CONSTRUCTION OF OPTIMAL PORTFOLIO USING SINGLE INDEX MODEL AND CONSTANT CORRELATION MODEL FOR KOMPAS 100 INDEX OVER THE PERIOD 2014 – 2018

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Abstract: The purpose of this research is to test which method is better used for optimal portfolios, namely the single index model or constant correlation to help investors make investments. The sample consisted of 46 companies that have consistently joined in Kompas 100 in the period February 2014 to July 2018. After optimizing the portfolio, both methods were tested using the risk-adjusted method, namely Sharpe, Treynor, and Jensen Index. By using the single index model, 11 companies are included in the optimal portfolio of 46 samples. While using the constant correlation model there are 9 companies that enter into an optimal portfolio of 46 samples. After conducting the risk-adjusted method the best method is to use a single index model because it provides the best performance between the two portfolios.

Keywords: Optimal Portfolio, Single Index Model, Constant Correlation Model, Indonesia Stock Exchange, and Kompas 100

1. Introduction

Some economists provide an understanding of investment, Investment is the current commitment of dollars for a period in order to derive future payments that will compensate the investors for (1) the time the funds are committed, (2) the expected rate of inflation during this period, (3) the uncertainty of the future payments. In an investment there is a risk that is in an investment [1].

Diversification must be done to reduce the risk contained in this type of investment, such as combining asset in a portfolio to obtain maximum return [2], but for reducing the risk investors should do diversification for the portfolio such as theories created by William Sharpe using single index model method, and in this research also using correlation model method.

Many researchers have conducted research on how to create an optimal portfolio. Eka Nurjanah and Irni Yunita and Dr. Mulyanto Nugroho has conducted research to make optimal portfolios using the single index model and the constant correlation model. The results of research from Eka Nurjanah produce that by comparing with these two methods, producing a single index model is the best.

After making an optimal portfolio, a performance test needs to be performed to determine which portfolio has better performance among the single index models or use a constant correlation model. Performance portfolio evaluation uses Sharpe Ratio, Treynor Ratio, and Jensen Ratio. Sharpe ratio is done by dividing the excess return to portfolio variability, which is stated by the standard deviation. On the other hand, the Treynor ratio uses different dividers, which divides the excess return with the systematic risk known as a beta portfolio. Jensen's ratio is a ratio that shows the difference between the level of actual return obtained by a portfolio and the level of expectation if the portfolio is in the capital market line. An optimal portfolio with a higher ratio means the optimal portfolio has better performance than the other optimal portfolio formed [5].

The purpose of this research is to create an optimal portfolio using a single index model and a constant correlation model by using data from Kompas 100. After the optimal portfolio is created and evaluated using the Sharpe Ratio, Treynor Ratio, and Jensen Ratio to find out which method produces the best. Based on theory and method, this research uses quantitative method. The sample of this research is 46 companies that consistently registered in Kompas 100 from February 2014 to July 2018. This research also uses the daily closing price of each share, the IHSG closing price as a market index and the SBI rate as a proxy risk-free rate.

2. Theoretical Background

2.1 Optimal Portfolio Using Single Index Model

According to Jogiyanto. Calculations to determine the optimal portfolio will greatly facilitate if only based on a number that can determine whether security can be included in the optimal portfolio [4]. Scattered numbers are the ratio between return and beta. This ratio is:

$$ERB_r = \frac{E(R_i)-(R_f)}{\beta_i} \quad (1)$$

The optimal portfolio will contain assets that have high ERB ratios. Assets with a low ERB ratio will not be included in the optimal portfolio. Thus a cut-off point is needed, which determines the limit of what ERB value is said to be high. to find out this limiting point can be determined by the following steps:

1. Sort securities by the largest ERB value to the smallest ERB value. Securities with the largest ERB value are candidates for inclusion in the optimal portfolio.
2. Calculate the value of Ai and Bi for each of the securities of i as follows:

$$\text{Ai}=\frac{[\text{E}(\text{R}_\text{i})-\text{R}_\text{BR}]\cdot \beta_\text{i}}{{\sigma_{ei}}^2} \text{ And } B_i = \frac{{\beta_i}^2}{{\sigma_{ei}}^2} \quad (2)$$

Where

${\sigma_{ei}}^2$ = Variant of i. Securities residual error

Then the formula Ci becomes:

$$C_i = \frac{{\sigma_M}^2 \sum_{j=i}^{i} \frac{[\text{E}(\text{R}_\text{i})-\text{R}_\text{BR}]\cdot \beta_\text{i}}{{\sigma_{ej}}^2}}{1+ {\sigma_M}^2 \sum_{j=i}^{i} \frac{{\beta_i}^2}{{\sigma_{ej}}^2}} \quad (3)$$

1. The cut-off point (C *) value is the Ci value, where the ERB value last time was still higher than the Ci value.
2. The securities that form the optimal portfolio are securities that have an ERB value at point C *. Securities that have smaller ERBs with ERB point C * are included in the formation of optimal portfolios.

