Optimizing models of a stock portfolio issued by Financial Investment Companies

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Abstract

The complex methodology used in financial portfolio management proves that H. Markowitz optimization approach is one of the most applied techniques on developed global financial markets.

Financial information spreading and processing speed, real time access to information, the performance maximization criterion for managed portfolios, are fundamental factors requiring higher reaction speed from the portfolio manager in order to take the appropriate strategic decisions.

Sustained decision process requires specific applications and flexibility to present financial circumstances, a relevant example being Crystal Ball software.

This paper intends to test in practice the facilities offered by Crystal Ball regarding a stock portfolio and to compare the results generated by Markowitz approach.

1. Introduction

In order to reach the objective of testing different financial instruments portfolio optimization techniques on the Romanian capital market, irrespective of they being specific to the modern portfolio theory (i.e. H. Markowitz, W. Sharpe), or provided by integrated software solutions (i.e. Crystal Ball, Palisade), regarding risk analysis and the largely used optimization methods, as a firs step, a set of stocks listed on a regulated market should be selected, i.e. listed on the Bucharest Stock Exchange.

Even though the Bucharest Stock Exchange does not match all the requirements for a perfect competition market, as it is an emergent capital market with a still reduced number of issuers and available financial instruments, as well as a low liquidity, we have considered it highly important to study the applicability of two renowned techniques on a stock portfolio, i.e. the Markowitz approach and the optimization carried out through the Monte Carlo simulation in the Crystal Ball software.

2. Characteristics of the employed selection criteria

There are several criteria that lay at the basis of each financial instrument selection process and which mainly refer to the following aspects:

- **the analyzed period**

We have considered it relevant to demarcate a statistical period of evolution for the daily market quotations between **11th November 2005** and **30th November 2007**. There are 512 trading sessions in the chosen time period, according to table 1.

Table 1 Analysis spectrum

Period	Number of trading sessions
nov.2005- dec.2005	**29 days**
ian.2006-dec.2006	**248 days**
ian.2007- nov.2007	**235 days**
Total	512 days

- **stock liquidity**, estimated according to other three sub criteria: number of trading days (C1), the traded volume (C2) and the estimated traded value;
- **the representativeness degree** (C4) of the Romanian economy (the origin of the issuers must cover to a better extent the Romanian economy sectors represented within the stock exchange)

The (C1) criteria, regarding issuers' presence on the Bucharest Stock Exchange, has been defined as the ratio between the sessions in which the issuers have been traded (Nsi) and the total number of trading sessions (NTs), at the level of each separate year:

$$C_{1i} = N_{si} * 100 / N_{sT} \ [\%] \quad (1.)$$

The retained values for C1 criteria have met the imposed condition of a 66.66% minimum, which is considered to be a suitable weight in order to study the statistical behavior of the issuer.

3. The resulted portfolio by applying the established criteria

The use of these criteria on the issuers listed on the Bucharest Stock Exchange has offered the fundamentals for the final option, which is the selection of a portfolio composed only by stocks issued by the Financial Investment Companies (SIF). We based our statement on the following observation:

- the common characteristic of the Romanian stock market, over the chosen period, is given by the fact that a number of eight issuers (see table 2) have regrouped more than a third of the total traded volume in the stock exchange and a percent of 75% of the total traded value.

Table 2 Stock results esults for the "dominant" issuers

		2005		2006		2007	
	[%]	Volume	Value	Volume	Value	Volume	Value
1	SIF1	2.6%	8.0%	1.8%	6.4%	2.7%	8.9%
2	SIF2	4.3%	12.7%	4.6%	15.4%	4.5%	14.3%
3	SIF3	5.2%	14.7%	3.3%	10.6%	3.0%	8.7%
4	SIF4	1.8%	3.8%	2.6%	5.8%	3.0%	6.5%
5	SIF5	4.4%	15.1%	4.1%	15.8%	4.3%	15.9%
	Total I	**18.3%**	**54.4%**	**16.4%**	**54.0%**	**17.5%**	**54.3%**
6	BRD	0.2%	4.3%	0.3%	7.1%	0.3%	7.7%
7	TLV	6.9%	11.9%	6.1%	9.7%	9.3%	8.5%
8	SNP	17.4%	11.3%	12.0%	9.3%	9.3%	5.0%
	Total II	**24.5%**	**27.5%**	**18.4%**	**26.1%**	**18.9%**	**21.2%**
	TOTAL	**42.9%**	**81.8%**	**34.7%**	**80.1%**	**36.4%**	**75.5%**

