OPPORTUNITIES FOR DETERMINING THE EFFICIENCY CURVE IN THE PORTOFOLIO OF COMPANIES LISTED ON BUCHAREST STOCK EXCHANGE

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Abstract: *This article is organized in four parts. The first part presents theoretical aspects on determining the efficiency curve and the steps to be taken on this. The second part begins with a case study presenting the methods of determining the efficiency curve of a stock portfolio, in the case of several entities listed on the Bucharest Stock Exchange. The third part shows how useful Microsoft Excel is to determine the Markovitz efficiency curve of a stock portfolio. On completion of this work, we present the findings on the methods of determining the Markovitz efficiency curve using Microsoft Excel, and their related interpretations.*

Key words: *portofolio, return, efficiency, border, risk.*

JEL Clasification: *M40, M41*

1. Introduction

The focus of this study is to present functions and econometric models in Excel in order to determine the efficient border of a stock portfolio, listed on the exchange. The application presented in this work is based on a case study, using real data, on five companies listed on the Bucharest Stock Exchange:

- Alumil RomIndustry (ALU)
- Nuclearelectrica (SNN)
- OMV Petrom (SNP)
- Transgaz (TGN)
- SIF Oltenia (SIF5)

The research method used for this case study consists in researching, comparing, analysing and using statistical and mathematical methods for determining the efficiency border of stock portfolio.

„The portfolio profitability depends on separate returns on its component securities and the shares of these securities in the portfolio. No matter how we combine and diversify the securities in a portfolio, we will not be able to get a return higher than it is expected, one of the titles' highest return.

The Markovitz diversification model leads to identifying these risky securities portfolios, which offer the maximum of expected return for the amount of risk incurred by capital investors, depending on their behavior (aversion or preference) to risk. Efficient border starts with the minimal risk portfolio assumed by the investors, showing the greatest aversion to risk"[1].

2. Theoretical aspects on determining the markovitz efficiency curve

Choosing the investment portfolio for the stock exchange, is based on the analysis of data provided by the financial statements at a certain point, the instruments used in making investment decisions being basic analysis and technical analysis. In the choice of investment portfolio should be sought the option which combines exchange traded securities and thus, make investors a gain as a result of their investment, under specific risk on stock exchanges.

The section aiming the portfolio's efficiency is „finding the most efficient combination of securities at a given risk level, namely that the investor is willing to subjectively take. Consequently, geometric formulas of all possible combinations should be searched for, starting with the low-risk one. This research leads to the identification both of the „efficient border” and the portfolio showing „absolute minimum variance”[2].

The determination of the efficient border is an econometric method, allowing investors to place their savings in the portfolio that ensures the proposed profitability in terms of assumed risk.

The steps to be followed for determining the Markovitz efficiency curve for a stock portfolio are as follows:

- ✓ Calculating weekly average rates;
- ✓ Calculating weekly average returns;
- ✓ Calculating a share average return, its risk, share volatility and correlation between the stock and market return;
- ✓ Creating the correlation coefficients matrix of stocks returns, included in the portfolio;
- ✓ Creating covariance matrix of stock returns;
- ✓ Calculating the inverse of covariance matrix;
- ✓ Calculating the share of each vector corresponding to a stock portfolio;
- ✓ Establishing the risk and returns for each portfolio;
- ✓ Creating effective border.

In the following lines, we shall determine the efficiency border for a portfolio, chosen according to returns brought during the previous period, with the risk assumed by the investor for investments on Bucharest Stock Exchange.

3. Opportunities for determining the efficiency curve of the portfolio formed by five actions: Alumil Romindustry, Nuclearelectrica, Omv Petrom, Transgaz, Sif Oltenia, using functions in Microsoft Excel

Based on the theoretical aspects described above, in this paragraph we shall try to create both the optimal portfolio and efficient border for a portfolio of five (random) stocks listed on Bucharest Stock Exchange.

