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THE NON-CLASSICAL BREAK-EVEN POINT IN PORTFOLIO SELECTION

Introduction

The purpose of combining portfolio analysis with fundamental analysis lies in the use of the elements of fundamental analysis in the process of constructing the portfolio, as well as in the process of selecting an optimum portfolio. A portfolio thus constructed is appropriate in terms of long-term investment. For this purpose, the article proposes the use of the non-classic concept of the company's break-even point. The concept, together with the securities portfolio, is an extension of the classic analysis of revenues against costs. Hence, the proposal of introducing the term "non-classical break-even point" (*NBEP*).

The first step is to calculate the synthetic measure of development *TMAI* (Taxonomic Measure of Attractiveness of Investment), with the help of economic and financial indicators used in the assessment of the company's economic and financial condition.[1] Then, the 20 best companies in terms of the *TMAI* level have their optimum portfolios constructed for the given rate of return with the use of the Markowitz model. The group of portfolios selected in this way is made up of optimum portfolios lying on the line of effective portfolios. Each portfolio's break-even point is calculated. The analysis of the portfolio's non-classical break-even point constitutes the basis for selecting an optimum portfolio, i.e. the one with the most profitable break-even point. Analyses may be made for groups of companies selected in other ways, for instance for groups from one sector. The study was carried out on companies listed on the Warsaw Stock Exchange within the time period 2005–2009, which made it possible to assess the effectiveness of the procedure. The companies under research belong to the construction sector.

The non-classical break-even point (*NBEP*) method

As mentioned above, the break-even point analysis is based on the relations between the sales, costs and profits in the period when the current level of activity enables the pro-

[1] W. Tarczyński [2002, p. 101–111].

duction of a given quantity of goods. A correct interpretation of the break-even point requires, however, certain assumptions[2]. The most important ones are:

– only one assortment of products is manufactured (for which the volume of production is known),
– there is an unambiguous division of total costs into fixed and variable costs,
– total costs and total revenues are linear functions of the production volume (i.e. variable costs per unit and selling prices per unit are constant).

In practice, it often happens that the information on unambiguous division of costs into fixed and variable is unavailable.[3] Moreover, while estimating the break-even point in companies manufacturing a variety of assortments, the sales are always regarded as a total amount. In such cases the only information available is the data on the values of sales and total costs.

To solve this problem, we may find an empirical regression of the revenues *P* related to total costs *K*:

$$P = \alpha_0 + \alpha_1 K + U, \tag{1}$$

$$\alpha_0 \leq 0, \tag{2}$$

$$\alpha_1 \geq 1. \tag{3}$$

Employing the estimates α_0 and α_1 from the revenues model (1) and bearing in mind that the break-even point is the production quantity or value assuring the equation $K = P$ is true, we can calculate the empirical non-classical break-even point applying the following formula:

$$P_0 = \frac{\hat{\alpha}_0 \cdot P}{P - P \cdot \hat{\alpha}_1} = \frac{\hat{\alpha}_0 \cdot P}{P \cdot (1 - \hat{\alpha}_1)} = \frac{\hat{\alpha}_0}{1 - \hat{\alpha}_1}. \tag{4}$$

Graphically, the non-classical break-even point is a break-even line (compare: Figure 1), which is a bisector of the angle in the first quarter of the co-ordinate system, meeting the assumption $K = P$. In the case when the total revenue function appears below the break-even line the company is in the profitability area (margin of safety), otherwise it is unprofitable.

[2] M. Gazińska, W. Tarczyński [1997, p. 61].

[3] Data made widely available (e.g. to investors) by the companies listed on the Warsaw Stock Exchange does not include the division of costs into fixed and variable costs. This division is impossible to assess on the basis of the information from basic financial reports provided (balance sheet and profit and loss account),.

