PROJECT REPORT

RISK ANALYTICS & MANAGEMENT

ASSET - LIABILITY MANAGEMENT STRATEGY

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Executive Summary

Asset Liability Management is the most important aspect for the Financial Services to manage liquidity risk, particularly the management of credit and interest rate risk associated with assets and liabilities. Failure to identify the risks associated with business and failure to take timely measures in giving a sense of direction threatens the very existence of the institution. Implementing Asset Liability Management (ALM) function in banks is not only a regulatory requirement but also an imperative for strategic bank management.

This project had a core objective of matching the liabilities of JH Financial Services, Inc. where 30% of the liabilities will be paid in year 4 and 70% will be paid in year 5. To form an optimized portfolio, we employed a hybrid bond selection (Active and Passive) strategy where our bonds were constantly rebalanced to hedge against interest rate, duration, convexity, and credit risks (Passive). Our strategy also involves selling out of a bond position in year 4 in order to match the required liability (Active). Our total cash flow in year 4 was **$116,492,214.01** which was greater than our liability (**$100,889,900)**. In year 5, we had a liability of **$241,163,700.00** and our total cash flow from assets was **$242,461,131.28.** After matching the liability, we had an expected Net Profit of **$1,297,431.28.**

Investors are willing to be aware of two main risks that may influence the bond portfolios' investment value, and such risks are the credit risk concerning the possibility of rating changes and even the defaults and the interest rate risk which takes the interest rate fluctuations into the mind. Here, we will introduce the modified duration initially and the Credit VaR approach as well for our risk assessment. To be specific, the modified duration measures the sensitivity of the portfolio exposed to the changes in interest rates, which brings the idea for evaluating the potential impacts caused on the bond's price and expected YTM. In our case, both the portfolios held during year 1 to 4 and the one getting after selling the bonds in year 5 are included in the consideration, and a stable MD shown as **5.89%** by which the portfolio will change in response to 1% change in the interest rate. Additionally, the Credit-VaR measures the portfolio's risk given changes in the value of bonds as a result of possible changes in their respective ratings. It serves as a measure of portfolio risk coming from credit risk and the risk associated with the chosen portfolio asset weightings. It also pays special attention to the intra-portfolio asset correlation as a high correlation among the bonds will increase their corresponding Credit VaR. After the simulation paths, the Credit VaR for our portfolio at the 99% percentile was **U.S$ 77.7 million.** The portfolio had an expected value in year 5 of $**334 million** with a standard deviation of **3.1%**.

1.1 Project Introduction

The project is based on the background faced by Janet's asset-liability risk management group for annuities at JH Financial Services, and an asset management strategy that will be applied to match the distribution of the liability and assets should be pursued in the team's works. Initially, getting familiar with the annuity products is required, which contains the understanding of the fixed annuities and the variable ones that are defined as the two types of contracts held between an investor and an insurance company towards the periodic payments starting from a specific date. Specifically, in a fixed annuity, the insurance company guarantees a minimum rate of interest and a periodic payment amount decided per dollar in the investor's account; while on the contrary, the variable annuity invests the purchase payments from among a range of different investment options and thus the rate of return for the investor will depend on the performance of the exact investment option selected. As for this project, the group will concentrate on the variable annuities and a portfolio of the investment will be focused on. To explicate the portfolio of annuities here which owns a net accrued premium of $300 million, there is a pool covering 24 available bonds with a 7-year maturity and 5 bonds are suggested to be chosen to keep the model relatively simple, whose annual yield will be tracked by a bond index and assumed as following the normal distribution with an expected annual yield of 2.3% and an annual standard deviation of 2.8%. Furthermore, the benefit payments are estimated to be taken at approximately 30% at the end of the 4^{th} year, and the rest will be paid at the end of the 5^{th} year.

1.2 Assumptions

- The coupons are paid at the end of March annually, and the accrued coupon payments appreciate at an annual 1-year T-Bill rate of 1%.
- The bond's probability of default was determined at the end of year 4 to ascertain which bond in the portfolio was likely to default so that we could sell it in order to meet year 4 liability
- The optimal portfolio will maximize value while also minimizing interest rate and credit risk

2.0 Bond Selection

2.1 Basic Idea

Hybrid Bond Selection Strategy

We employed a hybrid (Active & Passive) bond selection strategy for our portfolio. The active strategy involved liquidating some of the bonds in year 4 to match liabilities due to probable changes to interest rate, credit ratings, and yield curve shifts. whereas the passive strategy was employed to meet our

project objective. Since our objective was not so much about maximizing returns but to get cash flows that match the U.S $300 million liability where 30% is paid in year 4 and 70% is paid in year 5, we adjusted the monitored and adjusted the bonds as needed.

To achieve this objective, we used a simulation strategy where the bond duration and convexity, bond ratings with its transition matrix for all bonds in its state, and interest rate risk sensitivity were captured. The interest rate sensitivity involved the possibility of selling a bond in year 4 that had a higher yield to maturity. The simulation had 10000 paths and was used to choose an optimal bond portfolio and its weights based on interest rate risk, credit risk, and returns. It was conducted under different possible credit migration transition probabilities together with corresponding forward curves their durations as well as convexities based on expected market changes during the five-year investment horizon.