- according to the data in the above table, there can be further observed the fact that the SIF's have constantly represented more than 54% of the total traded value on the Bucharest Stock Exchange

The insufficient maturing degree is highlighted by the low liquidity available compared to other regional capital markets. The number of issuers is maintained at a low level and, the stock volatility is still high. The new, foreign or domestic, capital entry is still limited. Because of the need to obtain resources, the acquisition of new securities on the capital market is highly completed through the liquidation of other positions, which, in

turn, can induce pressures on prices. In other words, the balancing of the demand and supply can take place at levels liable to determine the growth of stock volatility.

It is difficult to anticipate a reduction in investor's interest for securities that are still seen as "stars" on the stock market (i.e. SNP, SIFs, BRD, TLV), especially with the current economic conditions. This preference of the investors has developed because of the lack of other investment opportunities (i.e. public utilities[1] and issuers from other sectors than services).

The highlighted aspects let us make the statement that, as long as the issuers in the field of financial services (SIFs and banks) maintain their market position, the problem of modeling the Romanian capital market resides in treating this category separately as opposed to the rest of the economic sectors represented in the Bucharest Stock Exchange.

4. Portfolio optimization using the Markowitz method

The application used to determine the minimum absolute variance and the maximum profitability portfolio, has provided the following of the **SIF** portfolio:

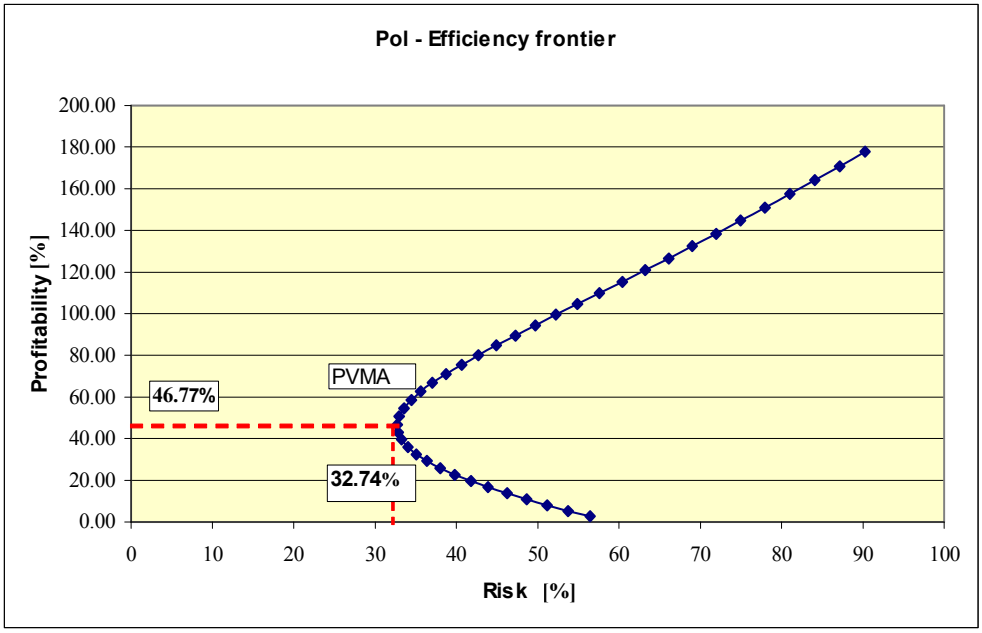
Table 3 Risk and rentability for the SIF postfolio