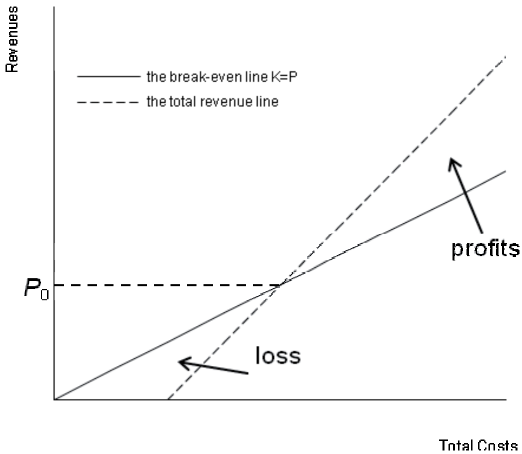

Fig. 1. The non-classical break-even point – the revenue function related to the total cost, and the break-even line

Source: own research.

While calculating the non-classical break-even point (4) on the basis of the econometric model of revenues related to the total costs we use the estimators of the structural parameters of the revenues function. Therefore, so calculated a break-even point is only an estimate. The error made while accepting this measure may be estimated by the calculation of the non-classical break-even point of a certain profit and the non-classical break-even point of a certain loss.[4]

The non-classical break-even point of a certain profit is calculated on the basis of the identification of an estimated function of revenues related to total costs (1), lessened by the standard deviation of the random component in the revenues model – S:

$$P^{(-)} = \hat{\alpha}_0 + \hat{\alpha}_1 K - S \tag{5}$$

and taking the condition $K = P$ into consideration. As a result we have:

$$P_s = \frac{\hat{\alpha}_0 - S}{1 - \hat{\alpha}_1}. \tag{6}$$

The non-classical break-even point of a certain loss may be calculated in a similar way:

$$P^{(+)} = \hat{\alpha}_0 + \hat{\alpha}_1 K + S, \tag{7}$$

[4] For more on certain accumulation and certain deficit for the total cost and revenue functions see: E. Hozer [1976] and J. Hozer [1993, p. 91].

i.e.:

$$P_z = \frac{\hat{\alpha}_0 + S}{1 - \hat{\alpha}_1}. \tag{8}$$

Graphically, the non-classical break-even point of a certain profit and certain loss (compare: Figure 2) defines a critical interval (P_s, P_z), below which there is an area of certain losses and above which there is an area of certain profits.

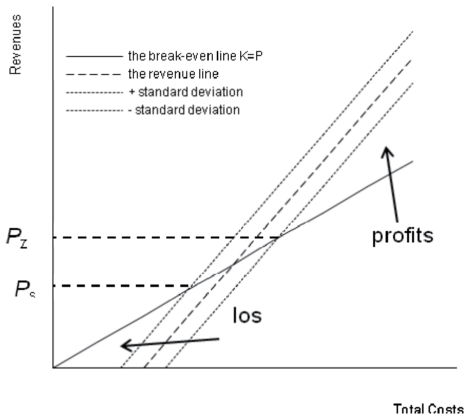

Fig. 2. The non-classical break-even point of a certain profit and certain loss

Source: own research.

We should also bear in mind that this approach does not require knowledge on production as a quantity. The only assumptions which have to be met are the linearity of the costs-revenues relation and the assumptions (2) and (3). Such estimations of the break-even point are of high usefulness as the calculations may be based only on the data included in financial reports (profit and loss account prepared at the end of each month, quarter of a year or a year) and no other detailed data is necessary.

Diagnostic function *NBEP* method

There are several problems that can be encountered in empirical research. One of them concerns the assumptions (2) and (3). Very often when the data at our disposal takes the form of a time series of revenues and total costs in a particular company, the parameters of the estimated revenue function (1) do not meet those two assumptions.

Therefore, the next step in our study should be to analyse the revenue function in detail. Many researchers and practitioners in the field of economics assume that one of the best revenue functions describing those revenues in relation to the total cost is the s- shapely function (compare: Figure 3).[5]

Three basic phases[6] may be distinguished in the variation of the revenues function. They may be approximated by linear functions:

- Phase 1 – development
- Phase 2 – optimal
- Phase 3 – negative effects of scale.