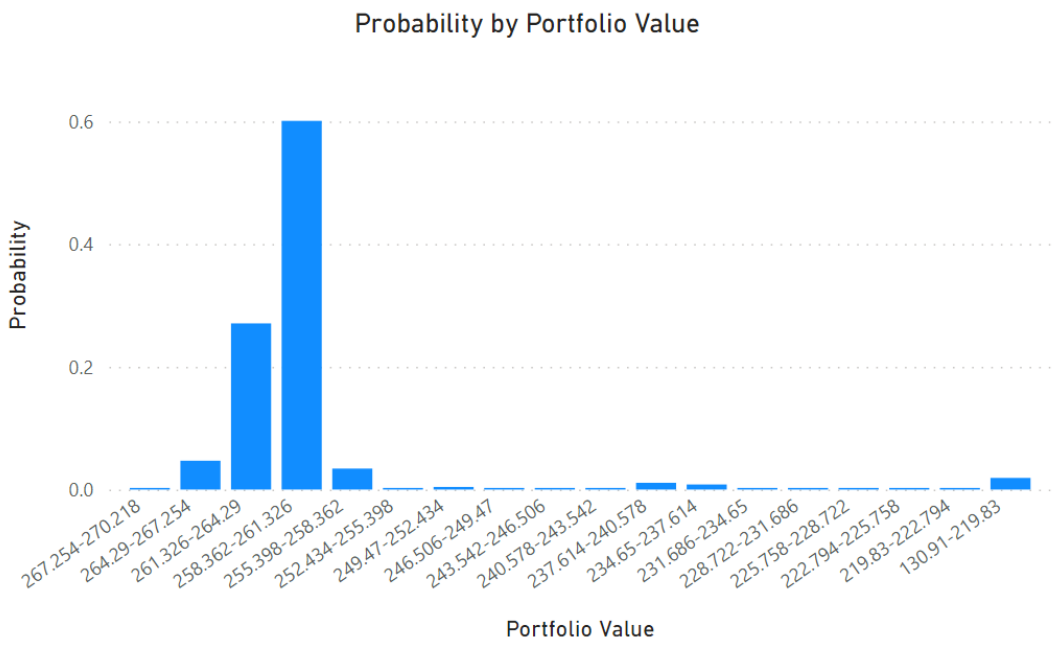


Figure 1: Distribution of portfolio value in year 5 (excluding cash flows)

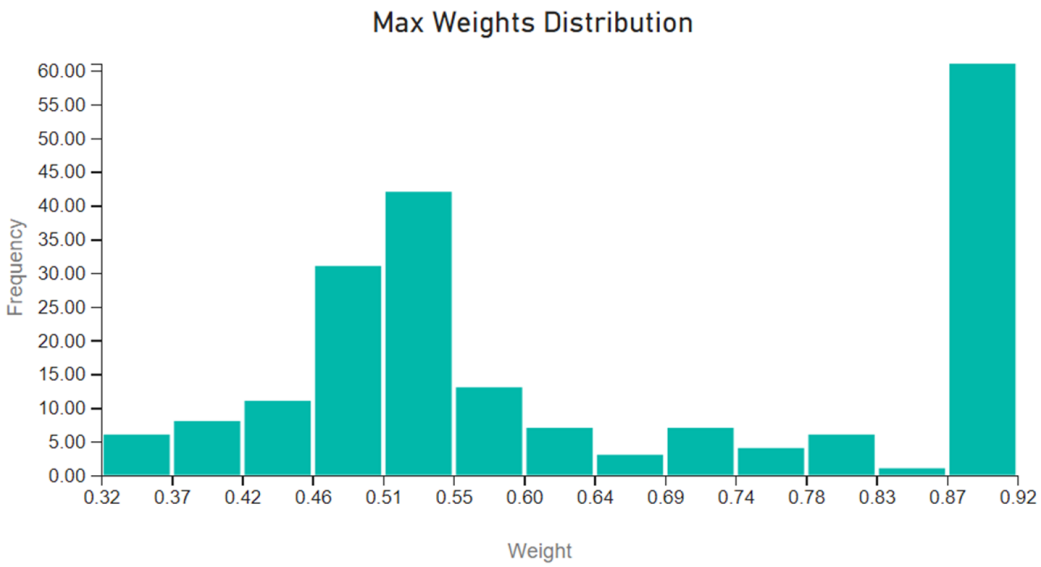


Figure 2: Distribution of maximum weight in optimized portfolios

Portfolio duration and convexity was measured as the weighted sum of bond duration and convexities. Credit risk was measured as a simulated value of credit VaR from 2500 possible ending states in year 5 in portfolio comparison, and as weighted individual credit risks in the optimizations. The simulation of VaR for portfolio selection and crude measure of VaR in portfolio optimization were done to increase the speed of the simulation. After simulating VaR for 1000 distinct possible portfolios, VaR was found exactly through enumeration of all possible states for the top five portfolios. The two risk measures were used to counter the effect of skewed weights giving the highest cash flows in the optimization, allowing discovery of portfolios with high value but lower maximum weighting (See Figure 2 for results distribution).

The main constraint of the problem was cash-flow matching. The cash flows do not only include the payments of coupons from these individual bonds but also repayment of principal because some of the bonds would be sold at the end of year 4 and the rest will be sold at the end of year 5 to match our respective cash flows. The cash flow for year 4 was modified by selling some of the bonds to meet our liabilities.