After securities that form the optimal portfolio have been determined, the next step is to determine the proportion for i securities to be:

$$W_i = \frac{Z_i}{\sum_{j=1}^{k} Z_j} \quad (4)$$

With a Zi value of:

$$Z_i = \frac{\beta_i}{{\sigma_{ei}}^2}(ERB_I - C*) \quad (5)$$

Where :

W_i = Proportion of securities i

k = The number of securities in the portfolio is optimal

β_i = Beta securities i

${\sigma_{ei}}^2$ = variant of securities residual error-i

ERBi = Excess return to Beta security-i

C* = cut-off point value, which is the largest Ci value.

2.2 Optimal Portfolio Using Constant Correlation Model

According to Pratiwi and Yunita (2013). The best way to forecast the correlation coefficient, which presents the correlation between all securities pairs in the same, is known as a constant correlation model. In a

constant correlation method, the ideal portfolio structure has the same methodology with a single index model; the difference is all securities listed by their excess return to the standard deviation (ERS). ERS can be calculated by using this formula:

$$ERS_i = \frac{(E(R_i)-R_f)}{\sigma_i} \quad (6)$$

In the constant correlation model, the standard deviation (σ_i) substitutes the beta as its risk indicator.

Furthermore, the value of C_i is used to determine the cut-off point calculated based on the following formula :

$$C_i = \frac{\rho}{1-\rho+i\rho}\sum ERS \quad (7)$$

Where ρa correlation coefficient is assumed constant for all securities. To meet its assumption that the correlation coefficient among stocks are constant, the used value is the average value of the correlation coefficient value (ρ_{ij}) among stocks, as following:

$$\rho = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}\rho_{ij}}{N} \quad (8)$$

Where the number of ρ_{ij}which are calculated as follows:

$$N = \frac{n(n-1)}{2} \quad (9)$$

Next, all stocks or securities which have a higher excess return to standard deviation than C* are included in the optimal portfolio.

The amount of optimum investment for each security is calculated as follows:

$$W_i = \frac{Z}{\sum_{j=1}^{N} Z_j} \quad (10)$$

Where,

$$Z_i = \frac{1}{(1-\rho)\sigma_i}\left[\frac{E(R_i)-R_f}{\sigma_i}\right] - C^* \quad (11)$$

The expected return of the portfolio is the weighted average of expected return from each single securities in the portfolio. The expected return of portfolio is calculated as follows:

$$E(R_p) = \sum_{i=1}^{n} W_i \cdot E(R_i) \quad (12)$$

Then, the risk of this portfolio can be calculated using the following equation:

$$\sigma_p{}^2 = \sum_{i=1}^{n} W_i{}^2\sigma_i{}^2 + \sum_{i=1}^{n}\sum_{\substack{j=1 \\ i\neq j}}^{n} W_i \cdot W_j \cdot \sigma_{ij} \quad (13)$$

Where :

$\sigma_i{}^2$ = Variance return of Security i
σ_{ij} = Covariance Between securities i and j return,

3. Result and Discussion

3.1 Single Index Model

The following table is the calculation result for optimal portfolio construction using single index model :

Table 1 The calculation result of optimal portfolio construction using single index model

Stock code	E(R)	β	α	σei	ERB	A	B	ΣA	ΣB	C
TBIG	0,0022	0,7278	0,7278	0,0153	0,00280	0,0969	34,52	0,10	34,52	0,000007
BJBR	0,0011	0,8850	0,8850	0,0008	0,00108	1,0113	932,99	1,11	967,50	0,000079
ICBP	0,0011	0,9074	0,9074	0,0015	0,00098	0,5329	545,84	1,64	1513,35	0,000113
ACES	0,0008	0,8492	0,8492	0,0007	0,00077	0,8498	1096,22	2,49	2609,57	0,000159
BBCA	0,0009	1,0372	1,0372	0,0003	0,00070	2,7928	4009,26	5,28	6618,82	0,000269