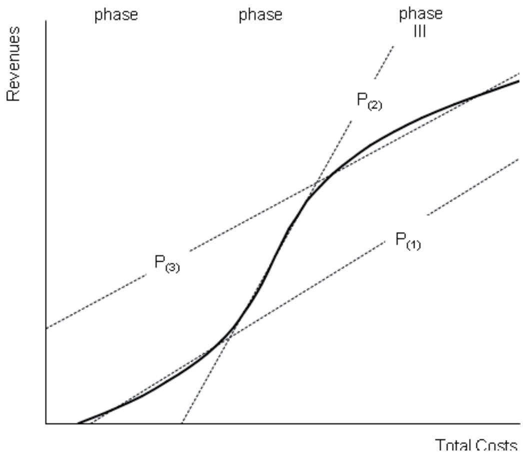

Fig. 3. The revenue function and its linear estimation in three phases of variation

Source: own research.

Taking the effects of scale into account, we can state that the first and the second phase represent the economies of scale, while the third one signifies the lack of them[7]. In order to identify all the phases of the variation of revenues, an analysis of the structural parameters of linear revenue functions can be carried out.

Assume the following revenue functions:

- phase I $P_{(1)} = \alpha_{01} + \alpha_{11}K,$ (9)
- phase II $P_{(2)} = \alpha_{02} + \alpha_{12}K,$ (10)
- phase III $P_{(3)} = \alpha_{03} + \alpha_{13}K.$ (11)

Then the structural parameters of the functions (9)-11) meet the following assumptions:

$$\alpha_{02} < \alpha_{01} < \alpha_{03}, \quad \alpha_{03} > 0, \quad \alpha_{01}, \alpha_{02} \leq 0 \qquad (12)$$

[5] R.G.D. Allen [1938, p. 117–121]; A. Barczak [1971, p. 37]; S. Kruszyński [1962].

[6] J. Hozer [1993, pp. 114–115.

[7] J. Hozer, M. Gazińska [1995].

$$\alpha_{12} > \alpha_{11} > \alpha_{13}, \quad \alpha_{12} > 1, \quad \alpha_{11} \approx 1, \alpha_{13} < 1. \tag{13}$$

Based on the relations (12) and (13) we may state that the interpretation of the non-classical break-even point (meeting the conditions (2) and (3)) is correct only in the optimal phase.

In the development phase, when the α_{11} parameter oscillates around 1, the non-classical break-even point tends to infinity:

$$\lim_{\alpha_{11} \to 1+} P_0 = \lim_{\alpha_{11} \to 1+} \left(\frac{\alpha_{01}}{1-\alpha_{11}} \right) = -\infty, \quad when\, \alpha_{01} > 0. \tag{14}$$

Graphically, the revenue function becomes the break-even line (i.e. the revenues are equal to total costs regardless of the value of the preceding). A practical remark – when the break-even point is estimated with the employment of formula (4), the high value of the break-even point may signify that the company is in its development phase, or (especially in small companies) it may point to cost-creating performance.

In the third phase of the variation of the revenue function, if the estimated α_{03} parameter takes positive values, while the estimated α_{13} parameter is lower than 1, then this is contradictory to assumptions (2) and (3). The calculation of the break-even point in such a case seems to be paradox, although P_0 (calculated according to formula (4)) takes negative values. Graphically (see: Figure 4) the non-classical break-even point P_0 would represent the maximum value of production that is still profitable.

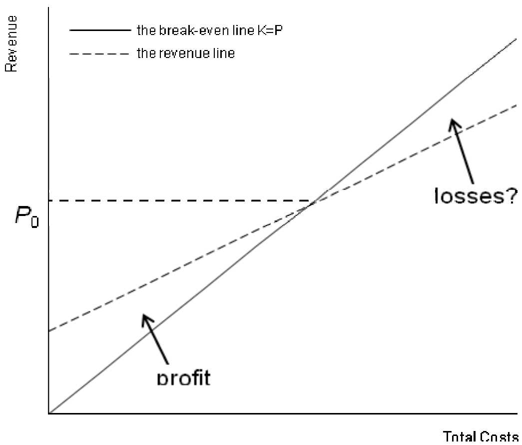

Fig. 4. The revenue function related to the total costs when conditions (6) and (7) are not met, and the break-even line

Source: own research.

Which solution can be proposed in the case when the total costs indicate to the development phase while the break-even point takes high positive values (tends to infinity) or when the variation of total costs signifies the wastefulness (negative economies of scale) while the application of the break-even point leads to seemingly contradictory conclusions?