Table 1: Portfolio Formation

Bond Issuer	Coupon	Rating	Price	YTM	conX	dev	EV in Y4	EV in Y5	Weight	VaR
TARGET CORP	3.375	A	106.549	2.313	48.360814	-0.0542762	$99.75	99.8460839	0.02	77.70
WASTE MGMT INC	7.375	A-	127.468	2.484	44.395421	-0.0464952	$110.92	107.422498	0.37430465	77.70

AT&T INC SER B	6.625	BBB	120.642	2.945	44.4467611	-0.047108	$105.69	103.622315	0.18192997	77.70
TIME WARNER INC	6.625	BBB	117.461	3.45	43.9561632	-0.046574	$105.69	103.622315	0.40376535	77.70
CABOT CORP	4	BBB	103.95	3.079	47.5807135	-0.052773	$98.57	98.7823289	0.02000003	77.70

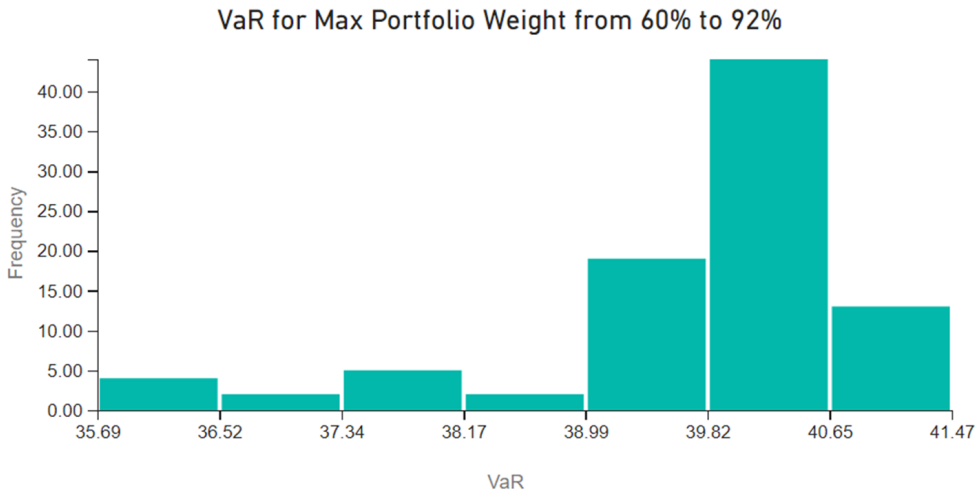
The simulation was run in a piecewise fashion. First, the duration/convexity of the portfolio and probabilities of each rating in years 4 and 5 were calculated. Then using the migration matrix probabilities and the 4 and 5-year forward curve data, prices of the bonds in years 4 and 5 were determined. Portfolios were randomly selected and then optimized based on previously mentioned measures. Portfolio VaRs and values in year 4 were recorded and used to sort the entire set of simulated portfolios. The top valued portfolios were selected to compare and then the best portfolio was chosen based on credit VaR and expected value.

2.2 Simulation Results

The results from our simulation returned these bond combinations as the best to form our portfolio. The table illustrates the names of the bonds, ratings, YTM, Convexities, Deviations, Expected Bond values in year 4 and year 5 calculated using the forward curves and transition matrix in year 4 and 5 for all possible states. The optimization returned weights with Time Warner holding about 40% of our portfolio, Waste Management Inc. holding about 37%, AT&T Inc. holding 18%, and Cabot Corp and Target Corp holding 2% each.

Further analyzing the simulation results, it can be seen that the simulation produced skewed distributions of portfolio values, weights, and values at risk. The selected portfolio had an expected value in year 5 of **$334 million** with a standard deviation of about **3.1% .** This is expected to meet the liabilities with sale of bonds in year 4, potential strategies of which are addressed below. The value at risk for the portfolio was about $31.4 million per "share" of the portfolio, equating to a total of **$77.7 million.**

Comparing these values with the distribution of results produced by the simulation, it can be seen that the portfolio fell at the top of the distribution of portfolio values, and in the middle of the distribution of credit value at risk. When adjusting for skewed portfolios, it can be seen that this portfolio had less risk than the most skewed portfolios (Figure 3) and more value than most of the less skewed portfolios (Figure 4).



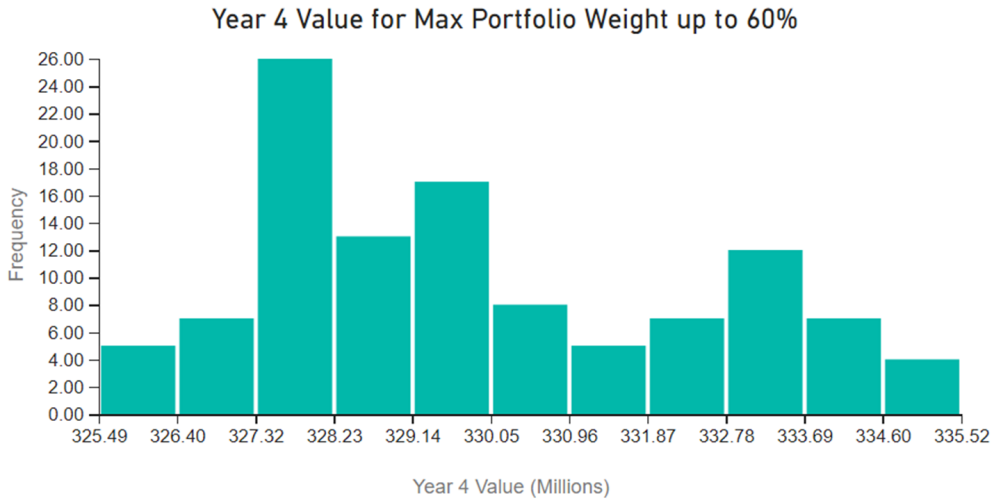


Figure 3 (Top): Distribution of simulated portfolios with maximum weighting above 60%. This defines "skewed" portfolios which put most of the weight on one or two bonds, increasing credit risk.

