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Portfolio Selection of Health Care and Oil and Gas Sector By The Means of Genetic Algorithms Based on Population and Survival of The Fittest

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Abstract: Portfolio selection is one of the most important and vital decisions that a real or legal person, who invests in stock market should make. The main purpose of this paper is to determine the optimal portfolio with regard to stock returns of companies, which are active in Health Care and Oil and Gas Sector of Nigerian Stock Exchange. For achieving this purpose, annual statistics of companies' stocks spanning from 2010 – 2014 have been used. For analysing statistics, information of companies stocks, the Genetic Algorithms and Particle Swarm Optimization (GAPSO) and Knapsack Problem have been used with the aim of increasing the total return, in order to form a financial portfolio.

Keywords: *Genetic Algorithms, Survival of the fittest, Portfolio selection, Return, Knapsack Problem.*

1. Introduction

As stated by Olowe [6] the Nigerian Stock Exchange was established in 1960 as the Lagos Stock Exchange. In 1977 it became The Nigerian Stock Exchange, with branches established in some of the major commercial cities of the country with Lagos as the head office of the Nigerian Exchange and an office in Abuja. The Exchange started operations in 1961 with 19 securities listed for trading. Today there are 262 securities listed on The Exchange, made up of 11 Government Stocks, 49 Industrial Loan (Debenture/Preference) Stocks and 194 Equity / Ordinary Shares of Companies, all with a total market capitalization of approximately N287.0 billion, as at August 31, 1999. Nowadays, stock market acts a very important role in economic development using the tools like pricing, reducing the risk, resource mobilization and optimal allocation of capital as explained by [3].Selecting the optimal portfolio is the most important issue.

Meta-heuristic algorithms have been used in portfolio selection problem including Genetic algorithm which include [7], [2], [1], and also using particle swarm [3]. Ant colony algorithm was also used, for instance [5] .

In this research some of the superior companies of stock market have been chosen and the information of their return is gathered. First, using the Knapsack model, portfolio selection problem changed into a mathematical model and then in order to select the optimal portfolio, Genetic Algorithms and PSO(GAPSO) is used for solving the Knapsack model.

2. Method and Material

Mathematically, Consider a general problem of allocating n items to a knapsack with capacity C. Let x_i be the number of units of item i in the knapsack, and define v_i and w_i as the unit revenue and weight of item i.

The general problem can be represented as

$$\text{Max} \quad v_1x_1 + v_2x_2 + \ldots\ldots\ldots\ldots v_nx_n$$

$$\text{S.t} \quad w_1x_1 + w_2x_2 + \ldots\ldots\ldots\ldots w_nx_n \leq C \qquad (1)$$

It can also be represented as

$$\textit{Maximize} \sum_{i=1}^{n} v_i x_i \qquad (2)$$

$$\textit{Subject to} \ \sum_{i=1}^{n} w_i x_i \leq C \qquad (3)$$

$$x_i \ \forall \ \{0,1\} \quad 1 \leq i \leq n$$

x_i is set to either 1 or 0: 1 means that the i-th activity is carried out, 0 means the i-th activity is not carried out. The essence of knapsack problem is to pursue the maximum profits with the constraint of limited total available resource.

In this work, we harmonize GAPSO and Knapsack problem in matrix form. The following procedure illustrated ways of harmonizing GAPSO and Knapsack problem. Based on this information, the steps of harmonizing GAPSO are as follows.

Step 1: **Parameters Setting**. Define the parameters: Particles as a Population p, acceleration coefficients k_1 and k_2, maximum number of iterations n_{max}, inertia weight w, maximum velocity of the particles v_{max}, mutation rate r_{mu}

Step 2: **Initialization**: generate a population of n xm dimensional problem

Step 3: **Fitness evaluation and Ranking**: Using equations (2) and (3), evaluate the $f_{fitness}$

Step 4: **GA method**: Apply Genetic Algorithm (GA) operators (crossover and mutation)

Step 5: Selection: Select the best chromosomes from the fitness

Step 6: **Crossover**: Pairs chromosomes and perform crossover by applying two point crossover.

Step 7: **Mutation**: Apply mutation on the crossover using single point mutation.

