A STUDY ON PORTFOLIO OPTIMIZATION TECHIQUES IN MUTUAL FUND

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CHAPTER 1

ABSTRACT

This topic introduces the concept of mutual funds and the need to optimize your portfolio. Focusing on the technicalities, Author tries to answer the basic question, "What does mutual fund jargon mean and how we can optimize our portfolio and invest according to our risk aversion" The Mutual Fund is just like a bank a financial intermediary. However, the claim that an investor obtains while making an investment through a mutual fund is quite different from the one that the investor receives by depositing the money in the bank. Mutual funds are created when collected capital is invested in shares, bonds, money market instruments, or corporate bonds. These pooled funds are run by professional investment managers, and millions of investors get equity portfolios that they can invest in without having to pay large fees. In the mutual sense, returns minus costs are distributed to all shareholders.

Significance of the Study

Mutual funds have emerged as the primary way to save and invest for the average citizen. Due to rapid economic growth in India, the mutual fund industry is growing rapidly and will continue to do so. Mutual funds make saving and investing easier, as well as they bring the advantages of market trading to the table. mutual funds have their own benefits, such as professional management, diversification, accessibility, liquidity, and oversight, as well as well as full disclosure.

Due to large-scale financial products like mutual funds in the financial markets, market structures are becoming more complex, but at the same time frame of mind. Because of this, mutual funds must be understood from a different perspective; they are important to research now in terms of how investors perceive and expect them to be affected by a fund's performance. Investing today presents a wide variety of

investment opportunities on the financial market. It is also possible for an investor to receive a return on their investment.

CHAPTER 2

Review of Literature

i. **Lalit K. Bansal (1997)**'Investment Perception towards mutual fund' This article tells us view from Mr. Bansal's point of view in which he quotes "A Mutual Fund is better understood by the functions it performs and role it plays. It is a non-depository financial intermediary. Mutual Fundsaremobilizerofsaving,particularlyfromthesmallandhouseholdsector,for investmentsinstockandmoneymarket.MutualFunds,thus,provideanalternative totheinvestorswhoinsteadofmakingdirectinvestmentsinshareofbondsthrough publicissuesorthroughsecondarymarket,subscribetothecorpusofmutualfunds. Mutual funds mobilize funds by selling their own shares also known asunits.

ii. **BhaskarBiswas(2013)**'InvestigationofOutperformanceandUnderperformance of Some Selected Diversified Equity Fund Schemes in Indian Mutual Fund Industry' This article investigates out performance and under performance of diversified funds, by studying the performance of some ten best and ten worst performing diversified equity mutual funds for the period from 2009 to 2012. Selected diversified equity funds have been analyzed through arithmetic mean return, risk analyzed by standard deviation, beta measures for market sensitivity, alpha measures the risk return relationship and Sharpe ratio measures the risk premiumportfolio.

iii. **John C. Bogle (1993)** "The Index Mutual Fund" This book gives a very good illustration of indexing, of buying stocks and equities, of buying bonds and fixed income, how they move in relation to each other, and what all this means to mutual funds. It also talks about many mutual fund issues, such as what the fees actually are and how costs impact yourportfolio.Andthebookhelpsputintoperspectivemutualfundperformanceso you can alignexpectations.

iv. **Seema Sharma, M. A. Khan, R. K. Srivastava (2016)** 'Mutual Fund in INDIA' In India, investors have a wide variety of investment opportunities to choose from. "Risk" and "and" "return" are the major factors which a person's goal in investment has to consider when evaluating alternative investment opportunities. The introduction of mutual funds has helped investors in their ability to pool money and grow their investments at the same time. mutual fund is a viable investment for the small investor because it buys a professional-managed mix of securities at a reasonable price and provides diversification as well The paper's goal is to comprehensively cover mutual fund evolution, as well as the effect on the small investor, as well as ELSS funds. This analysis aims to help the inexperienced investor who is pressed for time (or energy) and burdened by taxes.

v. **Jeff Grover and Angeline M. Lavin**: 'Passive Versus Optimized Investing in Retirement Plan Portfolios' While Modern Portfolio Theory (MPT) provides excellent insight into which assets should be included in an investor's optimal portfolio, understanding the underlying statistical techniques for portfolio optimization is a major challenge. Even the simplest of methods requires a good knowledge of statistical concepts. The investor's knowledge of the theoretical basis of MPT presents a conceptual constraint on his/her ability to understand these basic requirements when determining which asset investment strategy will optimize his/her portfolio.