Figure 4 (Bottom): Distribution of portfolio values for non-skewed portfolios.

2.3 Simulation Analysis

Analyzing the simulation, it can be seen that portfolio selection focuses on optimizing credit risk and portfolio value while individual portfolio weighting optimizes optimized portfolios in the order of interest rate risk, then profitability, then credit risk. This was done through control over the standard deviations of each of the terms going into the optimization, giving the largest order of magnitude of variance to interest rate risk, the second most to profitability, and the least to credit risk. The rationale behind this was that credit and interest rate risk would be correlated with credit risk and only one

would need significant weighting. Price needed less weighting as well as optimizing for price too much could lead to skewed weights.

The objective function given below is a utility function where the first term represents change in portfolio price for a 1% YTM change, the second term represents the weighted average of individual bond credit VaRs, and the third term represents the portfolio value normalized to match the previously described standard deviation scaling. The distributions of objective function terms are given in Fig. 5.

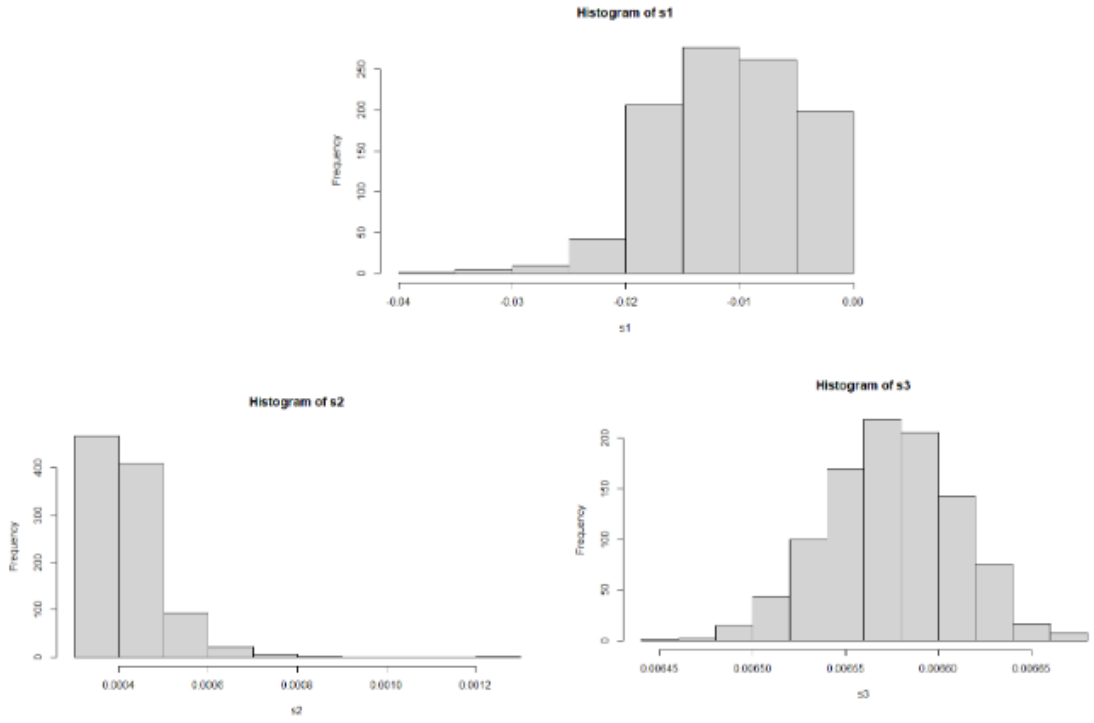
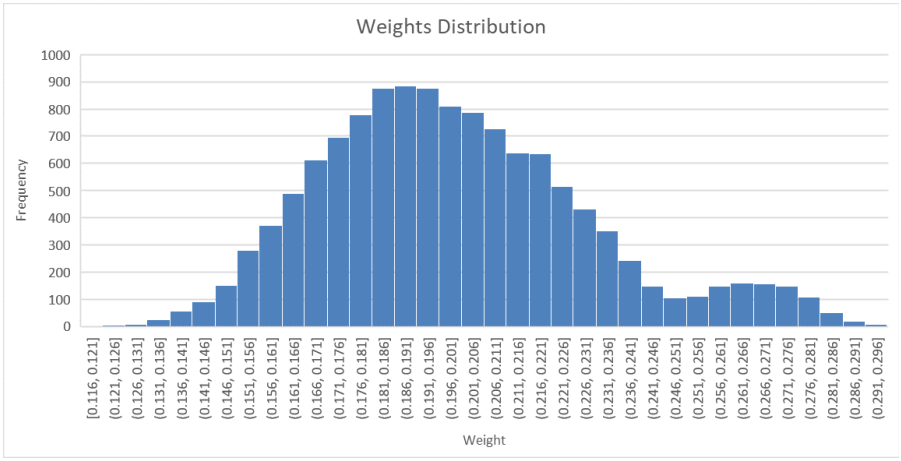