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Step 8: **PSO method**: Apply PSO operators i.e velocity and position updates using the following equations:

$$\begin{cases} v_{pn}^{t+1} = v_{pn}^{t} \times w + k_1 \times rand1(\ ) \times \left(p_{best_{pn}}^{t} - x_{pn}^{t}\right) + k_2 \times rand2(\ ) \times \left(g_{best_{pn}}^{t} - x_{pn}^{t}\right) \\ x_{pn}^{t+1} = x_{pn}^{t} + v_{pn}^{t+1} \end{cases}$$

Step 9: Shows the best G_{best}

3. Illustration

The statistical data used in this paper includes all of the accepted and active companies in Nigerian Stock Exchange (NSE) in healthcare and oil and gas sector. From these companies some of them have been chosen to study on because they had the following qualifications:

1. They are companies listed in Nigerian Stock Exchange spanning from 2010 to 2014 with uninterrupted transactions during this time;
2. The Transactions of their stock not stop more than three months;
3. The information of financial statements is available.

However, data from only 18 companies were used for the analysis based on the above qualification. In all, there were 1237 observations of Daily Stock Prices (DSP).

Table 1 below is a table showing Daily Stock Price (DSP). The first row captures the names of the various listed shares while the first column indicates dates from January 2, 2010 to December, 2014. The entry for each cell indicates the share price for that particular share on the corresponding date. In this thesis, the following Health Care and Oil and Gas sector was used:

Table 1: List of Company in Health Care and Oil and Gas Sector

Company	Ticker	Sector
Total Nigeria Plc	TOT	Oil and Gas
Eterna Oil	ETE	Oil and Gas
Conoil	CON	Oil and Gas
Japaul Oil & Maritime Service	JAP	Oil and Gas
Mobil Oil Nigeria Plc	MOB	Oil and Gas
MRS	MRS	Oil and Gas
Forte Oil	FOR	Oil and Gas
Oando Oil	OAN	Oil and Gas
Ekocorp Plc	EKO	Healthcare
Evans Medical Plc	EVA	Healthcare
Fidson Healthcare Plc	FID	Healthcare
Glaxo smithkline	GLA	Healthcare
May & Baker Nig. Plc	MAY	Healthcare
Morison Industries	MOR	Healthcare
Neimeth Int'l Pharmaceuticals	NEI	Healthcare
Nigeria-German Chemicals Plc	NIG	Healthcare
Pharma-Deko Plc	PHA	Healthcare
Union Diagnostic Service	UNI	Healthcare

The Percentage return will represent our data points. In order to obtain an estimate for an expected return on our investments or expected profit, we will solve for the mean of our data points from the percentage return. We will also calculate the Earning per share price which was extracted from the annual reports of each oil companies. Table 3 shows the Expected profit (EP) and Earning per share (EPS)

Table 2. Daily Stock Price Movement

Date	CON	ETE	FOR		NIG	PHA	UNI
31/12/2014	38.11	2.75	227.25	.....	7.00	2.61	0.50
				....			
30/12/2014	40.11	2.75	214.00		7.00	2.61	0.50
29/12/2014	40.11	2.75	209.00		7.00	2.49	0.50
24/12/2014	44.44	2.75	219.90		7.00	2.49	0.50
23/12/2014	44.44	2.75	213.25		7.36	2.49	0.50
22/12/2014	44.44	2.75	208.99		7.36	2.49	0.50
19/12/2014	44.44	2.75	205.33		7.00	2.49	0.50
18/12/2014	44.44	2.75	216.13		7.00	2.49	0.50
17/12/2014	49.23	2.75	216.90		7.00	2.49	0.50
16/12/2014	49.23	2.75	207.58		7.00	2.49	0.50
...							
.....							
12/03/2010	40.00	7.00	42.58		15.04	4.97	0.63
11/03/2010	39.00	7.09	42.58		15.04	4.97	0.60
10/03/2010	39.54	7.16	40.56		15.04	4.97	0.60
09/03/2010	39.54	6.82	40.50		15.04	4.97	0.63
08/03/2010	39.54	6.50	39.70		15.04	4.97	0.60
05/03/2010	39.54	6.30	41.25		15.04	4.97	0.63
04/03/2010	39.54	6.00	43.42		15.04	4.97	0.60
03/03/2010	39.54	5.99	45.70		15.04	4.97	0.58
02/03/2010	37.66	5.71	47.46		15.04	4.97	0.61
01/03/2010	35.87	6.00	45.20	.....	15.04	4.97	0.61

Table 3. Expected Profit and Earning Per Share of listed Stocks

Stocks	Mean(Expected Profits) (EP)	Earning Per Share (EPS)
TOT*	0.0036	11.796
ETE*	0.0440	0.706
CON**	-0.0260	298.4
JAP*	0.0706	1.596
MOB**	-0.0380	1227.2
MRS*	0.0220	3.188
FOR**	-0.1551	4.89
OAN*	0.1427	2.64
EKO*	0.0333	31.35
EVA*	0.0333	0.33
FID**	-0.0483	24.5
GLA**	-0.0692	2.88
MAY*	0.0713	0.22
MOR*	0.1568	16.58
NEI*	0.0384	9
NIG*	0.0628	1.38
PHA*	0.0612	18.64
UNI*	0.0203	2.3

As shown in table 3 stocks with * by their names have positive figures as their mean whiles those with the ** have negative mean. A share with a positive mean indicates that share is expected to yield positive returns (profits) while those with negative means those shares will decline in value over a period. With the main objective of this work being to maximize the return on our investments with the help of knapsack concept, we will now consider stocks with positive expected returns. These profitable stocks are shown in the table below with their respective earning per share.

