0.6 | 330,000,000.00 | 31.73% | 73.71% | 5.503 | 1.155864 | 96,082,049.63 |
| SBGI | 0.6 | 75,400,000.00 | 31.73% | 73.71% | 3.675 | 1.092608 | 20,751,870.13 |
| YRCW | 0.6 | 112,000,000.00 | 73.19% | 96.41% | 2.845 | 1.034900 | 16,149,275.94 |
| YRCW | 0.6 | 950,000,000.00 | 73.19% | 96.41% | 2.845 | 1.034900 | 136,980,465.57 |

| Q3 2010 | | | | | | | |
|---------|-----|---------------------|--------|--------|-------------------|----------|------------------|
| Company | LGD | EAD = Loan Exposure | PD | WCDR | Maturity in years | MA | Economic Capital |
| FEIC | 0.6 | 100,000,000.00 | 4.38% | 26.68% | 4.253 | 1.312746 | 17,567,564.62 |
| X | 0.6 | 750,000,000.00 | 2.74% | 21.68% | 2.165 | 1.136403 | 96,867,219.55 |
| HSBC | 0.6 | 1,800,000,000.00 | 0.47% | 9.43% | 0.247 | 0.828412 | 80,205,079.53 |
| ACXM | 0.6 | 375,000,000.00 | 1.83% | 18.33% | 4.587 | 1.493434 | 55,459,224.98 |
| ACXM | 0.6 | 120,000,000.00 | 1.83% | 18.33% | 3.587 | 1.355871 | 16,112,256.38 |
| PLAB | 0.6 | 130,000,000.00 | 34.53% | 76.33% | 0.916 | 0.997238 | 32,510,896.98 |
| SBGI | 0.6 | 330,000,000.00 | 50.29% | 87.47% | 5.253 | 1.107664 | 81,542,249.70 |
| SBGI | 0.6 | 75,400,000.00 | 50.29% | 87.47% | 3.425 | 1.061401 | 17,853,010.20 |
| YRCW | 0.6 | 112,000,000.00 | 73.15% | 96.40% | 2.595 | 1.030185 | 16,096,322.72 |
| YRCW | 0.6 | 950,000,000.00 | 73.15% | 96.40% | 2.595 | 1.030185 | 136,531,308.80 |

| Q4 2010 | | | | | | | |
|---------|-----|---------------------|--------|--------|-------------------|----------|------------------|
| Company | LGD | EAD = Loan Exposure | PD | WCDR | Maturity in years | MA | Economic Capital |
| FEIC | 0.6 | 100,000,000.00 | 2.91% | 22.24% | 4.003 | 1.342991 | 15,575,543.63 |
| X | 0.6 | 750,000,000.00 | 2.40% | 20.52% | 1.915 | 1.113041 | 90,746,870.31 |
| ACXM | 0.6 | 375,000,000.00 | 1.21% | 15.32% | 4.337 | 1.538127 | 48,848,066.06 |
| ACXM | 0.6 | 120,000,000.00 | 1.21% | 15.32% | 3.337 | 1.376866 | 13,992,544.36 |
| PLAB | 0.6 | 130,000,000.00 | 10.33% | 42.00% | 0.666 | 0.978369 | 24,164,778.86 |
| SBGI | 0.6 | 330,000,000.00 | 26.31% | 67.92% | 5.003 | 1.155615 | 95,211,066.72 |
| SBGI | 0.6 | 75,400,000.00 | 26.31% | 67.92% | 3.175 | 1.084571 | 20,416,895.35 |
| YRCW | 0.6 | 112,000,000.00 | 72.43% | 96.21% | 2.345 | 1.025664 | 16,393,291.26 |
| YRCW | 0.6 | 950,000,000.00 | 72.43% | 96.21% | 2.345 | 1.025664 | 139,050,238.38 |

| Q1 2011 | | | | | | | |
|---------|-----|---------------------|--------|--------|-------------------|----------|------------------|
| Company | LGD | EAD = Loan Exposure | PD | WCDR | Maturity in years | MA | Economic Capital |
| FEIC | 0.6 | 100,000,000.00 | 2.97% | 22.43% | 3.753 | 1.311805 | 15,318,881.78 |
| X | 0.6 | 750,000,000.00 | 3.14% | 22.97% | 1.665 | 1.073620 | 95,818,987.01 |
| ACXM | 0.6 | 375,000,000.00 | 1.37% | 16.20% | 4.087 | 1.474896 | 49,207,179.88 |
| ACXM | 0.6 | 120,000,000.00 | 1.37% | 16.20% | 3.087 | 1.321058 | 14,103,889.86 |
| PLAB | 0.6 | 130,000,000.00 | 10.49% | 42.36% | 0.416 | 0.962477 | 23,922,311.86 |
| SBGI | 0.6 | 330,000,000.00 | 28.59% | 70.49% | 4.753 | 1.138667 | 94,456,537.23 |
| SBGI | 0.6 | 75,400,000.00 | 28.59% | 70.49% | 2.925 | 1.071143 | 20,302,061.25 |
| YRCW | 0.6 | 112,000,000.00 | 73.16% | 96.40% | 2.095 | 1.020722 | 15,943,350.58 |
| YRCW | 0.6 | 950,000,000.00 | 73.16% | 96.40% | 2.095 | 1.020722 | 135,233,777.22 |