CHAPTER 3

Research Design

Rationale Behind Selecting this Topic

- Mutual fund houses, mutual fund managers, and the funds themselves can become the integral part of our economy if they act in concert to maintain market liquidity. I find the concept of investing in mutual funds and portfolio optimization a good investment avenue which needs to be studied in a detailed manner.
- Due to the changing present scenario for the investment in various sectors the one of the sectors i.e.,

investment in the new vista mutual funds. In respect of mutual funds how alternate opportunity of gain in income through investment and to study the increase in the net asset value.

- Also there was a huge problem of selecting the portfolio based on the risk aversion of the investors. Investors are mostly confused on how much they should allocate to mutual funds according to the risk preference hence this study will help them to find the answer of how much to invest in the specific portfolio based on their risk preferences.

Objectives of the Study

- To study present position of mutual funds,
- To study portfolio optimization techniques,
- To study the Fund allocation into mutual fund based on the risk aversion of an investor.

Data Collection:

- The data collected here is secondary data. Taking the data of AXIS BANK BLUECHIP MUTUAL FUND which invests in top blue chip companies which comprises of around 30 companies. These 30 companies' daily returns from 01/01/2020 to 31/12/2020 has been obtained and several portfolio optimization techniques have been tested to check which techniques settles best and according to the result obtained the investor should go for the mutual fund or not. If the investor can go for that mutual fund then how much should he allocate into that according to the risk aversion.
- Reason for taking secondary data is, because the techniques used for portfolio optimization uses historical data and the main variable here is the stock prices so the daily prices of the stocks for the year 2020 is taken and the study is done based on that.

Research Methodology:

In this study we will take three portfolio optimization techniques to find out the optimum portfolio and among those we will select the technique which can give maximum returns. Mutual fund which we are taking over here is BLUECHIP MUTUAL FUND BY AXIS BANK, All the three techniques are tested in the same mutual fund as we are finding the best possible technique and later on we will also decide the portion to be allocated to the mutual fund from the portfolio based on the risk appetite. The three portfolio optimization techniques are as follows:

- **Equal Weighted**
- **Risk Parity**
- **Mean-Variance (Markowitz portfolio Theory)**

❖ Equal weighted

In this method we will assign equal weights to all the stocks and make a portfolio. This method is most useful when the returns are purely random and we don't have any views on how they will move.
For example: if there are 10 interested stocks and the portfolio amount comprises of 1,00,000. Then according to equal weighted we will assign 10,000 to each stock and make a portfolio. We will do this when we don't have any specific view for the stocks and the stocks selected are purely random.

❖ Risk Parity:

In this method the risk contribution of all the asset is equally weighted. The difference in this method from the one given above is that the risk is equally weighted rather than the stocks. In other word if there is more risk in the asset then its weightage in the portfolio will be automatically low and if the asset's risk is low then the asset's weightage in the portfolio will be more so that the weightage of risk is equal.
in this method the risk is calculated as annual volatility (standard deviation) and they are taken as inverse and given weights relating to the total volatility of portfolio. Then based on the solution the stocks are given weights. So in this way we assign weights based on the risk.

$$w_B = \frac{1/\sigma_B}{1/\sigma_B + 1/\sigma_S}.$$

❖ Mean-Variance (Markowitz portfolio Theory):

In this method we maximize our expected return of the portfolio for the given level of risk. This is the mathematical framework in which the weights of the portfolio is arranged in such a manner so that portfolio's expected return gets maximizes for the given level of risk, so this makes the portfolio optimum. This method assumes that the returns are normally distributed.

the weights are the main solution to the optimization problem for the different levels of expected returns. As we are taking the combined expected return and volatility of the portfolio so we can take the expected return by taking the average annual return of individual stocks, but in case of volatility we need to bring covariance into the picture which will find out the correlation between each stock with every other stock individually and then with the help of a formula we will be able to find the annual volatility of portfolio. After we get expected return and volatility of the portfolio, we will find the Sharpe Ratio using the risk free rate and then using the solver we will change the weights in such a way so that sharpe ratio gets maximized. After we achieve the best sharpe ratio we will then use a formula to determine the actual amount an investor should allocate to the mutual fund from his portfolio based on his/her risk appetite.