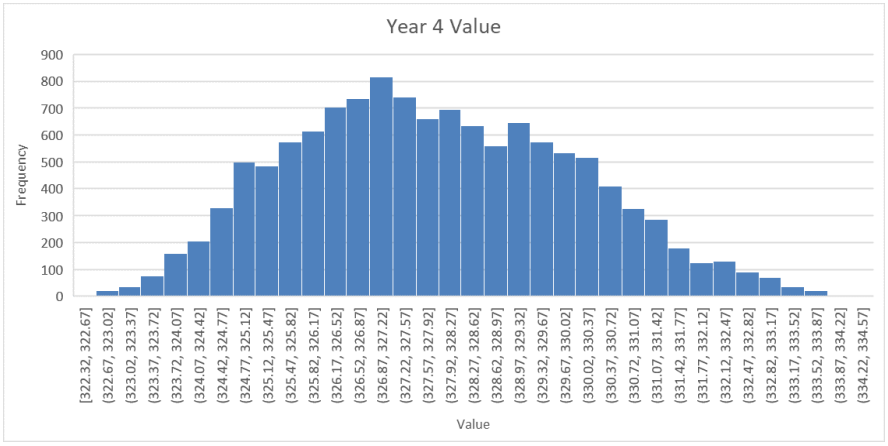
Figure 5: Histograms of the distributions of the objective function terms, s1 being the first term, s2 being the second, and s3 being the third. The variances of each were $3e^{-2}$, $7e^{-4}$, and $7e^{-3}$

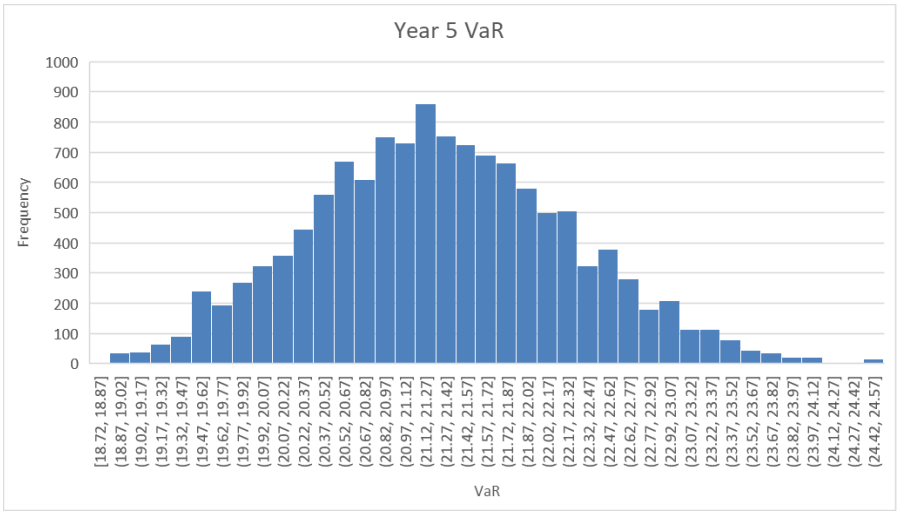
$$-10WI + \frac{1}{300}W(E-D) - \frac{1}{500}\frac{300\frac{W}{P}(C+E)}{L}$$

Upon review and analysis of model output and term distributions, it was determined that matching orders of magnitude of variances could potentially improve model performance. Abridged simulations were run (10-50 portfolios) and it was found that a similarly valued top portfolio with less credit VaR in year 5. This portfolio selection had slightly less value in year 4 when compared to the originally selected portfolio but also had significantly less cash flow value by year 4 ($53.3 million vs the original 68.6 million). Because of the lower cash flows, the selected portfolio from the second optimization

method was not expected to outperform the originally selected portfolio. Results of the second optimization can be seen in Figures 6, 7, and 8.







Figures 6 (top), 7 (middle), and 8 (bottom). Distributions of portfolio weights, values, and VaRs across all simulated portfolios for the second simulation. It can be seen that the second simulation tended to create portfolios with much lower VaR than the first simulation, but also lower expected values. Tuning of objective function terms could lead to higher overall values in the distribution.

3.0 Cash Flow Valuation and Matching Process

3.1 Sale of Single Bond

We started simulating the 10000 paths for possible cash flows by constraining them to a mean of 2.3% and a standard deviation of 2.8%. With a 1% accrued coupon rate, we further calculated the future values of the possible cash flows from the simulation to get year 4 cashflow of U.S $101.42 million with a standard deviation of 6.85% and year five cash flow of the U.S $242.52 million with a standard deviation of 20.61%.

To match these cash flows and meet liabilities in year 4 and year 5, the cash flows from the coupon payments were multiplied by the number of bonds bought for each position plus a coupon accrued rate of 1% to get the cash flows for each bond in the first four years. In year 4, the cash flows alone from the coupon payments of **$68,679,313.23** could not match the liability of **$101.42 million** owed so we made a decision to sell **AT&T INC SER B.**

AT&T INC SER B is a BBB-rated bond that had 1.46% probability of default in year 4 and 2.11% probability of default in year 5 with an expected bond price of $105.6 and $103.622315 in year 4 and 5 respectively, and a weight of 18.19% of portfolio weight. We made a decision to sell this bond because it has a higher probability of default in year 4 and 5, and holds a considerable amount of weight in our portfolio. The cash flows from the least weighted bonds (Cabot Corp and Target) are greater than AT&T INC SER B, yet when we combine the sale of these two bonds with the accrued coupon payments in year 4, we can still not match year 4 liability. In selling the bonds, we multiplied our holdings with the Expected Value (EV in year 4) and added to our accrued coupon cash flow to get **$116,492,214.01** which was greater than our liability. After paying off **$101.42 million** which was 30% of our liability, we were left with **$15,758,337.15** after accruing a 1% treasury rate to year 5.