ADRO	0,0011	1,3779	1,3779	0,0010	0,00068	1,2962	1902,13	6,58	8520,95	0,000305
BJTM	0,0006	0,6614	0,6614	0,0004	0,00062	0,6536	1060,92	7,23	9581,87	0,000320
JPFA	0,0008	1,2366	1,2366	0,0010	0,00055	0,8010	1462,69	8,03	11044,56	0,000334
UNTR	0,0008	1,3085	1,3085	0,0007	0,00052	1,2979	2492,26	9,33	13536,82	0,000351
GGRM	0,0007	1,1283	1,1283	0,0005	0,00051	1,3042	2559,76	10,64	16096,58	0,000365
BDMN	0,0007	1,2825	1,2825	0,0008	0,00042	0,8942	2103,71	11,53	18200,29	0,000369
BBNI	0,0007	1,4575	1,4575	0,0005	0,00036	1,4328	3973,35	12,96	22173,64	0,000368
TLKM	0,0006	1,1306	1,1306	0,0004	0,00035	1,2747	3609,49	14,24	25783,14	0,000367
ANTM	0,0004	0,9034	0,9034	0,0009	0,00031	0,2907	951,35	14,53	26734,48	0,000365
ITMG	0,0005	1,0165	1,0165	0,0009	0,00029	0,3444	1195,42	14,87	27929,90	0,000363
RALS	0,0005	1,0308	1,0308	0,0008	0,00027	0,3602	1309,91	15,23	29239,82	0,000360
PTBA	0,0004	1,0963	1,0963	0,0014	0,00024	0,2029	834,64	15,44	30074,46	0,000358
PNBN	0,0004	0,8826	0,8826	0,0006	0,00022	0,2845	1288,22	15,72	31362,69	0,000354
CTRA	0,0005	1,6939	1,6939	0,0009	0,00020	0,6108	3061,57	16,33	34424,25	0,000344
ADHI	0,0004	1,3095	1,3095	0,0008	0,00017	0,3406	2041,13	16,67	36465,38	0,000337
TINS	0,0003	1,0881	1,0881	0,0008	0,00014	0,2109	1461,96	16,88	37927,34	0,000331
ASII	0,0003	1,4785	1,4785	0,0005	0,00009	0,3550	3977,60	17,24	41904,94	0,000314
SSIA	0,0002	1,1430	1,1430	0,0008	0,00004	0,0626	1598,90	17,30	43503,84	0,000306
AKRA	0,0002	0,7577	0,7577	0,0005	0,00003	0,0302	1140,10	17,33	44643,94	0,000300
SMRA	0,0001	1,6586	1,6586	0,0009	-0,00002	-0,0567	3062,10	17,27	47706,04	0,000284
BMRI	0,0001	1,5490	1,5490	0,0008	-0,00004	-0,1352	3176,11	17,14	50882,15	0,000268
KLBF	0,0001	1,1351	1,1351	0,0005	-0,00005	-0,1360	2848,05	17,00	53730,19	0,000255
INDF	0,0001	1,2833	1,2833	0,0005	-0,00006	-0,2191	3538,42	16,78	57268,61	0,000239
JSMR	0,0001	1,1265	1,1265	0,0004	-0,00007	-0,1940	2933,60	16,59	60202,20	0,000227
WIKA	0,0000	1,2603	1,2603	0,0007	-0,00010	-0,2513	2439,16	16,34	62641,36	0,000216
LPPF	0,0000	1,2815	1,2815	0,0009	-0,00011	-0,1994	1818,94	16,14	64460,31	0,000208
INTP	-0,0001	1,5439	1,5439	0,0007	-0,00018	-0,5776	3219,05	15,56	67679,36	0,000193
BEST	-0,0001	1,4167	1,4167	0,0011	-0,00019	-0,3543	1877,64	15,21	69556,99	0,000184
ASRI	-0,0002	1,4566	1,4566	0,0007	-0,00022	-0,6382	2876,39	14,57	72433,38	0,000170
EXCL	-0,0001	1,1996	1,1996	0,0009	-0,00025	-0,3904	1555,44	14,18	73988,82	0,000163
UNVR	-0,0002	1,1409	1,1409	0,0009	-0,00035	-0,4863	1380,37	13,69	75369,19	0,000155
SMGR	-0,0003	1,3932	1,3932	0,0006	-0,00036	-1,1071	3106,47	12,59	78475,66	0,000138
ISAT	0,0000	0,3474	0,3474	0,0004	-0,00038	-0,1255	329,27	12,46	78804,93	0,000136
MNCN	-0,0004	1,3382	1,3382	0,0009	-0,00042	-0,8280	1954,52	11,63	80759,45	0,000124
LPCK	-0,0006	1,4975	1,4975	0,0008	-0,00052	-1,3863	2660,10	10,25	83419,55	0,000106
PGAS	-0,0006	1,3939	1,3939	0,0009	-0,00054	-1,1526	2135,11	9,09	85554,66	0,000092
AALI	-0,0004	0,8701	0,8701	0,0005	-0,00065	-0,9013	1390,76	8,19	86945,42	0,000082
GJTL	-0,0005	1,0529	1,0529	0,0010	-0,00067	-0,7715	1154,56	7,42	88099,98	0,000073
MLPL	-0,0007	1,1940	1,1940	0,0012	-0,00069	-0,8086	1164,90	6,61	89264,88	0,000065
BMTR	-0,0009	1,0978	1,0978	0,0010	-0,00093	-1,1784	1262,90	5,43	90527,78	0,000052
BWPT	-0,0007	0,6046	0,6046	0,0017	-0,00147	-0,3243	221,10	5,11	90748,88	0,000049