Table 4. Profitable shares with their respective prices.

Variables	Stocks	Mean(Expected Profits) (EP)	Earning Per Share (EPS)
x_1	TOT	0.0036	11.796
x_2	ETE	0.0440	0.706
x_3	JAP	0.0706	1.596
x_4	MRS	0.0220	3.188
x_5	OAN	0.1427	2.64
x_6	EKO	0.0333	31.35
x_7	EVA	0.0333	0.33
x_8	MAY	0.0713	0.22
x_9	MOR	0.1568	16.58
x_{10}	NEI	0.0384	9
x_{11}	NIG	0.0628	1.38
x_{12}	PHA	0.0612	18.64
x_{13}	UNI	0.0203	2.3

Table 4 captures profitable shares as well as their respective prices. The various expected profits for the individual shares will form the coefficients of the objective function of our problem whiles their corresponding earning per share prices will be the coefficients of the constraint.

3.1. Formulation of the capacity

There are millions of shares of these stocks which are traded daily on the stock exchange. The amount of money you need to invest on the Nigerian Stock Exchange (NSE) depends on the price of shares you select. Shares are usually traded in batches or round lots of 100. Where the price of a particular stock is high, an investor can contact a broker to buy fever than 100 shares or what is commonly referred to as odd lots. In this study, we shall adopt the ₦ 10.00 per share as the amount to be invested.

3.2. Objective Function

The objective function which seeks to maximize the Return of Investment (R), will be equated to the summation of the expected returns of the various individuals shares. The coefficients of the objective function are derived from the expected profits indicated in the table.
Thus is given by:

$$R = 0.0036x_1 + 0.044x_2 + 0.0706x_3 + 0.022x_4 + 0.1427x_5 + 0.033x_6 + 0.0333x_7 + 0.0713x_8 + 0.1568x_9 + 0.0384x_{10} + 0.0628x_{11} + 0.0612x_{12} + 0.0203x_{13}$$

3.3. Constraint

The constraint consist of the summation of the individual earning per share which is on the financial statement of each stock is considered. These coefficients are indicated in the table as the earning per share.
Thus is given by:

$$11.796x_1 + 0.706x_2 + 1.596x_3 + 3.188x_4 + 2.64x_5 + 31.35x_6 + 0.33x_7 + 0.22x_8 + 16.58x_9 + 9x_{10} + 1.38x_{11} + 18.64x_{12} + 2.3x_{13} \leq 10$$

The developed model in chapter three was employed to carry out the analysis of Table 4.8. The solution set (TOT, ETE, JAP, MRS, OAN, EKO, EVA, MAY, MOR, NEI, NIG, PHA, UNI) with the optimal value is (0 1 1 0 1 0 1 1 0 0 1 0 1). All entries with 1 indicate that particular stock is part of the optimal solution. All entries with 0 indicates that particular stock was not part of the optimal portfolio. The optimal portfolio consists of the following shares ETE, JAP, OAN, EVA, MAY, NIG and UNI. The optimal solution obtained for the objective function is ₦ 0.4450 and the portfolio consists of (0 1 1 0 1 0 1 1 0 0 1 0 1). This implies every investment of ₦ 10.00 will yield a return of 44.5%.

4. Conclusion

The GAPSO Model equation was used to solve a real life problem of Healthcare and Oil and gas sector in Nigeria Stock Exchange by modelling their problem as a knapsack problem. With these, we were able to plot the daily closing price; percentage return and square return series from 2010 – 2014. We observe that the model can be used for selecting portfolio. The optimal portfolio consists of the following shares Eterna Oil, Japaul Oil and Maritime Oil, Oando Oil, Evans Medical Plc, May & Baker, Nigeria-German and Union Diagnostic Service. The optimal solution obtained for the objective function is ₦ 0.4450 and the portfolio consists of (0 1 1 0 1 0 1 1 0 0 1 0 1). This implies every investment of ₦ 10.00 will yield a return of 44.5%.

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