	Risk %	Average daily profitability %	SIF1	SIF2	SIF3	SIF4	SIF5	Profitability /year %	Risk/year %
1	3.527	0.01	0.73	0.71	-1.6	1.48	-0.33	2.59	56.44
2	3.36	0.02	0.7	0.66	-1.47	1.4	-0.29	5.25	53.76
3	3.197	0.03	0.67	0.61	-1.34	1.32	-0.26	7.98	51.15
4	3.04	0.04	0.64	0.56	-1.21	1.23	-0.22	10.78	48.63
5	2.889	0.05	0.61	0.51	-1.08	1.15	-0.19	13.65	46.22
6	2.746	0.06	0.58	0.46	-0.95	1.07	-0.15	16.6	43.93
7	2.611	0.07	0.55	0.4	-0.83	0.99	-0.12	19.62	41.78
8	2.487	0.08	0.52	0.35	-0.7	0.9	-0.08	22.72	39.79
9	2.375	0.09	0.49	0.3	-0.57	0.82	-0.05	25.9	38.00
10	2.276	0.1	0.46	0.25	-0.44	0.74	-0.01	29.16	36.42
11	2.193	0.11	0.43	0.2	-0.31	0.66	0.02	32.5	35.08
12	2.127	0.12	0.4	0.15	-0.18	0.57	0.05	35.94	34.03

[1] Transelectrica and the allocation rights for Transgaz have been listed in the period following the one for which the sample has been defined

13	2.079	0.13	0.37	0.1	-0.05	0.49	0.09	39.46	33.27
14	2.052	0.14	0.34	0.05	0.07	0.41	0.12	43.07	32.84
15	**2.046**	**0.15**	**0.31**	**0**	**0.2**	**0.33**	**0.16**	**46.77**	**32.74**
16	2.062	0.16	0.28	-0.05	0.33	0.24	0.19	50.57	32.98
17	2.097	0.17	0.25	-0.1	0.46	0.16	0.23	54.47	33.56
18	2.153	0.18	0.22	-0.16	0.59	0.08	0.26	58.47	34.45
19	2.227	0.19	0.19	-0.21	0.72	0	0.3	62.57	35.63
20	2.317	0.2	0.16	-0.26	0.85	-0.08	0.33	66.78	37.07
21	2.422	0.21	0.13	-0.31	0.97	-0.17	0.37	71.09	38.75
22	2.54	0.22	0.11	-0.36	1.1	-0.25	0.4	75.52	40.63
23	2.668	0.23	0.08	-0.41	1.23	-0.33	0.44	80.06	42.69
24	2.807	0.24	0.05	-0.46	1.36	-0.41	0.47	84.72	44.91
25	2.953	0.25	0.02	-0.51	1.49	-0.5	0.5	89.5	47.25
26	3.107	0.26	-0.01	-0.56	1.62	-0.58	0.54	94.4	49.71
27	3.267	0.27	-0.04	-0.61	1.75	-0.66	0.57	99.43	52.27
28	3.432	0.28	-0.07	-0.67	1.87	-0.74	0.61	94.58	54.91
29	3.601	0.29	-0.1	-0.72	2	-0.83	0.64	99.87	57.62
30	3.775	0.3	-0.13	-0.77	2.13	-0.91	0.68	115.3	60.40
31	3.952	0.31	-0.16	-0.82	2.26	-0.99	0.71	120.86	63.23
32	4.131	0.32	-0.19	-0.87	2.39	-1.07	0.75	126.57	66.10
33	4.314	0.33	-0.22	-0.92	2.52	-1.15	0.78	132.43	69.02
34	4.498	0.34	-0.25	-0.97	2.65	-1.24	0.82	138.43	71.97
35	4.685	0.35	-0.28	-1.02	2.77	-1.32	0.85	144.6	74.96
36	4.873	0.36	-0.31	-1.07	2.9	-1.4	0.89	150.92	77.97
37	5.063	0.37	-0.34	-1.12	3.03	-1.48	0.92	157.4	81.01
38	5.255	0.38	-0.37	-1.18	3.16	-1.57	0.95	164.05	84.08
39	5.447	0.39	-0.4	-1.23	3.29	-1.65	0.99	170.87	87.16
40	5.641	0.4	-0.43	-1.28	3.42	-1.73	1.02	177.86	90.26

Data analysis from table 3 shows that the efficient portfolio no.15 is the minimum absolute variance portfolio, as well as the maximum profitability portfolio (this being the case in which the two coincide).



The examination of the results expressed in the 40 portfolios from the table, shows the missing sales situation, successively for each SIF stock separately. The only efficient portfolio that meets the criteria of risk-profitability ratio maximum has the following weights for the five securities: **31%** SIF1, **20%** SIF3, **33%** SIF4 and **16%** SIF5.