The average value of SBI for the period 2014-2018 is 0,000168 and the expected market is 0,000318404. From the table above, it can be very clearly seen in around 11 companies from 46 sample companies that have ERB values greater than C. This shows that 11 companies are included in the optimal portfolio category using a single index model. To see the proportion of each stock can be seen from the diagram below

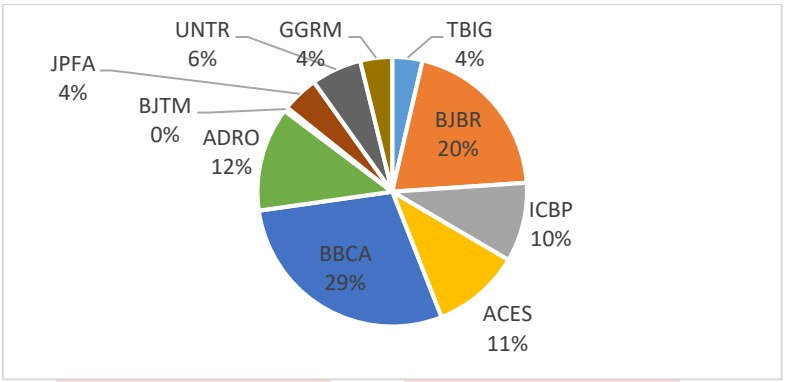

Figure 1 The Proportion of Single Index Model for Each Stock Single Index Model

From the chart above, it can be seen that the stock that has the largest proportion is BBCA at 29% while the most contemplated proportion is BDMN and TBIG by -0.50%.

Based on calculations using the single index model, the expected return is greater than the market return of 1.010%, this indicates that if the market goes up by 1%, the portfolio will increase by 1.010% but if the market goes down it will go down by beta. To calculate the expected return portfolio, the risk portfolio will be illustrated in the following table:

Table 2 Expected Return, Risk and Beta Portfolio

Return Portfolio	Risk		Beta Portfolio
1,036159	Std. Dev	Variance	1,010543
	0,009157	0,000084	

3.2 Constant Correlation Model

The table below is the calculation result for optimal portfolio using constant correlation model:

Table 3 The calculation result optimal portfolio construction using constant correlation model