The first conclusion arising after the analysis above is that a correct application and interpretation of the break-even point is possible only if the company is in the optimal phase. This seems to be a trivial conclusion, as it seems trivial that this is exactly the phase when the company is profitable.

While analysing phase 1 (development phase) the factors affecting the break-even point ought to be examined. In this case it should be checked whether the company is really in the development phase and whether the company generates high costs – if so, the structure and value of all cost types should be examined in detail.

If the phase is identified as a wastefulness phase, the following analytical procedures are suggested. First of all, the structural parameters of the revenue function should be evaluated. If parameter α_0 is slightly above zero while the α_1 parameter slightly below 1, the break-even point of a certain profit and certain loss should be calculated, since it may turn out that such variation of the total revenues may take place in the development phase.[8] Very high positive values of the parameter α_0 and very high negative values of parameter α_1 indicate the phase of increasing wastefulness.

The article proposes the employment of the non-classical break-even point in the portfolio analysis. After constructing a set of effective portfolios on the basis of the Markowitz model, the next issue is the choice of an optimum portfolio for the investor. Reference books mention a number of methods. The easiest one involves the selection of the portfolio for which the ratio of the expected rate of return to the expected risk is the smallest (the portfolio's coefficient of random variation). The proposal pursued in the article is aimed at calculating the non-classical break-even point for each effective portfolio and selecting the portfolio whose non-classical break-even point is the lowest.

Empirical analyses

The analysis was made on the basis of companies of the construction sector listed on the Warsaw Stock Exchange. The set constitutes 18 companies selected out of 43 (economic and financial data necessary to calculate the non-classical break-even point was available only for this number of companies). For each company and for the entire sector, the non-classical break-even point was calculated according to the procedure described earlier in the article (the calculations were made upon the yearly data for the 2001–2005 time period). The Markowitz model was then used to construct the line of effective portfolios for all companies in the construction sector, based on weekly rates of return for 2005. The evaluation

[8] Such a situation may take place when the company incurs significantly higher costs than the realised revenues.

of effectiveness was applied to portfolios chosen by the most favorable relation of expected risk and expected rate of return, as well as the most profitable portfolio with regard to the non-classical break-even point, as weighted and unweighted.

For years 2001–2005, revenue functions were estimated for the construction sector and individual construction companies listed on the Warsaw Stock Exchange (Table 1).

Table 1

Estimated models of revenues for the research stock companies

Company	$\hat{\alpha}_0$	$\hat{\alpha}_1$	R^2	S	F
1	2	3	4	5	6
Sector	0,662 p = 0,7070	1,092 p = 0,0000	0,9951	13,791	20994,54 p = 0,0000
Budopol	2,208 p = 0,6397	0,940 p = 0,0027	0,9656	2,647	84,151 p = 0,0027
Budimex	-36,542 p = 0,6808	1,179 p = 0,0061	0,9416	35,446	48,397 p = 0,0061
Elbudowa	29,732 p = 0,1016	0,976 p = 0,0003	0,9916	4,566	356,050 p = 0,0003
Elkop	1,484 p = 0,1692	1,030 p = 0,0009	0,9841	0,879	185,404 p = 0,0009
Energoap	1,350 p = 0,6145	1,091 p = 0,0009	0,9839	2,579	183,523 p = 0,0009
Energopl	10,138 p = 0,1862	0,843 p = 0,0139	0,8999	2,500	26,956 p = 0,0139
Enmontpd	-6,453 p = 0,4466	1,167 p = 0,0003	0,9913	1,808	342,754 p = 0,0003
Instal_K	-1,854 p = 0,4154	1,083 p = 0,0000	0,9994	0,757	4654,506 p = 0,0000
Instal_L	-1,276 p = 0,6694	1,096 p = 0,0004	0,9905	2,282	314,201 p = 0,0004
Most_exp	-9,034 p = 0,3086	1,119 p = 0,0004	0,9903	6,708	305,136 p = 0,0004
Most_pk	-5,698 p = 0,7649	1,156 p = 0,0101	0,9185	5,089	33,826 p = 0,0101
Most_zab	3,731 p = 0,8264	1,072 p = 0,0005	0,9888	19,151	264,066 p = 0,0005
PBG	13,563 p = 0,0852	1,138 p = 0,0000	0,9974	4,065	1166,356 p = 0,0000
Pemug	19,190 p = 0,1134	0,724 p = 0,0141	0,8987	3,989	26,607 p = 0,0141
Polimex	32,292 p = 0,1081	1,063 p = 0,0000	0,9990	15,070	2989,626 p = 0,0000
Prochem	8,412 p = 0,0183	1,027 p = 0,0000	0,9999	2,891	22075,5 p = 0,0000