$$w^{optimal} = arg\ min\ w^T \Sigma w - qRw$$

w = weight

∑ = covariance matrix

N = number of asset

R = expected return

Q = risk tolerance factor

Fund to be allocated to the specific mutual fund

E(r)-Rf/q^2*A/10

E(r) = Expected return

Rf = Risk Free rate

We are assuming range from 1-3 which is the average risk aversion rate

- 1 is taken for Risk Aggressive Investor
- 3 is taken for Risk Averse Investor

q = Standard Deviation

A = allocation based on Risk Aversion

CHAPTER 4

Analysis and Interpretation

We will take **AXIS BANK BLUECHIP MUTUAL FUND** which includes 30 companies listed in National Stock Exchange. Now we will find out the Optimum Portfolio using the three techniques mentioned above ne research methodology.

1) Equally – Weighted portfolio:

This strategy believes in diversification by assigning equal weights to all portfolio assets. If the number of assets in the portfolio is large, smaller weights are allocated to the assets. It is therefore the least concentrated in terms of weights. Such a portfolio management strategy ignores the characteristics of the assets, does not apply any constraint other than a budget constraint, and lacks an objective function.

S No.	Scrip	Avg. Daily Return	Avg. annual return	equal weights
1	WIRPO	0.0021	0.5271	0.0333
2	ULTRACEMCO	0.0014	0.3430	0.0333
3	TORNTPHARM	0.0020	0.5002	0.0333
4	TITAN	0.0016	0.3935	0.0333
5	TCS	0.0014	0.3431	0.0333

6	TATACONSUM	0.0028	0.7078	0.0333
7	TATASTEEL	0.0018	0.4441	0.0333
8	SHREECEM	0.0010	0.2414	0.0333
9	RELIANCE	0.0016	0.3966	0.0333
10	PIDILITIND	0.0012	0.2903	0.0333
11	NESTLEIND	0.0011	0.2781	0.0333
12	MOTHERSUMI	0.0014	0.3625	0.0333
13	MARUTI	0.0006	0.1576	0.0333
14	KOTAKBANK	0.0011	0.2844	0.0333
15	INFY	0.0025	0.6200	0.0333
16	ICICIGI	0.0008	0.1949	0.0333
17	ICICIBANK	0.0006	0.1418	0.0333
18	HINDUNILVR	0.0011	0.2737	0.0333
19	HDFCLIFE	0.0008	0.1932	0.0333
20	HDFCBANK	0.0008	0.2034	0.0333
21	HDFC	0.0007	0.1687	0.0333
22	DRREDDY	0.0026	0.6614	0.0333
23	DMART	0.0020	0.4923	0.0333
24	DIVISLAB	0.0033	0.8272	0.0333
25	CIPLA	0.0025	0.6285	0.0333
26	BHARTIARTL	0.0008	0.2116	0.0333
27	CHOLAFIN	0.0021	0.5347	0.0333
28	AXISBANK	0.0001	0.0157	0.0333
29	BAJFINANCE	0.0017	0.4267	0.0333
30	ASIANPAINT	0.0020	0.5005	0.0333

- **Average Daily return** = Mean (Daily Return)
- **Average Annual Return** = Average Daily Return*252
- **Equal Weights** = 1/30

- For finding the Expected Returns we will use Matrix Multiplication of Average Annual Return and Equal Weights which will give us the result as 37.88%. so if we assign equal weights to each stocks then the expected return will be equal to 37.88% per annum.

2) Risk Parity:

S No.	scrip	Avg. Annual Return	Daily Volatility	Annual volatility	inverse of volatility	weights
1	WIRPO	0.527114652	0.000628352	0.1583447	6.315337419	3.74%
2	ULTRACEMCO	0.34298337	0.000605921	0.1526921	6.549129384	3.88%
3	TORNTPHARM	0.500164506	0.000609882	0.1536903	6.506590506	3.85%
4	TITAN	0.39347601	0.000669897	0.1688140	5.923680681	3.51%
5	TCS	0.343063454	0.000488826	0.1231841	8.117933732	4.81%
6	TATACONSUM	0.707769547	0.000798968	0.2013400	4.966723341	2.94%
7	TATASTEEL	0.444141478	0.000961602	0.2423236	4.126712882	2.44%
8	SHREECEM	0.241390398	0.000572001	0.1441442	6.937496778	4.11%
9	RELIANCE	0.396645468	0.000877546	0.2211415	4.521990764	2.68%
10	PIDILITIND	0.290267445	0.00046142	0.1162779	8.60008506	5.09%
11	NESTLEIND	0.278149116	0.00045845	0.1155294	8.655803383	5.13%
12	MOTHERSUMI	0.362490754	0.001812325	0.4567058	2.189593299	1.30%
13	MARUTI	0.157590705	0.000885569	0.2231633	4.481023656	2.65%
14	KOTAKBANK	0.284372508	0.000844419	0.2127935	4.699390667	2.78%
15	INFY	0.619977048	0.000638813	0.1609810	6.211914918	3.68%
16	ICICIGI	0.194858269	0.000795865	0.2005581	4.986087565	2.95%
17	ICICIBANK	0.141843974	0.001134533	0.2859022	3.497699571	2.07%
18	HINDUNILVR	0.273693325	0.000475385	0.1197969	8.347460249	4.94%
19	HDFCLIFE	0.193160093	0.000846784	0.2133896	4.686264726	2.78%

20	HDFCBANK	0.203441853	0.00067736	0.1706947	5.858412298	3.47%
21	HDFC	0.168681293	0.000931946	0.2348504	4.258029175	2.52%
22	DRREDDY	0.66144864	0.000504123	0.1270391	7.871592069	4.66%
23	DMART	0.492291916	0.000590283	0.1487514	6.722626467	3.98%
24	DIVISLAB	0.827202515	0.000554297	0.1396830	7.159069128	4.24%
25	CIPLA	0.628518582	0.000629448	0.1586210	6.304335346	3.73%
26	BHARTIARTL	0.211615205	0.000743573	0.1873804	5.33673613	3.16%
27	CHOLAFIN	0.534735765	0.002169725	0.5467708	1.828919952	1.08%
28	AXISBANK	0.015720941	0.001582077	0.3986835	2.508255448	1.49%
29	BAJFINANCE	0.426689579	0.001539517	0.3879582	2.577597301	1.53%
30	ASIANPAINT	0.500522857	0.000488437	0.1230862	8.124390178	4.81%
					168.8708821	

- **Average Daily return** = mean (daily return)
- **Average Annual Return** = Average Daily Return*252
- **Daily Volatility** =

$$\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}}$$

- **Annual volatility** = Daily Volatility*252
- **Inverse of weights** = 1/Annual volatility (x)
- **Weights** = Individual/Total

In this technique we are giving equal contribution to the risk of the stocks. The stocks with higher volatility will be given less weight and the stock with lesser volatility will be given higher weight so in this way the risk contribution of all the stocks will be equal. Application of this technique is explained above. The annual volatility is taken and inverse of which is divided

with the total number so that the weight is determined. In the above example Nestle India having less volatility is ultimately given more weightage and Chola Finance having maximum volatility is given lesser weightage.

We will now use Matrix Multiplication of Average Annual Return and Weights obtained with the help of annual volatility, With the help of this method the expected return is calculated as 39.46% per annum.

3) Mean-Variance (Markowitz portfolio Theory):

This is the main technique in portfolio optimization as risk factor is given importance in this technique. Step by step explanation id given below:

The minimum variance frontier is a graph of the potential range of returns expected value that can be found for the different values of the variance can take. The global minimum variance portfolio is a portfolio of risk assets that is obtained by combining all risk assets with the lowest in risk. The effective boundary is the range of all investments within the minimum variance boundary and above (with a higher return than) the global minimum variance portfolio.

The expected return on portfolio is calculated as:

$$E(r_p) = \sum_{t=1}^{n} w_t E(r_t)$$

The variance of 2 Asset (x & y) portfolio is calculated as:

$$\sigma_p^2 = w_x^2\sigma_x^2 + w_y^2\sigma_y^2 + 2w_x w_y cov(r_x, r_y)$$

now we will Generalize the equation to accommodate more than 2 assets results in the equation:

$$\sigma_p^2 = \sum_{t=0}^{n} \sum_{f=1}^{n} w_t w_f \, cov(r_t r_f)$$

It is necessary to use matrix multiplication to determine when we move past the two-asset portfolio, it is necessary to use matrix multiplication to determine the optimum asset weights in the portfolio.