In year 5, we had a liability of **$242.52 million** to match. We had accrued coupon payment of **$13,887,264.38** from the remaining 4 bonds in our portfolio, an accrued carry-forward of **$15,758,337.15** including accrued treasury rate from year 4, and the sale of all the four bonds at Expected Bond Price in year 5 to get a total cash flow of **$242,461,131.28.** After matching the liability, we had a Net Profit of **$1,297,431.28.**

Due to our hybrid bond selection strategy, we were able to get an optimized portfolio with net profit. Refer to table 2 for our cash flow netting.

3.2 Proportional Sale of Entire Portfolio

While the strategy outlined above does allow for a decent net profit, it hinges on the value of only a single bond being enough to cover liabilities in year 4. Allowing for default of the AT&T bond would add increased liquidity risk in year 4. As an alternative strategy, the entire portfolio could be sold off proportionally, which would keep the risk profile while also being able to cover liabilities. The decision to follow this strategy would occur if the sale of the AT&T bond could not meet liabilities and produce a profit as expected. Proportional sale of the portfolio incurs some losses to expected value by year 5, with a 12.5% proportional sale making the expected value in year 5 **$241.9 million.** This strategy does not allow for as much profit but eliminates the risk associated with relying on one position to cover liabilities. With the proportional sale strategy, cash in year 4 would be **$101.8 million** and in year 5 would be **$241.9** million, both of which are expected to marginally cover liabilities of **$100.8** and **$241** million respectively, leaving about 2 million in profit.

4.0 Risk Assessment

4.1 Market Risk

After applying our optimal portfolio, the risk assessment should be taken into our consideration. Since only bonds are in the portfolio for this case, the market risk primarily faced by the portfolio is the interest rate risk, and the duration analysis will be utilized including both the duration and modified duration of the portfolio in order to measure the sensitivity of it to the interest rate risk. The formulas used for the calculation will be shown below, where CF is the cash flow indicated in the year i generated by the portfolio due to its coupon payments, F represents the face value, and P represents the price of the bond.

$$Duration\ (D) = \sum_{i=1}^{t} \frac{\frac{CF}{(1+r)^i} i + \frac{F}{(1+YTM)^t} t}{P}; Modified\ Duration\ (MD) = \frac{D}{1+YTM}$$

	Y1-Y4			Y5, after selling the bonds AT&T INC SER B		
Bond Issuer	Duration	Modified duration	Weight	Duration	Modified duration	Weight
TARGET CORP	6.38972	6.24527	2.00%	6.38972	6.24527	2.44%
WASTE MGMT INC	6.05920	5.91234	37.43%	6.05920	5.91234	45.75%
AT&T INC SER B	6.06706	5.89350	18.19%	-	-	-
TIME WARNER INC	6.03515	5.83388	40.38%	6.03515	5.83388	49.36%
CABOT CORP	6.37320	6.18283	2.00%	6.37320	6.18283	2.44%
	Portfolio YTM	Duration	Modified duration	Portfolio YTM	Duration	Modified duration
	0.02966	6.06381	5.88912	0.02971	6.06309	5.88814

From the results listed above, it claims that the portfolio value changes by around **5.89%** in the fourth year and stays stably in the fifth year after selling the bond AT&T INC SER B for 1% change in the yield.

4.2 Credit Risk

Besides the market risk, the credit risk should also be considered for the portfolio due to the potential changes in the bond credit rating. In setting up our simulation for bond selection, we calculated the Credit VaR for all the 24 bonds using the forward curves and transition matrix for year 5. We further added this to the objective function of our nonlinear optimization with the goal of selecting bonds with the minimal Credit VaR at the 99% percentile. The Credit-VaR measured the portfolio's risk given changes in the value of bonds as a result of possible changes in their respective ratings. Furthermore, we paid special attention to the intra-portfolio asset correlation because a high correlation among the bonds will increase their corresponding Credit VaR.

After the simulation paths, the Credit VaR for our portfolio at the 99% percentile was **U.S$ 77.7 million.** This value represents the total value at risk if the entire portfolio were held for the full 5 years. In year 4, the credit value at risk is $**49.1 million.** It becomes harder to get the true value at risk given the two strategies, especially for the first strategy which involves a new portfolio of 4 bonds after the sale of one bond. For the portfolio of 4 bonds not intended to be sold, the credit value at risk is **$48.8** million. For the proportional sale strategy, the value at risk in year 5 will decrease by the proportion that was sold in year 4, or 12.5%. This would give a credit value at risk in year 5 of **$68 million**.

5. Conclusion

To match the liabilities of JH Financial Services, Inc, a portfolio of 5 bonds was selected out of 24 available for selection. In order to achieve the optimal match, a piecewise simulation was run. The simulation consisted of choosing 1000 random portfolios, optimizing each one, and then choosing the optimal portfolio based on credit value at risk, interest rate risk measured by duration and convexity, and portfolio return. From this simulation, an optimal portfolio was found with a high relative expected value in year 5 and a lower-middle range credit VaR. The selected portfolio had a fairly good match to the return and standard deviation of the liabilities, and two strategies were outlined for covering the value of the liabilities in year 4. One strategy relies on selling a single bond and would result in a profitable portfolio, and the second involves a proportional selloff that generates little profit but matches liabilities.

A second optimization method was run, matching the variances of each of the terms to give them equal weighting. Comparing the results of this optimization to the first, it was found that the balancing out of term variances succeeded in creating a much more evenly weighted portfolio, but did not succeed in creating a portfolio that was expected to meet the liabilities in year 4, and the results of this model remain unused. Moving forward, the objective function of the model could be further tuned to better represent the relative utility of each of the terms used.

