ISSN No:-2456 – 2165

SVKM'S NMIMS Deemed to be UNIVERSITY | ANIL SURENDRA MODI SCHOOL OF COMMERCE

Research Paper

On

# Application of Operations Research in Banking & Finance

Submitted To:

Professor Tahereem Bardi

For the Project of Operations Research (B.B.A- B), Semester III

Submitted By:



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Date: 4th October, 2017

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## ACKNOWLEDGEMENT

We wish to express our sincere gratitude to Mrs. Tahereem Bardi for providing us the opportunity to work on this research project. It was a great learning experience on writing about the "Application of Operations Research techniques in Banking & Finance".

At the time of preparing this paper, we shuffled through a lot of books and websites, which helped us getting acquainted with a lot of new topics and concepts. We don't claim that all the information in the paper are included perfectly and therefore there might be shortcomings, factual errors and mistaken opinion, which might be partly acceptable for any original work.

Many people, including our team members, have made valuable remarks on this research paper, which gave us motivation to continuously improve our work.

We'd like to extend our gratitude to all the people who helped us directly or indirectly, in the best of their abilities.

Thank You.

## PLAGIARISM CERTIFICATE

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# ABSTRACT

This paper reviews the application of OR techniques in the field of banking and finance. The areas covered are maximization of returns in a financial portfolio and the understanding of passive portfolio management with the help of data analysis and case study briefings. The aim of this paper is to highlight the importance of Operations Research in the fields discussed and how mathematical agendas can help in getting a solution to any dynamic problem.

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# 1. IMPORTANCE OF OPERATIONS RESEARCH

Operation Research serves as a discursive branch which caters to two decision problems. The first is “how to use resources, to complete the task as much as possible” and the other one is “how to use the least amount of resources to complete a task”.

OR as a subject/theory plays an important role with recent exorbitant improvements in the availability of real time data, with the increasing technological advancements, it will only increase.

In finance problems, accordance between the variables are generally well defined and they are not restricted by the human behaviour & preferences. The financial applications are largely numeric explicit boundaries and objectives.

## 2. CASE STUDY ANALYSIS

### CASE 1: TO MAXIMISE THE RETURNS UNDER A FINANCIAL PORTFOLIO, WITH A GIVEN BUDGET TO FINANCE VARIOUS INVESTMENTS.

*A. Problem Definition:*

In this situation we are trying to assess the possibility of obtaining an optimal portfolio where the optimality depends upon the model used for designating risk and other aspects of the financial instruments.

Now consider a team of Financial Planners with Rs.10,00,00,000 to finance various investments. We'll consider 5 categories of loans/investments, and each of them comes with a different risk and return (1-10, 1 being the best):

| Loans/Investments | Return (%) | Risk |
|---|---|---|
| Mortgage | 11 | 4 |
| Personal Loans | 15 | 7 |
| Government Securities | 7 | 1 |
| Illiquid Assets | 8 | 3 |
| Equity | 18 | 9 |

The aim for the planning team is to allocate the funds in the categories, under following conditions:

- To maximise the average return per rupee invested
- To have an average risk of less than 6, over all the invested money
- To have at least 30% investments in the illiquid assets, i.e. Gold and Land.

- Rupee investments in equity and personal loans combined should not exceed the amount invested in government backed bonds.

Note: The surplus funds are invested in the savings account at the rate of 3.5% with no risk associated, post the portfolio formation.

*B. Model*

Let us number the investments from 1 to 5 and let $x_i$ be the rupees invested in investment 'i'. Let $x_s$ represent the surplus funds be put into the savings account.