The expected return on portfolio is calculated as:

$$E(r_p) = W^T R = [w_1 \dots \dots w_f] \begin{matrix} E(r_1) \\ \vdots \\ Er_{(f)} \end{matrix}$$

Where:

W is the vector for the weights of the individual assets (1 through f) in the portfolio and

R is the vector for the expected returns of the individual assets (1 through f) in the portfolio.

The portfolio variance is calculated as $\sigma_p^2 = W^T s(W)$

The standard deviation of the portfolio is calculated as $\sigma_p = \sqrt{W^T S(W)} =$

$$sqrt([w_1 \cdots w_f] \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1f} \\ \vdots & \ddots & \vdots \\ \sigma_{f1} & \cdots & \sigma_{ff} \end{bmatrix} \begin{matrix} w_1 \\ \vdots \\ w_f \end{matrix})$$

Where S is referred to as the variance-covariance matrix of the covariance between the returns of each asset in the portfolio. The covariance of the returns of the asset with the returns of the same asset is the value of the returns of the asset.The W definition remains the same as above.

Optimal weights of assets There are those in the portfolio that maximize the value of the Sharpe Ratio.

$$S_p = \frac{E(r_p) - r_f}{\sigma_p}$$

We will find out the results with help of formulas mentioned above:

At first we are taking weights as equal so that we will get the expected return of our portfolio, later on we will find out the standard deviation using the same equal weights. After we get both the result with which we will calculate the sharpe ratio using the expected return, standard deviation and risk free rate. As soon as we get the sharpe ratio, we will use the solver function in excel and tweak the weights in such a way that the sharpe ratio gets maximized. The main objective of maximizing the sharpe ratio will fulfill both the needs of maximizing the expected returns and minimizing the standard deviation of the portfolio.

- Risk free rate is taken as 5.89% which is the 10year government bond yield (India) as on 31st December, 2020

❖ Portfolio's expected return, Standard deviation and Sharpe ratio with equal weights:

Expected return = 37.88%

Standard deviation = 29.94%

Sharpe Ratio = 1.06

- Portfolio's expected return, Standard deviation and Sharpe ratio when calculated with the help of solver in Excel subjecting to maximize sharpe ratio and following constraints:
    1. There can be no negative weights, which mean we cannot go short on any stock,
    2. Minimum weight of the stock should be 1% in the portfolio,
    3. Maximum weight of the stock can be 10% in the portfolio.

Expected return = 54.93%

Standard deviation = 26.05%

Sharpe Ratio = 1.88

As we can see that when we used solver with certain constraints the result obtained is very fruitful. This is because the solver has given us the weights which we can assign to every stock and if the portfolio would have invested according to that then we would have got 54.93% of return with 26.05% of standard deviation (risk) which means our sharpe ratio changed from 1.06 to 1.88 from equal weights to new weights.

This technique helped us to find out the optimum expected return we can get from investing in this portfolio, But what about the risk of the same. How can a investor decide that how much he should invest in this portfolio based on his risk? An investor should invest in this portfolio or not? All these Questions Are Answered below.

Capital Allocation and the Separation Property:

The optimal mix of weights for assets in a risky portfolio is the mix that creates a efficient frontier that is tangent to the Capital Allocation Line (CAL). This results in the CAL with the largest slope (Sharpe

Ratio) and is therefore the optimal risk portfolio.

The separation property states that there are two independent tasks involved in the choice of portfolio property. The first is to determine the optimal risky portfolio. This risky portfolio is best regardless of the level of risk aversion of the client. In the second mission, the financial planner aims to determine the clients' appetite for risk and the capital allocation between the volatile portfolio and the risk-free asset, which is determined by the riskiness of the portfolio and the risk tolerance of the investor.

We are assuming range from 1-3 which is the average risk aversion rate

- 1 is taken for Risk Aggressive Investor
- 3 is taken for Risk Averse Investor

The above mentioned risk aversion numbers are taken from a research study 'Risk Aversion at Country Level' by Nester Gandelman

$$y^* = \frac{E(r_p) - r_f}{A\sigma_p^2}/10$$

Where y* is the proportion of the portfolio invested in the risky portfolio and A is a measure of the risk aversion of the investor.