| Q2 2011 | | | | | | | |
|---------|-----|---------------------|--------|--------|-------------------|----------|------------------|
| Company | LGD | EAD = Loan Exposure | PD | WCDR | Maturity in years | MA | Economic Capital |
| FEIC | 0.6 | 100,000,000.00 | 1.39% | 16.30% | 3.503 | 1.382893 | 12,372,611.93 |
| X | 0.6 | 750,000,000.00 | 2.37% | 20.41% | 1.415 | 1.051535 | 85,369,451.58 |
| ACXM | 0.6 | 375,000,000.00 | 1.15% | 14.97% | 3.837 | 1.466349 | 45,607,872.05 |
| ACXM | 0.6 | 120,000,000.00 | 1.15% | 14.97% | 2.837 | 1.301967 | 12,958,431.99 |
| PLAB | 0.6 | 130,000,000.00 | 4.97% | 28.36% | 0.166 | 0.924090 | 16,862,431.61 |
| SBGI | 0.6 | 330,000,000.00 | 21.22% | 61.39% | 4.503 | 1.154569 | 91,841,379.68 |
| SBGI | 0.6 | 75,400,000.00 | 21.22% | 61.39% | 2.675 | 1.073929 | 19,518,738.41 |
| YRCW | 0.6 | 112,000,000.00 | 48.60% | 86.51% | 1.845 | 1.021934 | 26,037,336.32 |
| YRCW | 0.6 | 950,000,000.00 | 48.60% | 86.51% | 1.845 | 1.021934 | 220,852,406.30 |

| Q3 2011 | | | | | | | |
|---------|-----|---------------------|--------|--------|-------------------|----------|------------------|
| Company | LGD | EAD = Loan Exposure | PD | WCDR | Maturity in years | MA | Economic Capital |
| FEIC | 0.6 | 100,000,000.00 | 0.87% | 13.11% | 3.253 | 1.410847 | 10,362,818.84 |
| X | 0.6 | 750,000,000.00 | 3.20% | 23.16% | 1.165 | 1.018129 | 91,453,548.91 |
| ACXM | 0.6 | 375,000,000.00 | 1.18% | 15.15% | 3.587 | 1.421151 | 44,673,255.75 |
| ACXM | 0.6 | 120,000,000.00 | 1.18% | 15.15% | 2.587 | 1.258355 | 12,657,867.80 |
| SBGI | 0.6 | 330,000,000.00 | 22.59% | 63.27% | 4.253 | 1.138435 | 91,701,840.35 |
| SBGI | 0.6 | 75,400,000.00 | 22.59% | 63.27% | 2.425 | 1.060662 | 19,521,092.11 |
| YRCW | 0.6 | 112,000,000.00 | 43.09% | 83.04% | 1.595 | 1.016817 | 27,294,832.11 |
| YRCW | 0.6 | 950,000,000.00 | 43.09% | 83.04% | 1.595 | 1.016817 | 231,518,665.18 |

| Q4 2011 | | | | | | | |
|---------|-----|---------------------|--------|--------|-------------------|----------|------------------|
| Company | LGD | EAD = Loan Exposure | PD | WCDR | Maturity in years | MA | Economic Capital |
| FEIC | 0.6 | 100,000,000.00 | 0.90% | 13.33% | 3.003 | 1.360711 | 10,149,906.77 |
| X | 0.6 | 750,000,000.00 | 3.02% | 22.59% | 0.915 | 0.990446 | 87,236,471.47 |
| ACXM | 0.6 | 375,000,000.00 | 1.19% | 15.21% | 3.337 | 1.379243 | 43,505,878.43 |
| ACXM | 0.6 | 120,000,000.00 | 1.19% | 15.21% | 2.337 | 1.216965 | 12,283,862.07 |
| SBGI | 0.6 | 330,000,000.00 | 22.13% | 62.65% | 4.003 | 1.129333 | 90,611,622.59 |
| SBGI | 0.6 | 75,400,000.00 | 22.13% | 62.65% | 2.175 | 1.050624 | 19,260,457.92 |
| YRCW | 0.6 | 112,000,000.00 | 43.45% | 83.28% | 1.345 | 1.009697 | 27,025,998.47 |
| YRCW | 0.6 | 950,000,000.00 | 43.45% | 83.28% | 1.345 | 1.009697 | 229,238,379.92 |

In order to calculate the amounts of economic capital for each quarter, we used the industry correlation.

