Optimizing Routes & Minimizing Costs Analysis

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This project has two parts, one is the transshipment model, and the other is the quadratic programming model.

PART I:

INTRODUCTION:

Allen, the South-Atlantic division manager of Rockhill Shipping & Transport Company, is negotiating a new shipping agreement with Chimotoxic, a manufacturer of chemicals for industrial use. Chimotoxic requests that Rockhill Shipping transfer its hazardous chemical waste from 6 separate chemical factories and dispose of it in 3 different places. Chimotoxic wants Rockhill to collect and transport waste from its six plants to three disposal sites. There are two methods for transporting waste products to waste disposal sites: direct shipping and shipping through intermediate points. We must conduct an analysis and inform the manager of the most cost-effective shipping method.

ANALYSIS:

Plant:	*Waste per Week (bbl)*
Denver	45
Morganton	26
Morrisville	42
Pineville	53
Rockhill	29
Statesville	38

Given, the total waste generated by Denver is 45 barrels, Similarly, Morganton, Morrisville, Pineville, Rockhill, and Statesville generates 26, 42, 53, 29 and 38 respectively. The cost of shipping for one barrel of waste to three different disposals sites from the plants is as shown below. For example, to ship the disposal waste from Denver plant to Orangeburg is 12 dollars, similarly all the other values are shown for other plants are shown below.

	Waste Proposal Site		
Plant:	***Orangeburg***	***Florence***	***Macon***
Denver	$12	$15	$17
Morganton	14	9	10
Morrisville	13	20	11
Pineville	17	16	19
Rockhill	7	14	12
Statesville	22	16	18

To find: Minimum cost of shipping when shipping directly from the waste generated plants to disposal sites.

We determine the lowest cost necessary for immediately delivering the garbage barrels. We must first estimate the amount of garbage at each disposal site in order to determine the cost. Excel Solver is used to estimate this amount. The goal is to keep costs as low as possible. The volumes of garbage transported from the waste facilities to the disposal sites serve as the decision factors. The limitations are:

No more waste should be sent to the disposal sites than what they can handle.

The above table shows the total amount of rubbish that the waste facilities are required to send each week.

So, utilizing solver, we get the following outcomes:

According to the below data, it will cost a minimum of $2,988 to transport garbage straight from waste producing plants to waste disposal facilities.

DECISION VARIABLES			
	Waste Proposal Site		
Plant:	***Orangeburg***	***Florence***	***Macon***
Denver	40.94	0.00	4.06
Morganton	0.00	0.00	26.00
Morrisville	0.00	0.00	42.00
Pineville	0.00	53.00	0.00
Rockhill	24.06	0.00	4.94
Statesville	0.00	27.00	11.00

CONSTRAINTS	LHS	SYMBOL	RHS
Orangeburg	65.00	<=	65
Florence	80.00	<=	80
Macon	88.00	<=	105
Denver	45.00	=	45
Morganton	26.00	=	26
Morrisville	42.00	=	42
Pineville	53.00	=	53
Rockhill	29.00	=	29
Statesville	38.00	=	38

OBJECTIVE	
MINIMUM COST	**2988**

To find: Minimize the cost of shipping when using waste generation plants and disposal sites as intermediate shipping points.

	Plant					
Plant:	Denver	Morganton	Morrisville	Pineville	Rockhill	Statesville
Denver	$---	$3	$4	$9	$5	$4
Morganton	6	---	7	6	9	4
Morrisville	5	7	---	3	4	9
Pineville	5	4	3	---	3	11
Rockhill	5	9	5	3	---	14
Statesville	4	7	11	12	8	---

We must estimate the amount transported from each place in order to determine the minimal cost necessary to transfer the garbage utilizing the waste producing facilities and disposal locations as intermediary shipping points. Excel Solver is used to generate this estimate. Like the prior direct shipment approach, constraints are calculated using the same algorithms.