1	2	3	4	5	6
Projprzm	7,881 p = 0,0663	1,143 p = 0,0000	0,9963	1,503	818,977 p = 0,0000
Ulma	-55,508 p = 0,2866	2,378 p = 0,0601	0,7432	8,715	8,684 p = 0,0601

Source: own research.

The estimated parameters of revenue models were used to calculate the non-classical break-even point for the construction sector (Figure 5) and for individual companies (Table 2).

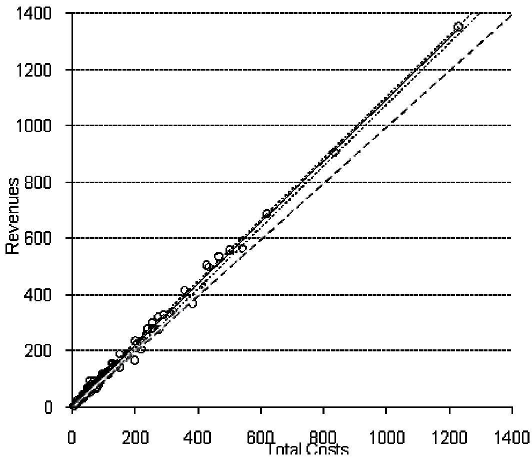

Fig. 5. The non-classical break-even point for the construction sector

Source: own research.

Table 2

The non-classical break-even points (PLN mil) for researched stock companies

Company	Non-classical break-even point according to formula		
	(4)	(6)	(8)
1	2	3	4
Sector	–7,196	142,707	–157,098
Budopol	36,800	–7,317	80,917
Budimex	204,145	402,168	6,123
Elbudowa	1238,833	1048,583	1429,083

1	2	3	4
Elkop	–49,467	–20,167	–78,767
Energoap	–14,835	13,505	–43,176
Energopl	64,573	48,650	80,497
Enmontpd	38,641	49,467	27,814
Instal_K	22,337	31,458	13,217
Instal_L	13,292	37,063	–10,479
Most_exp	75,916	132,286	19,546
Most_pk	36,526	69,147	3,904
Most_zab	–51,819	214,167	–317,806
PBG	–98,283	–68,826	–127,739
Pemug	69,529	55,076	83,982
Polimex	–512,571	–273,365	–751,778
Prochem	–311,556	–204,481	–418,630
Projprzm	–55,112	–44,601	–65,622
Ulma	40,282	46,606	33,957

The darkened fields show information on companies in the III phase of the function of revenues (adverse effects of the scale). The red font marks companies that were profitable in the entire period of the changeability regardless of all-in costs ("without the break-even point").

Source: own research.

On the basis of the assessed values of break-even points, it is possible to assign 3 groups of companies. The first group consists of firms with negative value of the break-even point, which, given values for α_1 greater than unity means that the firm is profitable in the whole area of volatility. The second group formed a company, which are characterized by a seeming break-even point – these are companies, for which the value α_1 as a function of revenues is less than unity, suggesting that the negative effects of scale – these are companies with high risk. The third group consists of firms with positive value of the break-even point, which, given values for α_1 greater than unity means a company with a low risk of loss of viability.

For companies in the construction sector, portfolios have been constructed on the basis of data for 2005 (weekly rates of return) with the employment of the Markowitz model. Table 3 presents the portfolio parameters – the expected rate of return and expected risk. Figure 6 is a graphic representation of data from table 3. With the use of the *NBEP*, a selection should be made of a portfolio with the lowest break-even point which ought to be relatively the quickest in generating profits.