Let's take A for

Risk Aggressive Investor as 1:
= ((54.93-5.89)/1*26.05^2)/10
= 0.72

So, if the Investor has Risk Aversion of 1, then he/she can invest 72% of his Investment in this portfolio. As he is a risk aggressive investor, he can take this risk and can invest greater portion of his money in this portfolio.

Risk Averse Investor as 3:

= ((54.93-5.89)/3*26.05^2)/10

= 0.24

So, if the Investor has Risk Aversion of 3, then he/she can invest 24% of his Investment in this portfolio. As he is a risk avrese investor, he cannot take big risk and can invest smaller portion of his money in this portfolio.

CHAPTER 5

Summary of Findings

Stock mutual funds play an important role in our economy, since there are many investors who don't have the necessary knowledge of the stock market. In the last couple of decades, mutual funds have gained a lot of favour due to their many other advantages, long- Tax benefits and consistently positive returns. Many investors are always without the knowledge of which mutual fund to invest in, because there are many fund options available. In this case, the analysis, the research will be used to provide information that helps calculate the most suitable risk profile for the investor's portfolio.

Previous studies have proved that the minimum variance portfolio theory tells us the optimum portfolio to invest in, but this study will tell you how much of a portion you should invest from your overall portfolio to this specific mutual fund based on your risk appetite. In our example of AXIS BANK BLUE CHIP MUTUAL FUND, we obtained optimum result of 54.93% return per annum with 26.05% of standard deviation (risk), this tells us that based on the data from 01/01/2020 to 31/12/2020, this specific mutual fund invested in weights according to minimum variance portfolio technique would have given 54.93% return where at least weightage given was 1% and highest weightage given was 10%.

This mutual fund had standard deviation of 26.05% annually, which can be more for someone and less for someone. Risk appetite is different for everyone; hence everyone would have different interest for this mutual fund. So how much to invest in the mutual fund is also very important. Thus in this study it has been made clear that a risk aggressive and risk averse investor will invest in different volumes so that their risk

appetite is also respected.The allocation equation will help the investor in deciding how much he should invest in the mutual fund.

CHAPTER 6

Recommendations and Conclusion

- The conclusions that come from this study show that an investor is solely responsible for their own decisions, as long as they put money in mutual funds and keep track of those funds, but they do not get outstanding returns until they make a conscious decision about what mutual fund to buy.
- The most prevalent component in the market is "Risk" and many fail to consider it as a primary component because they assume that they have already regulated the other important things. any investment presents its own risks. using our research, investors can identify the most suitable mutual fund and find out how much to put in it, as to satisfy their risk tolerance.
- A smart investor knows that If the investor has been able to answer these questions, they've proven themselves smarter than thousands of others who have simply put money into the market.
- However, though the strategies rely on past experience, there are risks that history will not be able to replicate itself. There is a high likelihood that the stocks will respond in a lot of the same ways as they have in the past. Thus, we need some estimates to make the predictions, which are derived using the most sophisticated models, and these methods yield the optimum results.

REFERENCES

- **Lalit K. Bansal (1997)** 'Investment Perception towards mutual fund'. *Journal of Business and Social Sciences Research*, *5*(2), 15-34.
- **BhaskarBiswas(2013)**'InvestigationofOutperformanceandUnderperformance of Some Selected Diversified Equity Fund Schemes in Indian Mutual Fund Industry'. *Asian Journal of Research in Social Sciences and Humanities*, *6*(5), 96-107.
- **John C. Bogle (1993)** "The Index Mutual Fund". *Theory and decision*, *76*(2), 179-199.
- **Seema Sharma, M. A. Khan, R. K. Srivastava (2016)** 'Mutual Fund in INDIA'. *Financial Analysts Journal*, *72*(1), 9-13.
- **Jeff Grover and Angeline M. Lavin**: 'Passive Versus Optimized Investing in Retirement Plan Portfolios'. *International Journal of Emerging Markets*.
- Economy. (2021). Retrieved from https://drishtikone.com/blog/category/business/economics/
- Portfolio. (2020). Retrieved from https://www.hindawi.com/journals/afs/2010/879453/