The number of garbage barrels sent from each intermediate location constitutes the decision variables.

	Plant & Waste Disposal Sites								
Plants & Waste Disposal Sites	Denver	Morganton	Morrisville	Pineville	Rockhill	Statesville	Orangeburg	Florence	Macon
Denver	0	$3	$4	$9	$5	$4	12	15	17
Morganton	6	0	7	6	9	4	14	9	10
Morrisville	5	7	0	3	4	9	13	20	11
Pineville	5	4	3	0	3	11	17	16	19
Rockhill	5	9	5	3	0	14	7	14	12
Statesville	4	7	11	12	8	0	22	16	18
Orangeburg	12	14	13	17	7	22	0	12	10
Florence	15	9	20	16	14	16	12	0	15
Macon	17	10	11	19	12	18	10	15	0

CONSTRAINTS	LHS	SYMBOL	RHS
Orangeburg	65.00	<=	65
Florence	80.00	<=	80
Macon	88.00	<=	105
Denver	45.00	=	45
Morganton	26.00	=	26
Morrisville	42.00	=	42
Pineville	53.00	=	53
Rockhill	29.00	=	29
Statesville	38.00	=	38

OBJECTIVE	
MINIMUM COST	**2674**

According to the data, the least amount needed to ship the garbage utilizing waste producing plants and waste disposal facilities as intermediate shipping locations is $2,674. Allen, the manager, would thus benefit from using the intermediate shipment technique rather than the direct shipping approach to obtain a reduced shipping cost.

PART II:

INTRODUCTION:

Several asset classes have been chosen by an investor for his portfolio. Using historical data, it has been predicted what return may be expected for each asset class. Analysis is required to identify how to deploy a $10,000 investment to yield a minimum 11% return with the least amount of risk. Examine the predicted returns and associated risk to see if there is any trend. The following is an estimate of the returns from each asset in the portfolio.

ANALYSIS:

Given,

	Expected Returns
Bonds	7%
High tech stocks	12%
Foreign stocks	11%
Call options	14%
Put options	14%
Gold	9%

The percentages in the table above are converted to numbers for calculational reasons. The assets covariance matrix is provided below.

	Bonds	High tech stocks	Foreign stocks	Call options	Put options	Gold
Bonds	0.001	0.0003	-0.0003	0.00035	-0.00035	0.0004
High tech stocks	0.0003	0.009	0.0004	0.0016	-0.0016	0.0006
Foreign stocks	-0.0003	0.0004	0.008	0.0015	-0.0055	-0.0007
Call options	0.00035	0.0016	0.0015	0.012	-0.0005	0.0008
Put options	-0.00035	-0.0016	-0.0055	-0.0005	0.012	-0.0008
Gold	0.0004	0.0006	-0.0007	0.0008	-0.0008	0.005