Table 3

Percentage composition of portfolio from the Markowitza model with parameters (rate of return, risk and portfolio's coefficient of random variation)

	Budopol	Budimex	Elbudowa	Elkop	Energoap	Energopl	Enmontpd	Instal_K	Instal_L	Most_exp	Most_pk	Most_zab	PBG	Pemug	Polimex	Prochem	Projprzm	Ulma
Portfolio 1	0,0036	0,1827	0,1628	0,0059	0,0152	0,0000	0,0000	0,0268	0,0000	0,0824	0,0695	0,0269	0,1000	0,0446	0,1223	0,0763	0,0809	0,0000
Portfolio 2	0,0190	0,0927	0,1353	0,0000	0,0090	0,0107	0,0062	0,0000	0,0205	0,0266	0,0808	0,0602	0,1566	0,0539	0,1456	0,0635	0,1193	0,0000
Portfolio 3	0,0475	0,0000	0,0000	0,0000	0,0000	0,0552	0,0029	0,0000	0,0555	0,0000	0,0966	0,1030	0,1852	0,0197	0,2113	0,0000	0,1785	0,0445
Portfolio 4	0,0964	0,0000	0,0000	0,0000	0,0000	0,0639	0,0000	0,0000	0,1108	0,0000	0,0164	0,1675	0,0000	0,0000	0,2203	0,0000	0,1818	0,1429
Portfolio 5	0,1700	0,0000	0,0000	0,0000	0,0000	0,0397	0,0000	0,0000	0,1704	0,0000	0,0000	0,2297	0,0000	0,0000	0,0959	0,0000	0,0420	0,2523
Portfolio 6	0,2695	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,1571	0,0000	0,0000	0,2018	0,0000	0,0000	0,0000	0,0000	0,0000	0,3715
Portfolio 7	0,3931	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0606	0,0000	0,0000	0,0576	0,0000	0,0000	0,0000	0,0000	0,0000	0,4887
Portfolio 8	0,5835	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,4165
Portfolio 9	0,8380	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,1620
Portfolio 10	0,9908	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0092

	Portfolio's coefficient of random variation V_p	Expected rate of return of portfolio R_p	*Expected risk of portfolio S_p*
Portfolio 1	2,6189	0,0069	0,0179
Portfolio 2	1,9420	0,0100	0,0194
Portfolio 3	1,7767	0,0150	0,0267
Portfolio 4	2,1149	0,0200	0,0423
Portfolio 5	2,5615	0,0250	0,0640
Portfolio 6	2,9957	0,0300	0,0899
Portfolio 7	3,4795	0,0350	0,1218
Portfolio 8	3,9871	0,0400	0,1595
Portfolio 9	4,6976	0,0450	0,2114
Portfolio 10	5,1350	0,0480	0,2465

Source: own research.

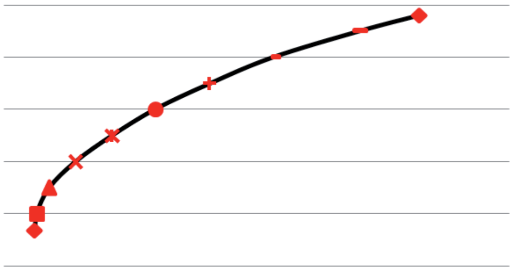

Fig. 6. Line of effective portfolio received on the basis of the Markowitz model (calculated on the basis of data from the table 3).

Source: own research.

Next, revenue functions (Table 4) and values of break-even points (Table 5) were estimated for the set of portfolios.