Appendix

Additional review of annuity products

1. Conception

The annuities are customizable contracts issued by the insurance companies, where the lump-sum premiums paid by the investors are guaranteed to be converted into the periodic payments made by the insurers either beginning immediately or at a signed future date. Typically, the annuities will offer tax-deferred growth of earnings including a guaranteed minimum amount as the death benefit, and this amount usually is the investors' total purchase payments. Also, considering the fact that the annuity products may allow the guaranteed distribution of incomes to start at any date agreed by both sides of the contract, the present value P of the annuity which n Year maturity can be generated as below, which PMT represents the amount of each annuity payment and r represents the interest rate.

$$P = PMT \times \left(\frac{1}{r} - \frac{1}{r(1+r)^{n}}\right)$$

2. Cash now or later

To go deeper to the date in which the insurer may decide to start their periodic payments to the investors, two basic configurations of annuity products can be concluded as the immediate annuities and the deferred ones. To be specific, the immediate annuities are funded with a single lump-sum payment as there is no accumulation period, which tend to be preferred by the investors who want the immediate investment return; however, the deferred annuities allow a series of premium payments made until some time in the future, and they are attractive to the qualified pension plans.

3. Types of annuities

When considering the types of annuity products, they can be generally separated as two types of annuities: fixed and variable.

- Fixed annuities

In a fixed annuity, the minimum rate of interest should be guaranteed for a set period of time or an indefinite period, and the periodic payments will also be a guaranteed amount regarding the amount in the investors' account.

- Variable annuities

In a variable annuity, by contrast, the rate of return and the amounts of periodic payments will fluctuate depending on the performances of the investment options that the investors decide to invest in using their annuity purchase payments.

Furthermore, there is another special type of annuity product that is recognized as the one owning characteristics of both fixed and variable annuities, which is named the equity-indexed annuity.

- Indexed annuities

In an equity-indexed annuity, a varied minimum guaranteed interest rate will be offered combined with an interest rate based on an equity index; for example, S&P 500. As for this kind of product, the investors who are willing to earn a higher investment return than the amount that can be gained from the fixed annuities while still owning some concern about the downside risks will be more likely to choose.

4. Regarding securities

The variable annuities are considered securities by the SEC, while the fixed annuities are not. With owning both characteristics of variable and fixed annuities, the equity-indexed annuity may or may not be a security, but typically it is not recognized as a security by the SEC.

Further Works

Besides the model and methodology we expressed in the report, we also applied another method as selecting the bond portfolio using the Sharpe Ratio, where the risk-adjusted performance of financial instruments are concentrated here. Similarly, the simulation of the liability and asset are implemented in order to find the distribution existing which considers the potential operation risk. However, the different idea involved for this method is to apply a gap analysis (for marching the liability with assets in both year 4 and 5) to find the optimal weight for each bond in our portfolio, and the main process here is to use Excel solver to get an optimal solution for maximizing the net worth of the portfolio and minimizing the risk of the liability in the year 3 not being covered simultaneously.

Table 2. Portfolio Formation Using Sharpe Ratios

No.	Bond Issuer	Coupon	S&P Rating	Weight
5	BOEING CO	3.2	BBB-	42.97%
11	SYNCHRONY FINANCIAL	5.15	BBB-	0.62%
20	TIME WARNER INC	6.625	BBB	58.18%
21	SCHWAB CHARLES CORP	3.25	A	4.01%
24	CABOT CORP	4	BBB	45.64%

The portfolio generated above is slightly different from the one we discussed in our main contents, and the future work we plan is to compare the risks and net worth of these two different portfolios to obtain a more proper suggestion for the Asset-Liability Management group (Excel is attached for the further view of our additional works).

Table 1: Bond Portfolio formation from the simulation

No.	Bond Issuer	Coupon	S&P Rating	Price	YTM	durs	cons	dev	D	EV	wts	VaR	y4	pf
14	TARGET CORP	3.375	3	106.549	2.313	5.6694 2639	48.360 81403	-0.0542 762232	53.8	99.846 08385	0.0200 000011 5	31.432 42871	334.50 31421	1
18	WASTE MGMT INC	7.375	3	127.468	2.484	4.8714 98468	44.395 42159	-0.0464 952136	53.8	107.42 24984	0.3743 046484	31.432 42871	334.50 31421	1
19	AT&T INC SER B	6.625	4	120.642	2.945	4.9330 31472	44.446 76106	-0.0471 079766 7	53.8	103.62 2315	0.1819 29965	31.432 42871	334.50 31421	1
20	TIME WARNER INC	6.625	4	117.461	3.45	4.8771 76992	43.956 16316	-0.0465 739617 6	53.8	103.62 2315	0.4037 653549	31.432 42871	334.50 31421	1
24	CABOT CORP	4	4	103.95	3.079	5.5152 70995	47.580 71354	-0.0527 736742 7	53.8	98.782 32886	0.0200 000279 7	31.432 42871	334.50 31421	1
18	WASTE MGMT INC	7.375	3	127.468	2.484	4.8714 98468	44.395 42159	-0.0464 952136	53.8	107.42 24984	0.3747 939861	31.656 84091	334.40 69534	2
19	AT&T INC SER B	6.625	4	120.642	2.945	4.9330 31472	44.446 76106	-0.0471 079766 7	53.8	103.62 2315	0.1820 752676	31.656 84091	334.40 69534	2
20	TIME WARNER INC	6.625	4	117.461	3.45	4.8771 76992	43.956 16316	-0.0465 739617 6	53.8	103.62 2315	0.4031 306976	31.656 84091	334.40 69534	2