*C. Objective*

To maximise

$11x_1 + 15x_2 + 7x_3 + 8x_4 + 18x_5 + 3.5x_s$

*C. Subjectto*

$x_1 + x_2 + x_3 + x_4 + x_5 + x_s = 10,00,00,000$

Now, to have an average risk of not more than 6,

$$\frac{4x_1 + 7x_2 + 1x_3 + 3x_4 + 9x_5}{x_1 + x_2 + x_3 + x_4 + x_5} < 6$$

As we can observe in this situation, that the given constraint is not linear, and thus we cross multiply to simplify this and obtain an equivalent linear constraint:

$-2x_1 + x_2 - 5x_3 - 3x_4 + 3x_5 < 0$

Now, we need 30% investments in the illiquid assets, so the constraint for this equation would be as follows:

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$x_4 > 0.3(x_1 + x_2 + x_3 + x_4 + x_5)$,

By simplifying this, we get:

$-0.3x_1 - 0.3 x_2 - 0.3 x_3 + 0.7 x_4 - 0.3x_5$

Furthermore, equity and personal loans combined should not be higher than the amount invested in government securities. The equation for this would be:

$x_2 + x_5 - x_3 < 0$

## CASE 2: TO UNDERSTAND PASSIVE PORTFOLIO MANAGEMENT WITH THE HELP OF INDEX TRACKING

*A. Method:*

Under the Index Tracking approach, Fund managers attempt to match the performance of a notional portfolio when they're sceptical about the overall market performance. This matching of the performance of an index can be done in two ways i.e. partial and full replication.

Under the full replication, the investment is made in every portion of the given index which is proportional to its market share. For example, issuing a whole new set of shares.

Under the partial replication, an investment is made in a small amplitude of the shares, while trying to match the performance of the entire index. This method is easier to rebalance and incurs low transaction costs. But then, it has a higher chance of having a Tracking Error, i.e. the measure of deviation of the chosen portfolio from the index, and in the field of wealth management, one of the key tasks of fund managers is to minimize the Tracking error, to the very possible extent.

Now, in this situation, it can be expressed as a Quadratic programming formula wherein the tracking error is the expected squared deviation of return from that of the index. We will calculate the quota of capital to be invested in each company as a part of the same quandary, for which we'll require a covariance matrix, defining the linearity of relationship between companies' index and the capitalization weights.

The solution shows a large & positive value when returns from the two companies ensue a very similar trail. On the contrary, a small &negative value occurs when returns are subsequent to roughly opposing trajectories. The capitalisation weights being referred to here are the normalized returns for the index, i.e. they're adjusted to remove the effects of seasonality, revenue and expenses, which happen to be the unusual influences. These normalized returns are computed by dividing the return for each company by sum of returns of all the companies.

Now the function, which needs to be minimized in our discussed Index Tracking problem, is given below. The symbols would be:

X: the trajectory subsuming the amount of capital to be invested in each unit of the index
H: the trajectory having the capitalization weight of each unit of the index.
G: 2-D matrix detailing the correlation between the units of the index.

Now, the objective function will be given by:
$f(X) = (X - H)^T . G(X - H)$, which can further be elaborated as
$f(X) = X^T.G. X - 2H^T.G.X + H^T.G.H$

In here, in the final equation, the terms are typified as follows:

a. First term denotes quadratic terms
b. Second term denotes linear terms
c. Final term gives rise to a constant, not necessary for function minimisation.

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## 3. CONCLUSIONS

- In the first case, by solving the equations we can obtain real time data, of the optimal allocation of the given amount of funds. It's cumbersome to obtain optimal portfolios as the calculations are precarious and there is constant meshing between the designed models and their respective solvability. This is done by modelling the problem, using linear programming, in which variables, objectives and the constraints are clearly defined to get to a particular solution.
- In the second case, we observe that how investors can combat the investment insecurities by laying an operation foundation over the calculation of Tracking Error in the process of Index Tracking. By assessing the results, the investor can select the units in his portfolio, which are return-risk wise, at par with the market index. This will enable them to have a fixed allocated portfolio for the long-term investments, which are meant to fetch the maximum returns, not taking into consideration, the short term bearish or bullish markets.
- Thus, OR techniques are well apparelled to vamp such problems as mathematical problems and provide a feasible solution to the same. These problems have perplexing relationships between the components and also, they might involve large set of such components, which are in fact, within well-defined boundaries and objectives.

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