Industry correlation:

| | Materials | Technology | Industrials | Financials | Communications |
|----------------|-----------|------------|-------------|------------|----------------|
| Materials | 1 | | | | |
| Technology | 0.8846 | 1 | | | |
| Industrials | 0.9999 | 0.8849 | 1 | | |
| Financials | 0.8693 | 0.8571 | 0.8693 | 1 | |
| Communications | 0.9285 | 0.9184 | 0.9288 | 0.8566 | 1 |

| | Economic Capital |
|----------------|-------------------------|
| Q4 2009 | 650,521,898.09 |
| Q1 2010 | 571,497,998.91 |
| Q2 2010 | 570,394,597.32 |
| Q3 2010 | 529,629,333.37 |
| Q4 2010 | 451,496,456.24 |
| Q1 2011 | 451,417,358.01 |
| Q2 2011 | 518,472,141.83 |
| Q3 2011 | 517,480,894.18 |
| Q4 2011 | 507,839,603.54 |

In order to calculate the Tier 1 Capital, we assume the 2009 Net Income of 11,728.00 million dollars remained constant through the next quarters. The Tier 1 Capital as of 2009 was 132,971 million, and the Risk-weighted assets in 2009 was 1,198,006 million, which was assume constant through the next quarters.

| | Q42009 | Q12010 | Q2 2010 | Q3 2010 | Q4 2010 | Q1 2011 | Q2 2011 | Q3 2011 | Q4 2011 |
|-------------------------|---------------|---------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Net Income | 11,728 | 11,728 | 11,728 | 11,728 | 11,728 | 11,728 | 11,728 | 11,728 | 11,728 |
| Economic Capital | | 142.874 | 142.598 | 132.407 | 112.874 | 112.854 | 129.618 | 129.370 | 126.959 |
| NI - EC | | 11,585.13 | 11,585.40 | 11,595.59 | 11,615.13 | 11,615.15 | 11,598.38 | 11,598.63 | 11,601.04 |
| | | | | | | | | | |
| Tier 1 Capital | 132,971 | 144,556 | 156,142 | 167,737 | 179,352 | 190,967 | 202,566 | 214,164 | 225,765 |
| RWA | 1,198,006 | 1,198,006 | 1,198,006 | 1,198,006 | 1,198,006 | 1,198,006 | 1,198,006 | 1,198,006 | 1,198,006 |
| Tier 1 Cap ratio | 11.10% | 12.07% | 13.03% | 14.00% | 14.97% | 15.94% | 16.91% | 17.88% | 18.85% |

The Tier 1 Capital ratio is above Federal Reserve Capital requirements of 4.5% for all quarters. Starting with 12.07% and continuously increasing over the following years because the Net Income minus the economic capital is always positive, and the amount of Tier 1 Capital is increasing (we are assuming no retained earnings).

(3) Summarize the key CCAR results for your bank in the recent years (from 2012 to 2015). You can obtain this information from CCAR or bank annual reports.

From 2012 to 2015 the CARR results of JPMorgan Chase & Co. as follow:

| JPMorgan Chase & Co. | Non-objection to capital plan | Conditional non-objection to capital plan | Objection to capital plan |
|----------------------|-------------------------------|---|---------------------------|
| 2012 | | yes | |
| 2013 | | yes | |
| 2014 | yes | | |
| 2015 | yes | | |

| CET1 Ratios | Q4'12 | Q1'13 | Q2'13 | Q3'13 | Q4'13 | Q1'14 | Q2'14 | Q3'14 | Q4'14 | TARGET (Basel) | TARGET (Fed) |
|-------------|-------|-------|-------|-------|-------|-------|-------|--------|--------|----------------|--------------|
| JPMorgan | 8.74% | 8.86% | 9.33% | 9.33% | 9.50% | 9.58% | 9.79% | 10.11% | 10.18% | 9.50% | 11.50% |

Chase Bank submitted its 2012 capital plan on January 9, 2012, and received notice of the Federal Reserve's conditional non-objection on March 13, 2012. In May 2012, Chase had to resubmit its capital plan to the Federal Reserve because it was listed under the conditional non-objection column of the CCAR 2012 report. In November 2012, Chase received a non-objection from the Federal Reserve.

On March 2013, the Federal Reserve informed the Firm that it did not object to the Firm's 2013 capital plan, but asked the Firm to submit an additional capital plan by the end of the third quarter to address weaknesses in their capital planning processes.

On March 2014, and 2015 the Federal Reserve informed the Firm that it did not object, on both a quantitative and qualitative basis, to the Firm's 2014 and 2015 capital plan.

CONCLUSIONS

Chase bank had good holdings even though it had multiple risk exposures. In this portfolio certain companies were on the brink of bankruptcy such as YRCW, X (United Steel Services), CIT. Also the models take the historic values into consideration and our analysis is intuitive with the companies' past events which makes it very reliable. In addition to this we are maintaining the rules and regulatory compliance while evaluating this portfolio (its constituent companies).

We tested our portfolio under different scenarios given by the FED's CCAR Supervisory Scenarios, where we shocked the Volatilities, CDS Spread, Credit Ratings, Market Capital and Risk-free rate. Under these scenarios, we assumed Net Income to be constant, we found that the Tier1 Capital Ratio was above the required 4.5 benchmark. This was conducted for 7 companies which spanned 5 different sectors. It is important to note that there could be changes if the Income changed for every quarter but we are not considering it.