The considered portfolio consists of the following five stocks:

- ➢ Alumil RomIndustry (ALU)
- ➢ Nuclearelectrica (SNN)
- ➢ OMV Petrom (SNP)
- ➢ Transgaz (TGN)
- ➢ SIF Oltenia (SIF5)

The observation period of statistical data covers 27.01.2014 – 23.05.2014. Daily rates of shares used during **the first stage** of the method for determining the Markovitz efficient border, that of calculating weekly average rates, were taken from the newspaper „Bursa”, daily issues of January, February, March, April and May.

The weekly average rates were calculated in Excel by using the *Average Function*, which calculates the arithmetic average of the daily rates. The data are presented in Table 1, which also includes weekly average index BET, calculated with the help of this function as arithmetic average of its daily values.

Table 1. Weekly Average Rates (lei/share)

Week	ALU	SNN	SNP	TGN	SIF5	BET IND
1	0.79166	9.7958	0.4666	181.1346	1.92062	6376.526
2	0.80916	9.15856	0.46512	183.1936	1.96382	6348.852
3	0.602	8.8989	0.46274	186.607	1.96002	6435.384
4	0.78236	8.98834	0.45266	191.0288	1.96178	6427.684
5	0.55936	9.0321	0.44008	190.7756	1.91162	6318.948
6	0.86516	7.14162	0.43428	191.3721	1.93288	6254.562
7	0.7152	8.93398	0.4385	193.0635	1.94582	6264.484
8	0.9279	9.0799	0.43658	195.3982	1.94442	6299.42
9	1.39292	9.33742	0.4326	196.2334	1.95946	6404.812
10	1.46068	9.17726	0.44676	198.3558	1.90682	6455.768
11	1.32704	7.4512	0.35882	163.1322	1.54702	5179.43
12	1.37168	7.6018	0.35966	162.3564	1.52108	5183.962
13	0.69294	1.88858	0.0887	79.90796	0.72648	2532.048
14	1.68862	9.5417	0.45888	201.2237	1.7606	6492.004
15	1.31386	8.92806	0.44734	198.6936	1.82276	6502.606
16	1.06678	8.30218	0.43034	191.6124	1.8314	6416.266

Source: authors' processing

As a general trend of the data above, there is a decrease in the rates of the 5 analysed sares, during the last of the period considered.

The second stage involves calculating the weekly average returns of the shares, taken into account by using the formula:

$$r_{i,t} = \frac{c_{i,t} - c_{i,t-1}}{c_{i,t-1}} * 100$$

, where $r_{i,t}$ – return on security i during the week t

c_i – the share rate i

t – week

The data are summarized in Table 2 below.

Table 2. Weekly Average Returns (%)

Week	ALU	SNN	SNP	TGN	SIF5	BET IND
1	-21.86	-4.31	-1.06	-1.19	-1.12	-1.06
2	2.210545	-6.50524	-0.31719	1.136724	2.249274	-0.434
3	-25.60186	-2.83516	-0.5117	1.863308	-0.1935	1.362955
4	29.96013	1.005068	-2.17833	2.369546	0.089795	-0.11965
5	-28.5035	0.486853	-2.77913	-0.1325	-2.55686	-1.69168
6	54.66962	-20.9307	-1.31794	0.312629	1.112146	-1.01894
7	-17.33321	25.09739	0.971723	0.883859	0.669467	0.158636
8	29.73993	1.633315	-0.43786	1.20926	-0.07195	0.557684
9	50.11531	2.836155	-0.91163	0.427476	0.773495	1.673043
10	4.864601	-1.71525	3.273232	1.081528	-2.68645	0.795589
11	-9.149163	-18.808	-19.6839	-17.7578	-18.8691	-19.7705

12	3.363878	2.021151	0.234101	-0.47558	-1.67677	0.0875
13	-49.48239	-75.1561	-75.3378	-50.7824	-52.2392	-51.1561
14	143.6892	405.2314	417.3393	151.8193	142.3467	156.3934
15	-22.19327	-6.43114	-2.51482	-1.25736	3.530615	0.163309
16	-18.80566	-7.01026	-3.80024	-3.56388	0.474006	-1.32778