22	GLAXOSMITHKLINE CAP PLC	3.375	3	105.257	2.521	5.6477 70328	48.179 93183	-0.0540 6870669	53.8	99.846 08385	0.0200 000049 8	31.656 84091	334.40 69534	2
23	HOME DEPOT INC	2.95	3	102.675	2.506	5.7708 52104	48.855 83694	-0.0552 6572919	53.8	99.041 0898	0.0200 000000 8	31.656 84091	334.40 69534	2
4	BOSTON SCIENTIFIC CORP	4	4	106.894	2.878	5.4463 89693	46.982 42342	-0.0521 1477576	53.8	98.782 32886	0.1076 885055	37.367 10794	334.66 91778	3
5	BOEING CO	3.2	4	99.285	3.229	5.6605 04906	48.150 44436	-0.0541 9752684	53.8	97.307 28546	0.0200 000043	37.367 10794	334.66 91778	3
9	PFIZER INC	3.45	3	106.184	2.453	5.6322 39277	48.110 21507	-0.0539 1688201	53.8	99.988 14162	0.0200 000003 2	37.367 10794	334.66 91778	3
11	SYNCHRONY FINANCIAL	5.15	4	109.389	3.551	5.1179 68342	45.037 10089	-0.0489 2782837	53.8	100.90 27037	0.8323 11304	37.367 10794	334.66 91778	3
17	INTERNATIONAL BUSINESS MACHS	3.5	3	105.121	2.674	5.5962 27668	47.849 12044	-0.0535 6982066	53.8	100.08 28468	0.0200 001805 8	37.367 10794	334.66 91778	3
4	BOSTON SCIENTIFIC CORP	4	4	106.894	2.878	5.4463 89693	46.982 42342	-0.0521 1477576	53.8	98.782 32886	0.0217 589730 7	37.659 65729	335.62 12734	4
11	SYNCHRONY FINANCIAL	5.15	4	109.389	3.551	5.1179 68342	45.037 10089	-0.0489 2782837	53.8	100.90 27037	0.9182 116074	37.659 65729	335.62 12734	4

14	TARGET CORP	3.375	3	106.549	2.313	5.6694 2639	48.360 81403	-0.0542 762232	53.8	99.846 08385	0.0200 291237 5	37.659 65729	335.62 12734	4
22	GLAXOSMITHKLINE CAP PLC	3.375	3	105.257	2.521	5.6477 70328	48.179 93183	-0.0540 687066 9	53.8	99.846 08385	0.0200 002957 3	37.659 65729	335.62 12734	4
23	HOME DEPOT INC	2.95	3	102.675	2.506	5.7708 52104	48.855 83694	-0.0552 657291 9	53.8	99.041 0898	0.0200 000000 1	37.659 65729	335.62 12734	4
2	3M CO	3.375	3	104.739	2.568	5.6552 11628	48.244 28023	-0.0541 399022 7	53.8	99.846 08385	0.0200 000008 2	37.968 22247	335.82 46598	5
8	DUKE ENERGY PROGRESSINC	3.45	3	104.25	2.757	5.6042 02857	47.876 38685	-0.0536 482092 3	53.8	99.988 14162	0.0200 000546 1	37.968 22247	335.82 46598	5
11	SYNCHRONY FINANCIAL	5.15	4	109.389	3.551	5.1179 68342	45.037 10089	-0.0489 278283 7	53.8	100.90 27037	0.9176 112628	37.968 22247	335.82 46598	5
12	INGERSOL RAND LUXEMBOURG	3.8	4	105.62	2.875	5.5018 27718	47.295 14709	-0.0526 535198 2	53.8	98.413 56801	0.0223 886816 1	37.968 22247	335.82 46598	5
22	GLAXOSMITHKLINE CAP PLC	3.375	3	105.257	2.521	5.6477 70328	48.179 93183	-0.0540 687066 9	53.8	99.846 08385	0.0200 000000 5	37.968 22247	335.82 46598	5

Table 2: Cash flows from the Bonds

					Liability	**$300,000,000.00**	
						Accrual	1%
				Cash flows from Simulations			
						Year 4	**$101,428,000**
						Year 5	**$242,524,700.00**
Bond Issuer	**EV in Y4**	**EV in Yr5**	**2023**	**2024**	**2025**	**2026**	**2027**
TARGET CORP	$99.75	99.8460839	191953.9367	193873.4761	195812.2108	197770.3329	191953.9367
WASTE MGMT INC	$110.92	107.422498	6561886.344	6627505.208	6693780.26	6760718.062	6561886.344
AT&T INC SER B	$105.69	103.622315	3027152.016	3057423.536	3087997.772	3118877.749	
TIME WARNER INC	$105.69	103.622315	6900234.712	6969237.059	7038929.429	7109318.724	6900234.712
CABOT CORP	$98.57	98.7823289	233189.383	235521.2768	237876.4896	240255.2545	233189.383
				Year 4 CF			Year 5 CF
			Coupon PMT	$68,679,313.23		Coupon PMT	$13,887,264.38
		Selling in Yr 4	AT&T INC SER B	$47,812,900.78		Selling All Other Bonds	$212,815,529.76
						Interest from Y4	$15,758,337.15
			Total CF Y4	$116,492,214.01		Total CF Y5	$242,461,131.28
					Net Profit		**$1,297,431.28**