Stock code	E(R)	Excess Return	Std. Dev	ERS	ΣERS	β	ρ	ρ/1-ρ - ρ_i	VARIANCE	C
TBIG	0,00089	0,00072	0,01363	0,05294	0,05294	1,03718	0,22897	0,22897	0,00019	0,01212
BJBR	0,00113	0,00096	0,02792	0,03432	0,08726	0,88495	0,22897	0,18631	0,00078	0,01626
ICBP	0,00111	0,00094	0,02920	0,03212	0,11939	1,37793	0,22897	0,15705	0,00085	0,01875
ACES	0,00085	0,00068	0,02357	0,02887	0,14826	1,30852	0,22897	0,13573	0,00056	0,02012
BBCA	0,00074	0,00057	0,01999	0,02872	0,17698	1,12834	0,22897	0,11951	0,00040	0,02115
ADRO	0,00069	0,00052	0,01928	0,02723	0,20421	1,45752	0,22897	0,10675	0,00037	0,02180
BJTM	0,00083	0,00066	0,02455	0,02679	0,23099	0,84916	0,22897	0,09646	0,00060	0,02228
JPFA	0,00057	0,00040	0,01600	0,02492	0,25591	1,13064	0,22897	0,08797	0,00026	0,02251
UNTR	0,00105	0,00088	0,03802	0,02328	0,27919	0,90742	0,22897	0,08086	0,00145	0,02257
GGRM	0,00085	0,00068	0,03047	0,02220	0,30139	1,23659	0,22897	0,07481	0,00093	0,02255
BDMN	0,00071	0,00054	0,02561	0,02126	0,32265	1,28248	0,22897	0,06960	0,00066	0,02246
BBNI	0,00058	0,00041	0,01946	0,02091	0,34356	0,66138	0,22897	0,06507	0,00038	0,02236
TLKM	0,00221	0,00204	0,12371	0,01650	0,36005	0,72779	0,22897	0,06110	0,01531	0,02200
ANTM	0,00051	0,00034	0,02678	0,01260	0,37266	1,69387	0,22897	0,05758	0,00072	0,02146
ITMG	0,00045	0,00028	0,02701	0,01048	0,38313	1,03084	0,22897	0,05444	0,00073	0,02086
RALS	0,00046	0,00029	0,02802	0,01044	0,39357	1,01647	0,22897	0,05163	0,00079	0,02032
PTBA	0,00044	0,00028	0,02820	0,00977	0,40335	0,90337	0,22897	0,04910	0,00080	0,01980
PNBN	0,00036	0,00019	0,02335	0,00833	0,41168	0,88264	0,22897	0,04680	0,00055	0,01927
CTRA	0,00039	0,00022	0,02662	0,00820	0,41988	1,30951	0,22897	0,04471	0,00071	0,01877
ADHI	0,00043	0,00027	0,03671	0,00725	0,42712	1,09631	0,22897	0,04279	0,00135	0,01828
TINS	0,00030	0,00013	0,01954	0,00674	0,43386	1,47854	0,22897	0,04104	0,00038	0,01781
ASII	0,00033	0,00016	0,02682	0,00584	0,43970	1,08814	0,22897	0,03942	0,00072	0,01733
SSIA	0,00021	0,00004	0,02678	0,00166	0,44137	1,14301	0,22897	0,03793	0,00072	0,01674
AKRA	0,00019	0,00002	0,02144	0,00093	0,44230	0,75774	0,22897	0,03654	0,00046	0,01616
SMRA	0,00014	-0,00003	0,02622	-0,00118	0,44112	1,65860	0,22897	0,03525	0,00069	0,01555

BMRI	0,00010	-0,00007	0,02391	-0,00276	0,43836	1,54901	0,22897	0,03405	0,00057	0,01493
KLBF	0,00011	-0,00005	0,01880	-0,00289	0,43547	1,13509	0,22897	0,03293	0,00035	0,01434
INDF	0,00009	-0,00007	0,01831	-0,00407	0,43140	1,12650	0,22897	0,03188	0,00034	0,01375
JSMR	0,00009	-0,00008	0,01842	-0,00432	0,42708	1,28330	0,22897	0,03090	0,00034	0,01319
WIKA	0,00003	-0,00014	0,02787	-0,00504	0,42204	1,28146	0,22897	0,02997	0,00078	0,01265
LPPF	0,00004	-0,00013	0,02301	-0,00565	0,41639	1,26032	0,22897	0,02910	0,00053	0,01212
INTP	0,00004	-0,00013	0,01890	-0,00701	0,40938	0,34737	0,22897	0,02827	0,00036	0,01158
BEST	-0,00010	-0,00027	0,03025	-0,00884	0,40055	1,41667	0,22897	0,02750	0,00091	0,01101
ASRI	-0,00013	-0,00030	0,02854	-0,01054	0,39000	1,19958	0,22897	0,02676	0,00081	0,01044
EXCL	-0,00011	-0,00028	0,02362	-0,01173	0,37828	1,54389	0,22897	0,02606	0,00056	0,00986
UNVR	-0,00015	-0,00032	0,02398	-0,01347	0,36480	1,45661	0,22897	0,02540	0,00057	0,00927
SMGR	-0,00023	-0,00040	0,02904	-0,01383	0,35097	1,14095	0,22897	0,02477	0,00084	0,00869
ISAT	-0,00040	-0,00057	0,02791	-0,02030	0,33067	1,33816	0,22897	0,02417	0,00078	0,00799
MNCN	-0,00072	-0,00089	0,04031	-0,02198	0,30869	0,60460	0,22897	0,02360	0,00163	0,00729
LPCK	-0,00033	-0,00050	0,02182	-0,02275	0,28594	1,39320	0,22897	0,02306	0,00048	0,00659
PGAS	-0,00054	-0,00070	0,02958	-0,02377	0,26218	1,05293	0,22897	0,02254	0,00088	0,00591
AALI	-0,00066	-0,00083	0,03339	-0,02481	0,23737	1,19404	0,22897	0,02204	0,00111	0,00523
GJTL	-0,00040	-0,00056	0,02205	-0,02555	0,21182	0,87009	0,22897	0,02157	0,00049	0,00457
MLPL	-0,00058	-0,00075	0,02759	-0,02726	0,18456	1,39395	0,22897	0,02111	0,00076	0,00390
BMTR	-0,00061	-0,00078	0,02590	-0,03010	0,15446	1,49747	0,22897	0,02068	0,00067	0,00319
BWPT	-0,00086	-0,00102	0,02936	-0,03487	0,11959	1,09777	0,22897	0,02026	0,00086	0,00242