Source: authors' processing

Based on the table above, the **third step** is performed: calculating a share average return, its risk, share volatility and correlation between the stock and market return. To calculate the share average return, we have used the *Average Function* in Microsoft Excel. To measure the share risk (ECART column) the classical formula of square mean deviation was used, namely: $\sigma_i = \sqrt{\frac{\sum_{t=1}^{16}(r_{i,t} - \overline{r_i})^2}{16}}$

The share volatility i (BETA column) was determined using the following mathematical formula: $\beta_i = \frac{\sigma_{iM}}{\sigma_M^2}$, where

σ_{iM} – covariance between the share return i and the market profitability

σ_M^2 - market risk (dispersion/variance)

The covariance between the share return i and the market profitability was determined by using the *Covar Function* in Excel. The columns: share return and market profitability were selected, in our case the BET profitability, and the result was divided by the value of BET index – ECART.

The correlation between the share return i and the market profitability (COREL-BET columns) was calculated by using the *Pearson Function*, which renders the correlation coefficient between the two variables. The results are sown in table 3.

Table 3. General data on market and shares

	RTB(%)	Ecart(%)	correl-BET	BETA
ALU	7.855262	45.14	0.829245	37.4377
SNN	18.41309	101.86	0.986268	100.4785
SNP	19.43549	104.33	0.989078	103.2243
TGN	5.371512	39.93	0.999504	39.91446
SIF5	4.489475	37.96	0.998441	37.91024
BET – 10	5.29	41.1		

Source: authors' processing

The shares average return, analysed in this work, range from the lowest value of 4.48 percent (SIF 5) to the highest 19.43% (SNP). To a SNP share return of 19.43% corresponds a risk of 104.33%, therefore we may say that this is the highest-risk share. Other high-risk share is SNN (101.86%) to a return of 18.41%. One may see that the higher the rate of return increases, the degree of risk associated with the share also increases. The risk associated with the stock market index is 41.1%, situated between the lowest and the ighest risk of the five actions which it covers.

The share with the greatest volatility is also SNP with 103.22%. The correlation coefficient with the market of this share is very close to 1, which means that systematic risk is high and specific risk is almost zero. It is recommended to increase the share of this stock in the portfolio when the BET value increases, and vice versa. All shares show returns which are directly proportional with the market return. The weakest correlation with the market may be seen in the case of ALU share.

The next stage, **stage four**, creating the correlation coefficients matrix of stocks returns, included in the portfolio, is used to assess the degree to which the risk of a given stock portfolio is reduced as a result of diversifying its structure. To calculate the correlation coefficients of the stock returns, the *Pearson Function* was used, for each type of correlation: ALU-ALU, ALU-SNN, ALU-SNP, SNP-TGN, TGN-SIF5 etc.

Table 4. The Matrix of Correlation Coefficients

correl 2014	ALU	SNN	SNP	TGN	SIF5
ALU	1	0.799	0.815	0.833	0.829
SNN	0.799	1	0.996	0.985	0.979
SNP	0.815	0.996	1	0.988	0.982
TGN	0.833	0.985	0.988	1	0.998
SIF5	0.829	0.979	0.982	0.998	1

Source: authors' processing

All correlations are positive. Due to the diversification of the stock portfolio, these positive correlations increase its risk. The closest correlation shows TGN to the other portfolio shares.

Stage five involves creating covariance matrix of stock returns, in the form of the matrix C. for setting covariance between the shares returns included in the portfolio, by using *Covar Function* for each covariance: ALU-ALU, ALU-SNN, ALU-SNP, ALU-TGN, ALU-SIF5, SNN-SNN, SNN-SNP, SNN-TGN, SNN-SIF5, SNP-SNP, SNP- TGN, SNP-SIF5, TGN-TGN, TGN-SIF5, SIF5-SIF5. The columns related to these returns shall be selected, and then the program automatically generates covariance. These will then move in the form of a matrix, as shown in the table below:

Table 5. Covariance Matrix

C	ALU	SNN	SNP	TGN	SIF5	average r	
ALU	2037.88	3678.57	3842.39	1501.77	1421.05	7.85	1
SNN	3678.57	10377.27	10594.76	4008.36	3787.62	18.41	1
SNP	3842.39	10594.76	10890.04	4117.49	3893.99	19.43	1
TGN	1501.77	4008.36	4117.49	1594.47	1513.12	5.37	1
SIF5	1421.05	3787.62	3893.99	1513.12	1441.43	4.48	1
average r	7.85	18.41	19.43	5.37	4.48	0.00	0
	1	1	1	1	1	0	0

Source: authors' processing

As one may see, for solving the matrix equation we have added a column containing the average return of shares over the analysed period (RTB column, table 3).

The next stage, **stage six**, requires calculating the inverse of covariance matrix. For this step, we use the *Minverse Function*. This function renders the inverse of covariance matrix. One can choose the Minverse function, select the covariance matrix of the share returns table, type Enter then, in the result window the new resulting matrix will be marked with the mouse in Excel, then the combination F2 and Ctrl + Shift + Enter is pressed, and the reverse matrix will be generated automatically. The table below shows the inverse of matrix C.

Table 6. The Inverse of Matrix C

C	ALU	SNN	SNP	TGN	SIF5	average r	
ALU	0.001695	0.002057	-0.0018	-0.0084	0.006448	0.036284	0.059103
SNN	0.002057	0.016167	-0.01488	-0.01089	0.007545	-0.07218	-0.2925
SNP	-0.001798	-0.01488	0.014161	0.001815	0.000701	0.074849	-0.32421
TGN	-0.008402	-0.01089	0.001815	0.171774	-0.1543	0.858614	4.766679
SIF5	0.006448	0.007545	0.000701	-0.1543	0.139602	-0.89757	-3.20907
average r	0.036284	-0.07218	0.074849	0.858614	-0.89757	-10.3669	-28.5997

	0.059103	-0.2925	-0.32421	4.766679	-3.20907	-28.5997	-172.408

Source: authors' processing

The next step to be covered to determine the Markovitz efficient border, involves multiplying the inverse of matrix C with the vector K, whose form is:

$$\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ E(rp) \\ 1 \end{pmatrix}$$

where, E(rp) is the expected return.

Vector K values are shown in the table below:

Table 7. Vector K

K1	K2	K3	K4	K5
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0.059	-0.292	-0.324	4.76	-3.2
1	1	1	1	1

Source: authors' processing

By multiplying these vectors with the inverse of matrix C we obtain the shares of vectors W, **the seventh stage** of the algorithm for determining the Markovitz efficient border. Multiplying two matrices in Microsoft Excel is done using *Mmult Function*. The procedure is identical to that of determining the inverse of a matrix, namely: select the Mmult function, select the two matrices to be multiplied, press Enter, and then mark the space for the new results, and press the combination F2 Ctrl + Shift + Enter, the calculations being generated automatically. As a result of this procedure, the following values of the vectors W were obtained:

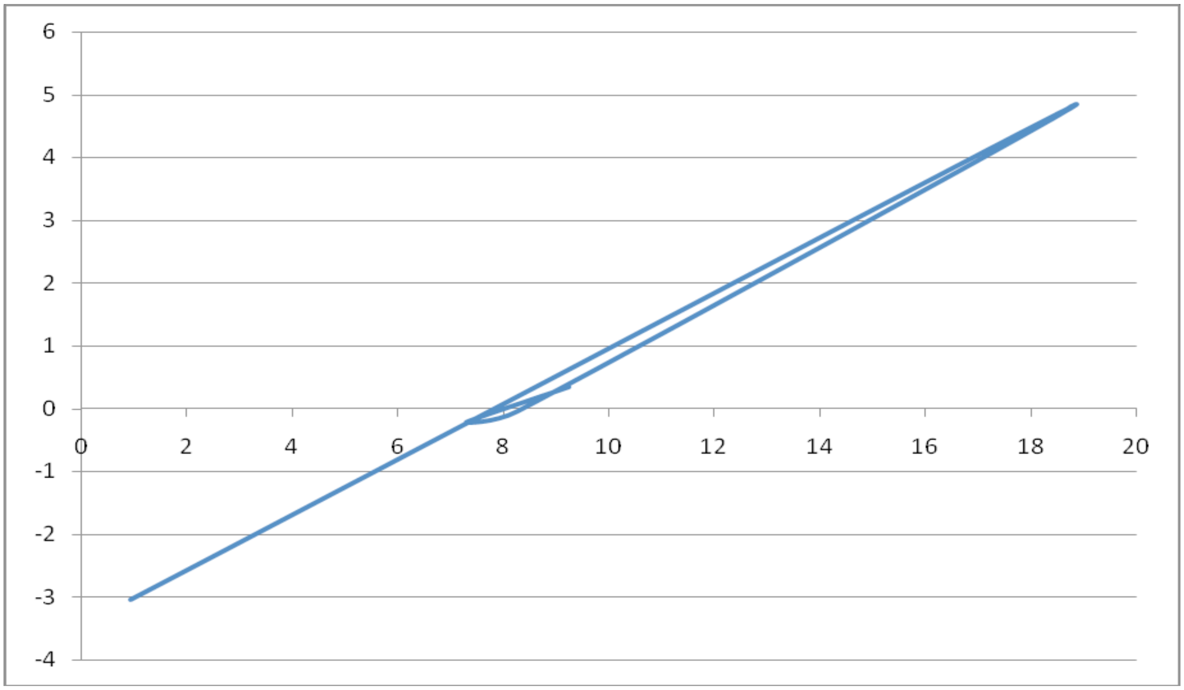
Table 8. Portofolios containing the 5 shares in percentage

	W1	W2	W3	W4	W5
	0.06	0.04	0.04	0.23	-0.05
	-0.29	-0.27	-0.26	-0.63	-0.06
	-0.31	-0.34	-0.34	0.03	-0.56
	4.81	4.51	4.48	8.85	2.01
	-3.26	-2.94	-2.91	-7.48	-0.33
return	0.34	-0.22	-0.05	4.8	-3.05
risk	9.25	7.31	8.27	18.77	0.95
beta	9.5	7.82	8.76	18.04	2.01

The table above shows the return, risk and volatility coefficient determined from the weighted average. The weights related to the shares included in each portfolio are multiplied with the values of return, risk and volatility coefficient of each share included in Table 3 (RTB, ECART and BETA columns), then they are added together. This is **stage eight** in determining the efficiency curve of the stock portfolio.

Based on the data series resulted on the return and risk of the obtained portfolios, efficient border may be created, **the ninth stage** of its determination algorithm.

Title: Efficient border determined by the Markowitz model



Source: authors’ processing

The optimal portfolio offers the best risk-return combination of the efficient border. One may notice that portfolios located on the right of the efficient frontier line provide superior return, but also a higher risk. On the other hand, the portfolios located on the left of the efficient frontier line are ineffective because the rate of return is below the optimal portfolio of investment, portfolios’ risk being much higher than that of the optimal portfolio.

One may also notice that for an increasing expected return, the weights also increase, in the case of ALU, SNP, TGN shares. At the same time, the weights of SIF5 and SNN shares reduce in the portfolio.

The return and risk of optimal portfolio are much lower than those offered by the market portfolio, represented by BET. According to this, under the current conditions of the economy, capital investments on the Romanian market provide, in most of the cases, negative returns.

This directly affects the investor’s earnings, who is forced to turn to other investments, such as bank deposits, treasury bills and bonds. The latter suppose the only viable and profitable investment opportunities until the returns offered by investments in securities will achieve positive and higher values.

4. Final conclusions

Through this study we have achieved our aim namely, determining the efficient border based on Markovitz model by using Microsoft Excel, so that the efficient border of a portfolio randomly chosen may be determined. From the study other types of portfolios may be determined, so that after determining their efficiency border, they will be a useful tool for the investor on the stock market, helping him/her in making investment decisions.

The determination of the efficiency border, together with a fundamental and technical analysis, represents a useful tool for reducing investment risk of participants on Bucharest Stock Exchange.

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