5. Optimization of the SIF portfolio using Crystal Ball software

Considering the results obtained through the Markowitz optimization method, we have considered it to be important testing the results also through another method. This method provides the necessary data for portfolio optimization, through generating the efficiency frontier, but also has another contribution in the determination of the realization chance of the imposed result (an expected profitability level), for a certain confidence level.

Another feature offered by this software is the fact that it allows for more flexible hypotheses of entry. Compared to the Markowitz method, in which one of the hypotheses refers to the normal distribution of the probabilities for the security profitability, the Crystal Ball software identifies, through the introduced set of data, the most adequate distribution (student, logistic, normal, triangular, rectangular, lognormal, beta, gamma,

exponential, etc.). Moreover, this software does not limit itself to the size of the statistical sample.

Crystal Ball is a Microsoft Office Excel application, meant to analyze the risk (or the chance to succeed) of the models, in uncertainty conditions. This application works and retains the results of some simulations, based on the introduced assumptions regarding the evolution of independent variables. In order to analyze the risk for the SIF portfolio, consisting of the five investment companies, the following steps have been pursued:

1. The same sample of 512 trading days has been used, from 11.11.2005 to 30.11.2007. Because of data comparability matters, in the days in which one of the five SIFs has not been traded, the closing price for the precedent day has been used (i.e. the daily price variation has considered to be zero).
2. The data set has also been adjusted for the situations of special events in the issuers' activity. This was only the case of SIF3, which has approved, in the General Stockholders Assembly, the distribution of free shares, the registering date being 18.05.2007. In 16.05.2007 there was a natural, ex-ante dividend quotation decrease. For this change not to affect the stockholders' portfolios, the variation was forced to zero.
3. The relative price variance compared to the previous session, i.e. $(p_{n+1}-p_n)/p_{n,}$ has been considered as a measure of the daily profitability for the security.
4. The crystal Ball application has identified as the most adequate distributions for the five SIF stocks, the logistic distribution for stocks of SIF1, SIF2, SIF3 and SIF4 and the Student distribution for the daily profitability for the stocks of SIF5 (see Figure 1).

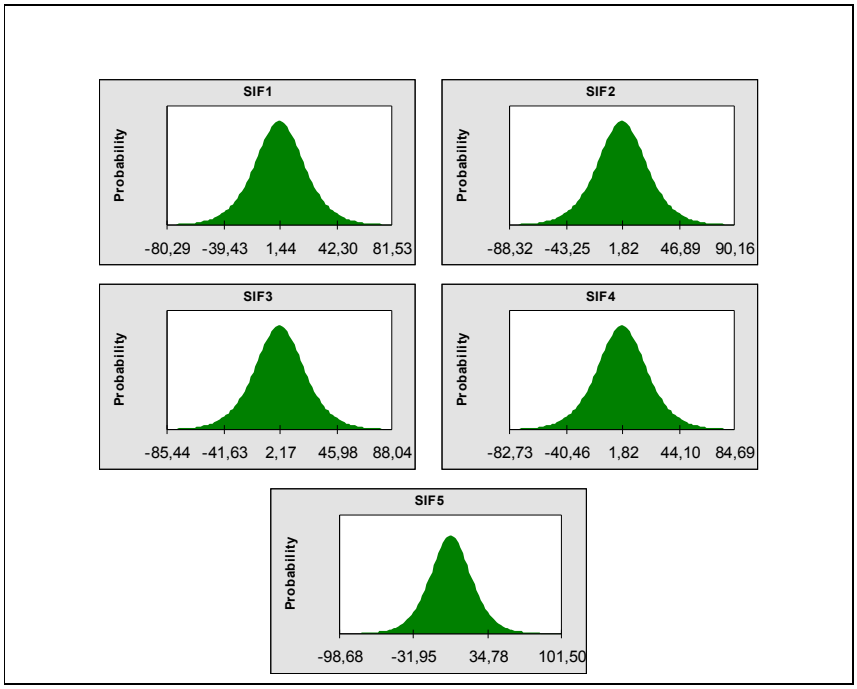


Figure 1. Daily profitability distribution for the SIF stocks

5. The median value has been determined, as a measure of the average profitability and, the standard deviation, as a measure for risk. Correlation coefficients have also been established between the variations of all SIF stocks (table 4):