Table 4

Estimated models of revenues for the researched portfolios

Portfolio	$\hat{\alpha}_0$	$\hat{\alpha}_1$	R^2	S	F
Portfolio 1	1,670 p = 0,3687	1,096 p = 0,0000	0,997	12,625	23915,667 p = 0,0000
Portfolio 2	2,005 p = 0,2875	1,095 p = 0,0000	0,997	12,598	23313,748 p = 0,0000
Portfolio 3	4,070 p = 0,0318	1,096 p = 0,0000	0,998	11,140	21471,563 p = 0,0000
Portfolio 4	3,731 p = 0,0777	1,095 p = 0,0000	0,998	11,060	21687,973 p = 0,0000
Portfolio 5	4,431 p = 0,0638	1,094 p = 0,0000	0,998	11,635	19392,172 p = 0,0000
Portfolio 6-7	3,065 p = 0,3836	1,078 p = 0,0000	0,988	11,494	1536,531 p = 0,0000
Portfolio 8-10	–18,143 p = 0,2358	1,577 p = 0,0007	0,780	10,325	28,284 p = 0,0007

Source: own research.

As it may be seen from the data presented in Table 4, the degree to which the empirical data fit model (1) is very high, which guarantees the correctness of the proposed method of selecting the optimum portfolio. The best portfolios from the point of view of the *NBEP* have been highlighted in Table 5 (Portfolios 3 and 5).

Table 5

The non-classical break-even points (PLN mil) for researched portfolios

Company	Non-classical break-even point according to formula		
	(4)	(6)	(8)
Portfolio 1	–17,469	114,570	–149,508
Portfolio 2	–21,033	111,122	–153,188
Portfolio 3	–42,312	73,488	–158,111
Portfolio 4	–39,214	77,027	–155,455
Portfolio 5	–46,892	76,247	–170,032
Portfolio 6–7	–39,447	108,491	–187,386
Portfolio 8–10	31,443	49,338	13,548

Source: own research.

Figures 7–8 present the break-even points for selected portfolios.

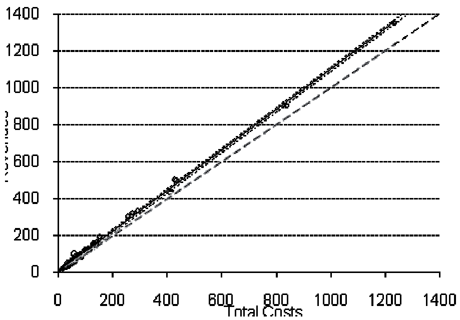

Fig. 7. *NBEP* for Portfolio 3
Source: own research.

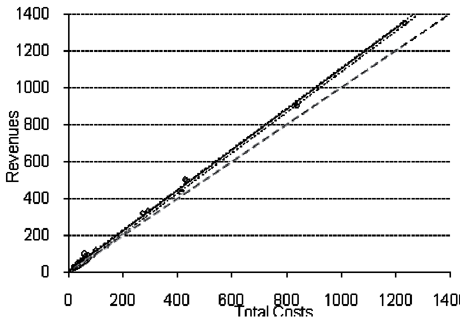

Fig. 8. *NBEP* for Portfolio 5
Source: own research.

For individual portfolios weighted break-even points were estimated – presented as shares of individual companies in the portfolio (Table 6).

For all constructed portfolios, rates of return were determined for the years 2006–2009 and for the day of March 19th 2010. Considering the coefficient of random variation, the optimum portfolio appears to be portfolio 3. When taking into account the portfolio's break-even point, the optimum portfolios are portfolios 3 and 5, whereas if the weighted break-even point is considered – portfolios 3 and 4 are indicated. The purchase of portfolios for the purpose of comparison was made in the last listing in 2005.

Table 6

The weighed non-classical break-even points (PLN mil) for researched portfolios

Company	Non–classical break–even point according to formula		
	(4)	(6)	(8)
Portfolio 1	148,923	209,479	88,367
Portfolio 2	77,526	136,809	18,242
Portfolio 3	–128,829	–42,025	–215,634
Portfolio 4	–116,114	–18,160	–214,069
Portfolio 5	–42,138	39,848	–124,124
Portfolio 6	16,516	64,388	–31,356
Portfolio 7	31,974	34,476	29,471
Portfolio 8	38,250	15,145	61,356
Portfolio 9	37,364	1,418	73,310
Portfolio 10	36,832	–6,818	80,483

Source: own research.