The calculation of the coefficient correlation (ρ) is done by averaging the stock's coefficient correlation matrix with the positive value of ERS which is only 24 stocks calculated on the matrix. ρ value is 0.2289. Depending on the estimate, only 9 stocks out of 46 stocks with an ERS value greater than the Ci limit are stocks. This means that only 9 eligible to use constant correlation model to be included in optimal portfolio development. The C*point for the model of constant correlation is the point at which the last values of the ERS are greater than Ci, is equal to 0.00233. The proportion of each stock which has been included in the optimal portfolio for a constant correlation model is shown in the following chart:

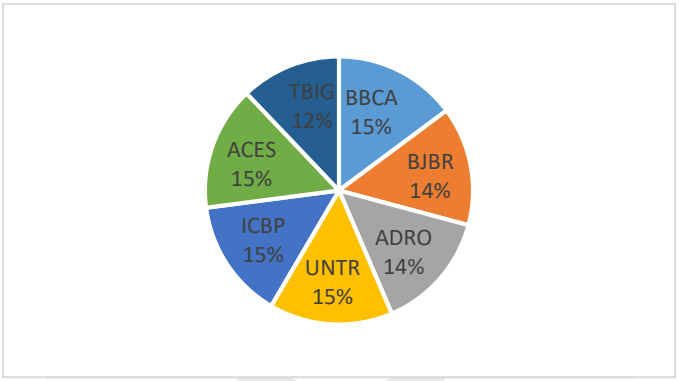

Figure 2 The proportion of investment for each stock constant correlation model

3.3 Portfolio performance

Sharpe Ratio		Treynor Ratio		Jensen Ratio	
SIM	CCM	SIM	CCM	SIM	CCM
0,989138	-0,0213049	1,035743	0,00081504	1,035845	0,00092089

The results of the three portfolio performance measurement indices show that portfolios formed using the single index model have higher performance values compared to portfolios formed using the constant correlation model.

4. Conclusion

1. Optimal portfolio formation using a single index model produces a portfolio of 10 companies. The combination of these shares is BBCA 28.99%, BJBR 20.52%, ADRO 12.63%, ACES 10.70%, ICBP 9.61%, UNTR 6.11%, JPFA 4.42%, GGRM 3.86%, TBIG 3.66%, BJTM -0.50%. at 6.06%, JPFA at 4.43%, TBIG at 2.43%, and BDMN at 1.91%.
2. The formation of an optimal portfolio using a constant correlation model produces a portfolio consisting of 7 companies. The combination of these shares is BBCA 14.83%, BJBR 14.34%, ADRO 14.38%, UNTR 14.91%, ICBP 14.49%, ACES 14.96%, and TBIG 12.10%.
3. The third value of the portfolio performance measurement index, namely Sharpe, Treynor, and Jensen, consistently shows that portfolios formed using the single index model have better performance when compared to using a constant correlation model. The three indices show portfolio performance for both portfolios, which means both portfolios are well diversified.

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