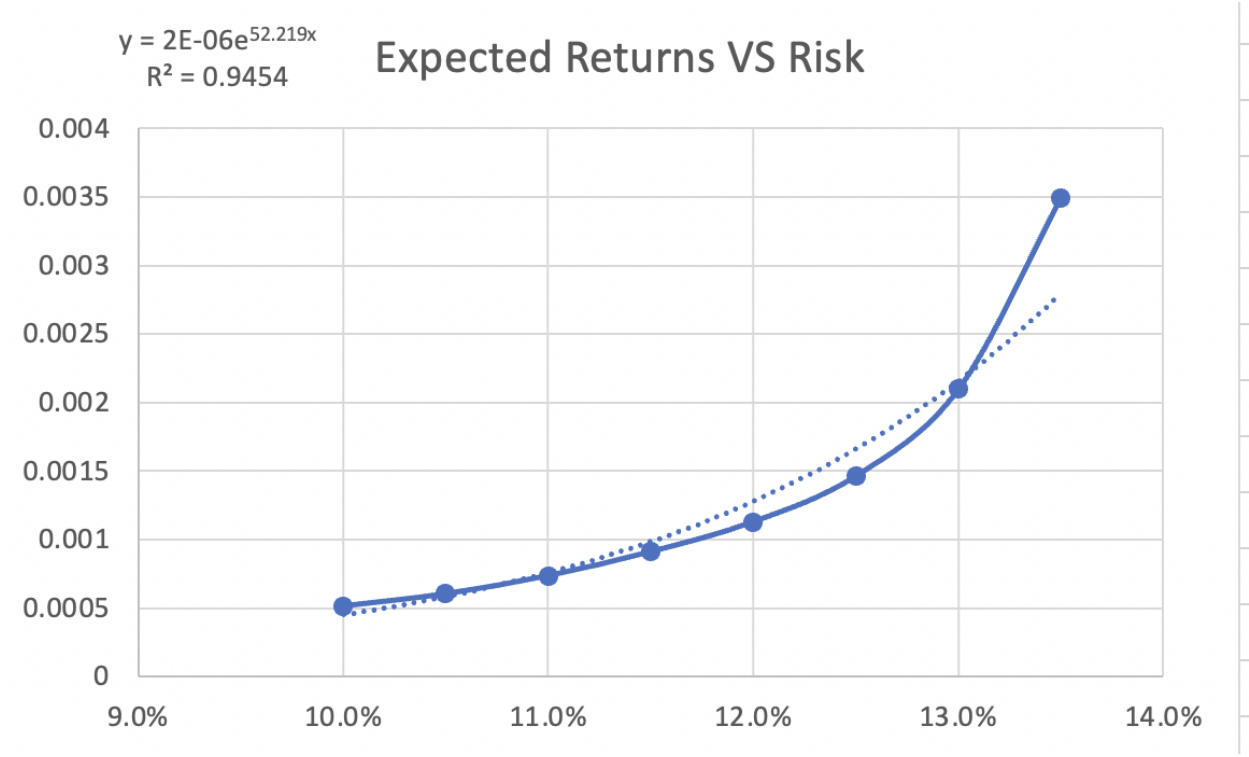
	Weights	Investment Allocation
Bonds	0.1898	1898.08177
High tech stocks	0.1086	1086.302012
Foreign stocks	0.2708	2708.275703
Call options	0.0479	479.4247276
Put options	0.2545	2544.698503
Gold	0.1283	1283.227284
TOTAL	1.0000	10000

With a minimum return of 11% and an investment of $10,000, we can calculate the weighting of investments distributed across each asset using Excel's solver while reducing risk. The weightage/percentage of each asset is shown above based on the solver result.

The minimal risk estimate is 0.000735634.

The following are the minimal risk values when the investment minimum return values are changed to 10%, 10.5%, 11%, 11.5%, 12%, 12.5%, 13%, and 13.5%.

Expected Returns	Risk
10.0%	0.000513906
10.5%	0.000603272
11.0%	0.000735634
11.5%	0.000910993
12.0%	0.001129351
12.5%	0.001463498
13.0%	0.00209792
13.5%	0.003496248



We can observe from the graph above that the minimal risk value likewise rises exponentially as projected returns rise. We may then conclude that Anticipated returns and risk are directly inversely proportionate to one another. By adding the exponential trendline to the previous chart, we can observe that y = 2E-06e52.219x and R2 = 0.9454. The model has the best fit since it has the highest predictive value, and because R2 is so near to 1, it indicates a positive association.

CONCLUSION:

Based on the analysis above, we can conclude that **Rockhill Shipping & Transport** Company should choose intermediate shipping rather than direct shipment since the minimum cost of intermediate shipping is $2,674, which is less than the cost of direct shipping, which is $2,988. It is recommended to invest the given sums to get a minimum return of 11% at the lowest risk value. For **allocations of investments**, it is recommended that the said amounts be invested to achieve a minimum return of 11% at the lowest risk value.

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