Operations Research Assignment 3

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1 Problem Statement - Savvy Stock Selection

Ever since the day she took her first economics class in high school, Lydia wondered about the financial practices of her parents. They worked very hard to earn enough money to live a comfortable middle-class life, but they never made their money work for them. They simply deposited their hard-earned paychecks in savings accounts earning a nominal amount of interest. (Fortunately, there always was enough money when it came time to pay her college bills.) She promised herself that when she became an adult, she would not follow the same financially conservative practices as her parents.

And Lydia kept this promise. Every morning while get- ting ready for work, she watches the CNN financial reports. She plays investment games on the World Wide Web, finding portfolios that maximize her return while minimizing her risk. She reads The Wall Street Journal and Financial Times with a thirst she cannot quench.

Lydia also reads the investment advice columns of the financial magazines, and she has noticed that on average, the advice of the investment advisers turns out to be very good. Therefore, she decides to follow the advice given in the latest issue of one of the magazines. In his monthly column the editor Jonathan Taylor recommends three stocks that he believes will rise far above market average. In addition, the well-known mutual fund guru Donna Carter advocates the purchase of three more stocks that she thinks will outperform the market over the next year.

BIGBELL (ticker symbol on the stock exchange: BB), one of the nation's largest telecommunications companies, trades at a price-earnings ratio well below market average. Huge investments over the last 8 months have depressed earnings considerably. However, with their new cutting edge technology, the company is expected to significantly raise their profit margins. Taylor predicts that the stock will rise from its current price of $60 per share to $72 per share within the next year.

LOTSOFPLACE (LOP) is one of the leading hard drive manufacturers in the world. The industry recently underwent major consolidation, as fierce price wars over the last few years were followed by many competitors going bankrupt or being bought by LOTSOFPLACE and its competitors. Due to reduced competition in the hard drive market, revenues and earnings are expected to rise considerably over the next year. Taylor predicts a one-year increase of 42 percent in the stock of LOTSOFPLACE from the current price of dollar 127 per share.

INTERNETLIFE (ILI) has survived the many ups and downs of Internet companies. With the next Internet frenzy just around the corner, Taylor expects a doubling of this company's stock price from dollar 4 to dollar

8 within a year.

HEALTHTOMORROW (HEAL) is a leading biotechnology company that is about to get approval for several new drugs from the Food and Drug Administration, which will help earnings to grow 20 percent over the next few years. In particular a new drug to significantly reduce the risk of heart attacks is supposed to reap huge profits. Also, due to several new great-tasting medications for children, the company has been able to build an excellent image in the media. This pub- lic relations coup will surely have positive effects for the sale of its over-the-counter medications. Carter is convinced that the stock will rise from dollar 50 to dollar 75 per.share within a year.

QUICKY (QUI) is a fast-food chain which has been vastly expanding its network of restaurants all over the United States. Carter has followed this company closely since it went public some 15 years ago when it had only a few dozen restaurants on the west coast of the United States. Since then the company has expanded, and it now has restaurants in every state. Due to its emphasis on healthy foods, it is capturing a growing market share. Carter believes that the stock will continue to perform well above market average for an increase of 46 percent in one year from its current stock price of dollar 150.

AUTOMOBILE ALLIANCE (AUA) is a leading car manufacturer from the Detroit area that just recently introduced two new models. These models show very strong initial sales, and therefore the company's stock is predicted to rise from dollar 20 to dollar 26 over the next year. On the World Wide Web Lydia found data about the risk involved in the stocks of these companies. The historical variances of return of the six stocks and their covariances are shown below.

Company	BB	LOP	ILI	HEAL	QUI	AUA
Variance	0.032	0.1	0.333	0.125	0.065	0.08

Covariances	LOP	ILI	HEAL	QUI	AUA
BB	0.005	0.03	−0.031	−0.027	0.01
LOP		0.085	−0.07	−0.05	0.02
ILI			−0.11	−0.02	0.042
HEAL				0.05	−0.06
QUI					−0.02

1.At first, Lydia wants to ignore the risk of all the investments. Given this strategy, what is her optimal investment portfolio; that is, what fraction of her money should she invest in each of the six different stocks? What is the total risk of her portfolio?

2.Now Lydia wants to take into account the risk of her investment opportunities. For use in the following parts, formulate a non-linear programming model that will minimize her risk (measured by the variance of the return from her portfolio), while ensuring that her expected return is at least as large as her choice of a minimum acceptable value.

2 Definition of Variables

2.1 Inputs

stocks <- The 6 different stocks chosen by Lydia
Mean <- Mean annual returns of the stock
Variance <- Variance - Co variance matrix of the annual return
objective <- Expected Returns from the portfolio
GAMS Input code:

Set i 'Stocks' / BB, LOP, ILI, HEAL, QUI, AUA /;

Alias (i,j);

Scalar objective 'objective annual return on portfolio '() / 75 /;

Parameter mean(i) 'Annual returns of the stock '()
/ BB 20, LOP 42, ILI 100, HEAL 50, QUI 46, AUA 30 /;

Table v(i,j) 'variance-covariance matrix
BB LOP ILI HEAL QUI AUA
BB 0.032 0.005 0.030 -0.031 -0.027 0.010
LOP 0.005 0.1 0.085 -0.07 -0.05 0.020
ILI 0.030 0.085 0.333 -0.11 -0.02 0.042
HEAL -0.031 -0.07 -0.11 0.125 0.05 -0.060
QUI -0.027 -0.05 -0.02 0.05 0.065 -0.020
AUA 0.010 0.020 0.042 -0.060 -0.020 0.08
;

2.2 Outputs

X ->proportion of portfolio invested in each asset
outputVariance ->Variance of the portfolio

GAMS Output code:

Variable
x(i) 'portfolio proportion invested in asset i'
variance 'variance of portfolio';

Positive Variable x;

3   Constraints

We are trying to minimize the Volatility of the Portfolio while getting an desired expected returns =75 percent.