Table 7

Rate of return from portfolios in years 2006–2009 and for 2010.03.19

Rate of return	2006	Ranks 06	2007	Ranks 07	2008	Ranks 08	2009	Ranks 09	2010	Ranks 10	Average
Portfolio 1	162%	8	260%	8	104%	1	127%	1	150%	1	4
Portfolio 2	170%	7	262%	7	102%	2	121%	2	140%	2	**4**
Portfolio 3	205%	5	269%	6	59%	3	82%	3	97%	3	4
Portfolio 4	218%	3	290%	5	16%	4	52%	6	62%	5	5
Portfolio 5	221%	1	345%	3	15%	5	59%	4	64%	4	3
Portfolio 6	212%	4	384%	2	6%	6	56%	5	56%	6	5
Portfolio 7	221%	2	387%	1	–18%	7	39%	7	30%	7	**5**
Portfolio 8	171%	6	297%	4	–40%	8	8%	8	–1%	8	**7**
Portfolio 9	66%	9	111%	9	–63%	9	–40%	9	–43%	9	**9**
Portfolio 10	3%	10	0%	10	–76%	10	–69%	10	–68%	10	**10**
WIG20	24%		30%		–33%		–10%		–8%		

Source: own research.

In the period up until the crisis, for the years 2006-2007, the highest factual rates of return were achieved by portfolios 7 (387 %), 6 (384 %) and 5 (345 %). These rates greatly exceeded the rate of return of the W*IG20* stock index (30%). However, considering the entire studied period from 2006 to 2010, the highest rates of return were obtained by portfolios 1 (150%), 2 (140%) and 3 (97%). These portfolios achieved better results than the *WIG20* stock index (–8%). This is of great importance since the study is comprised of companies from the construction sector, where the crisis first started.

Taking into account the weighted rank calculated out of the ranks for each year, portfolios 5 (64%), 1 (150%) and 2 (140%) turned out to be the most profitable. Portfolios chosen on the basis of the non-classical break-even point, weighted and unweighted, for each year from the 2006–2010 period were significantly better than the *WIG20* stock index. This confirms the validity of employing the portfolio's non-classical break-even point *NBEP* as a tool for choosing an optimum portfolio.

During the analysis of the remaining portfolios, it turned out that the portfolios that achieved lower results than the WIG20 stock index were portfolios 10 (–68%) and 9 (–43%).

Studying the expected rates of return and the expected risk for the analyzed portfolios (Figure 6), it can be clearly seen that aggressive portfolios constructed with the use of the Markowitz model always achieve results worse than the *WIG20* stock index.

Conclusion

The article proposes a method of selecting an optimum portfolio from the line of effective portfolios constructed according to Markowitz. The proposal relies on the use of non-classical break-even point set for the securities portfolio. The selection of an optimum portfolio from the group of all effective portfolios is made on the basis of the portfolio's most favorable (lowest) break-even point. In addition, in the case of a specific group of companies with which the portfolio is constructed, one can set the benchamark break-even point for all the companies and portfolios. Thus, a new analytical tool is created, facilitating the assessment of securities portfolios and the selection of the optimum one.

Studies carried out on companies of the construction sector listed on the Warsaw Stock Exchange for 2005–2010, confirm the validity of the course of research. The portfolios indicated by the non-classical break-even point clearly exceed the *WIG20* stock index both in the bull market period (2006–2007) and the bear market period (2008–2009 crisis).

It is interesting to note that it would not be profitable to invest in the aggressive portfolios using the Markowitz method. The studies confirm that the portfolio's coefficient of random variation has high practical value as a tool for selecting an optimum portfolio.

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Summary

The paper presents the use of non-classical break-even point (*NBEP*), both in the process of building a portfolio, and also in the process of choosing an optimal one. This method involves selecting the optimal portfolio from the proposed portfolios constructed using the Markowitz model.

The method has been verified by data from construction sector companies listed on the Warsaw Stock Exchange in 2005–2010. The portfolios indicated by the non-classical break-even point clearly exceed the *WIG20* stock index both in the rise period (2006–2007) and the fall period (2008–2009 crisis).

The proposal is based on the use of non-classical break-even point for the portfolio of identified securities. Out of all the optimized portfolios, the most effective were the ones that had the best (lowest) breakeven point. Thus, a new analytical tool can be created, facilitating the assessment and optimal choice of securities.