Table 4. Profitability and risk for the SIF protfolio

	daily		anualized	
Security	**risk [%]**	**profitability[%]**	**risk [%]**	**profitability[%**
SIF1	0,0219	0,0013	35,063	139,68
SIF2	0,0235	0,0013	37,578	138,28
SIF3	0,0240	0,0019	38,322	164,38
SIF4	0,0221	0,0012	35,412	134,34
SIF5	0,0230	0,0014	36,871	143,54

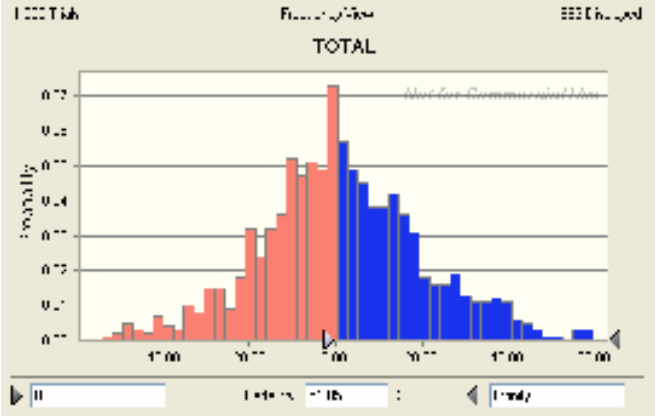
Corelation matrix

	SIF1	SIF2	SIF3	SIF4	SIF5
SIF1	1,000	0,799	0,762	0,786	0,816
SIF2		1,000	0,746	0,745	0,899
SIF3			1,000	0,729	0,753
SIF4				1,000	0,769
SIF5					1,000

6. Next, we have considered a portfolio in which each of the five SIF securities has an equal weight (20%) and it was checked, through the application the results degree of certainty. The final annualized profitability of the portfolio equals the weighted average of the profitability for each SIF, i.e. 43,67% (corresponding to an average daily profitability of 0,142%). Further, the problem of the probability of its achievement and of the level of confidence given to this value is raised.
7. The first step is defining hypotheses for the independent variables. These are the daily profitability of the stocks issued by the five SIFs and, the imposed conditions are:

accepting the distributions identified by the software, with the median and the standard deviation previously determined and the correlation with the other SIF stocks.

8. Next, the Crystal Ball application winds up a pre-established amount of numeric alternatives (Monte Carlo simulation, with a pre-established number of attempts), in accordance with the required hypotheses; they are all retained and centralized.
9. The result is then transposed in a distribution chart of the probabilities of each result, an example being the one in figure 2.



The chart shows us that, given the equal weights for all the five SIF securities, the chance of accomplishment for one portfolio profitability, i.e. 0%, is **51,85%**, at a 95% confidence level, following 1.000 attempts.

Figure 2. Estimation of the result realization probability

10. The final step is the establishment of the optimal portfolio. For this, the decision variables are defined, and the weight of each of the five SIFs in the portfolio. The efficiency frontier is set out considering in each imposed risk sub period, the maximum performance (the objective: return maximization) The results are presented in the risk-profitability diagram in figure 3.