1. Sum of the weights of the stocks in portfolio should sum to 1.
2. The Weighted returns of the stocks in portfolio should be the target expected returns = 20,40,60,70,80,90
3. Variance of the portfolio can be calculated using the the formula as implimented below.

GAMS Implimentation

Equation
sumProp 'proportion of the stocks must add up to 1.0'
portMean 'expression for mean of the portfolio'
portVar 'expression for variance of the portfolio';

sumProp.. sum(i, x(i)) =e= 1.0;
portMean.. sum(i, mean(i)*x(i)) =e= objective;
portVar.. sum(i, x(i)*sum(j,v(i,j)*x(j))) =e= outputVariance;

4   Solver

Solve the problem using the Built in Non Linear Programming Solver in GAMS.

solve portfolio using nlp minimizing variance;

5   Results

5.1   Question 1: Portfolio not considering Risks

As the first question deals with lydia investing without considering the risk. She should invest in the stock which gives the maximum returns.
she should invest InternetLife(ILI) which gives 100 percent and a volatility of 33.33 percent.

Stock Name	Weights	Expected Returns	Expected Variance
BB	0	20	3.2
LOP	0	42	10
ILI	1	100	33.3
HEAL	0	50	12.5
QUI	0	46	6.5
AUA	0	30	8

5.2 Question 2: Portfolio

Now lydia has to choose the portfolio considering the risk involved in the different stocks.
Normally under such circumstance we can either simulate the portfolio with different weights and check for the expected return and variance. Or we can solve using quadratic Linear Programming as we did in this case to find the right combination.

Below we compare some of the portfolio based on the parameter called sharpe ratio.

Should we choose a portfolio with least volatility or risk ?
Should we choose a portfolio with maximum retursn or risk ?
We use sharpe ratio to decide that//

Sharpe ratio = (Mean portfolio return Risk-free rate)/Standard deviation of portfolio return//

The Sharpe ratio is often used to compare the change in a portfolio's overall risk-return characteristics when a new asset or asset class is added to it.

Also assuming the sharpe ratio to be 6.5 percent. The Goverment bonds are hovering around 6 to 7 percent. I am taking the risk free rate as return on the one year fixed deposit of SBI bank.

Porfolio A - Expected Return 20 percent

Variance = 3.2 percent
Sharpe Ratio = 4.21875

Stock Name	Weights	Expected Returns	Expected Variance
BB	1	20	3.2
LOP	0	42	10
ILI	0	100	33.3
HEAL	0	50	12.5
QUI	0	46	6.5
AUA	0	30	8

Porfolio B - Expected Return 40 percent

Variance = 0.2 percent
Sharpe Ratio = 167.5

Stock Name	Weights	Expected Returns	Expected Variance
BB	0.229	20	3.2
LOP	0.210	42	10
ILI	0.034	100	33.3
HEAL	0.220	50	12.5
QUI	0.188	46	6.5
AUA	0.119	30	8

Porfolio C - Expected Return 60 percent

Variance = 2.1 percent
Sharpe Ratio = 25.4762

Stock Name	Weights	Expected Returns	Expected Variance
BB	0	20	3.2
LOP	0.133	42	10
ILI	0.271	100	33.3
HEAL	0.472	50	12.5
QUI	0.001	46	6.5
AUA	0.123	30	8

Porfolio D - Expected Return 80 Percent

Variance = 8.7 percent
Sharpe Ratio = 8.448

Stock Name	Weights	Expected Returns	Expected Variance
BB	0	20	3.2
LOP	0	42	10
ILI	0.6	100	33.3
HEAL	0.4	50	12.5
QUI	0	46	6.5
AUA	0	30	8

Porfolio E - Expected Return 90 Percent

Variance = 18.3 percent
Sharpe Ratio = 4.56284

Stock Name	Weights	Expected Returns	Expected Variance
BB	0	20	3.2
LOP	0	42	10
ILI	0.8	100	33.3
HEAL	0.2	50	12.5
QUI	0	46	6.5
AUA	0	30	8

100 Percent Return portfolio is same as the Portfolio which doesn't consider risk.

6   Comparison of Results

Portfolio	Expected Returns	Variance	Sharpe Ratio
A	20	3.2	4.2185
B	40	.2	167.5
C	60	2.1	25.4762
D	80	8.7	8.448
E	90	18.3	4.56284
Simple	100	33.33	2.8053

Based on her Risk taking ability, she could invest on the any of the portfolio, that will give better expected return for the given risk.

7   Appendix

1. Code and Solver results for Question 2