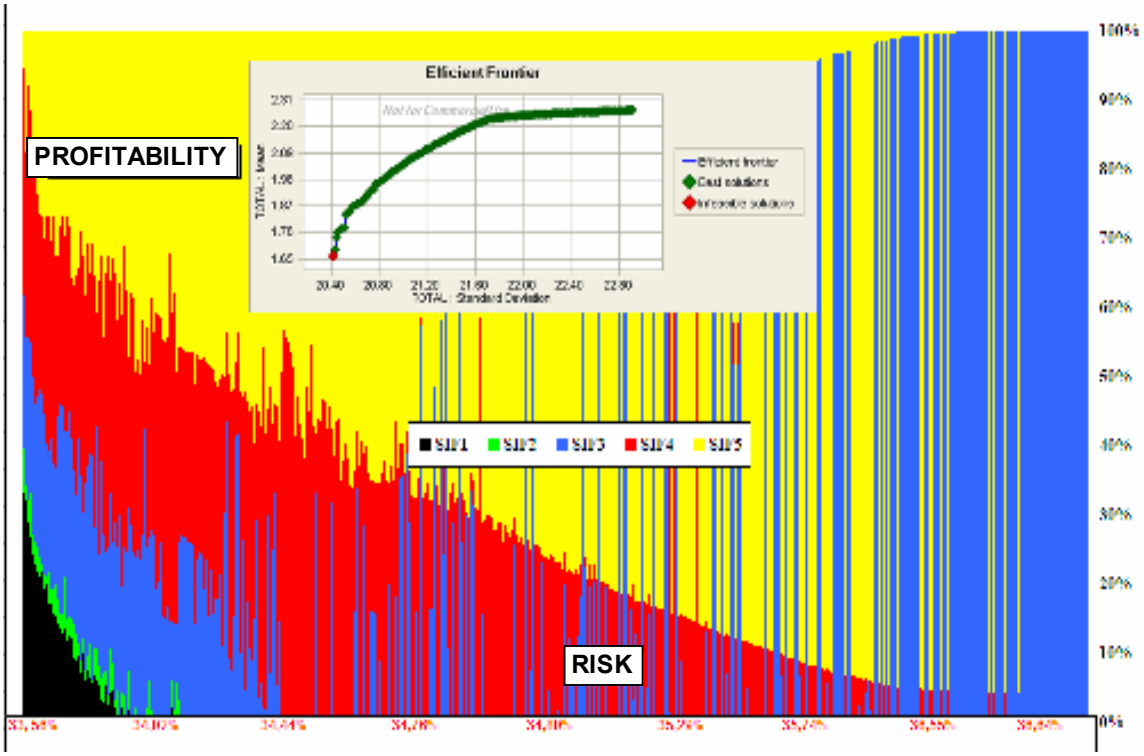


Figure 3. Efficiency frontier for the SIF portfolio

The interpretation of the diagram is as follows:

- the risk sub-periods are defined on the x-coordinate, with a 0,001% step and, the average annual profitability of the SIF portfolio is represented on the y-coordinate,
- at an annual risk level, say **33,56%**, the profitability of the SIF portfolio is **68,3%**, and the weights for the SIF securities are: **10,3%** SIF1, **0,6%** SIF2**, 43,6%** SIF3, 14,4% SIF4 and **31,1%** SIF5,
- data analysis (after 10.000 attempts) shows the insignificant presence of the SIF2 stocks in the portfolio (weight between 0% and 6%) and, the distribution of proportions in favor of two securities : SIF3 and SIF5,
- as it is selected a higher and higher profitability portfolio, there is a decrease in the portfolio diversification, an increase in the associated risk and, we can ascertain that no matter which profitability is higher than 80%, the SIF portfolio is only about procuring only SIF3 securities (!), with a risk level of 37%.

6. Conclusions

Testing the two methods on a portfolio of stocks issued by the Financial Investment Companies has shown the following:

1. The Markowitz method has identified a unique solution defined by the following elements:

- the weights for the five securities: **31%** SIF1, **20%** SIF3, **33%** SIF4 and **16%** SIF5,
- average daily profitability of the portfolio is **0,15%,** with an annualized profitability of **46,8%,**
- standard deviation: 2,046%, at an annual risk of 32,74%.

This raises uncertainties on the methods applicability on portfolio listed on an emerging capital market.

2. Crystal Ball identifies more solutions (efficient portfolios) in the risk range **32,67%** to **37,64%**, with the profitability values between: **42,55%** and **78,61%.** The working hypotheses differ in what regards the methodology used.

A disadvantage is the fact that, for a sufficiently high number of attempts (i.e. 10.000 for the present case), the application is a little unstable, as a 0,01% risk variation modifies the weights of each security in the portfolio.

On the other hand, the optimization depends significantly on the number of attempts: a low number can highly distort the final result.

Nevertheless the advantages are still obvious:

- Crystal Ball is easy to use, requiring normal hardware conditions;
- it is flexible because it allows the selection of the most adequate distribution for the independent variables and does not impose a certain size for the statistic sample;
- it estimates the probability of obtaining a result at a certain confidence level;

3. The results achieved through the two optimization methods are similar. We can state that, in general, the Markowitz model, together with tracking in time the evolution of the

statistical parameters of profitability and risk of the optimized portfolios are useful for efficient portfolio administration.

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