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# A Proposed scale for assessing the investment risk

## مقياس مقترح لتقييم مخاطر الاستثمار

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**Abstract**

In the context of of trade-off between return and risk, the investment decision makers need to measure risks using various measures, the researcher found weaknesses in using some traditional measures and their lack of objectivity in measuring real risks, which prompted him to propose a new scale for assessing and measuring risks.

The researcher described the proposed scale, explained its mechanism of action, and experimented it through ten virtual cases. The results of testing the scale showed that there were significant differences between the proposed scale and the traditional comparative measures such as the standard deviation and the coefficient of variance, which showed that the proposed scale was more objective in assessing and measuring risks and demonstrating the real concept of risk.

The researcher also tested the ability of the scales to distinguish between the studied cases and assess the degree of risk for each of them using the relative interquartile deviation, where the proposed scale outperformed the other measures, as the value of the relative interquartile deviation of the proposed scale was %118.31, while it was %3.13 for the standard deviation and %3.22 for the coefficient of variation.

**Keywords** :Risk, Investment risk.

**ملخص**

في إطار علاقة المبادلة بين العائد والمخاطرة وحاجة متخذي قرارات الاستثمار إلى قياس المخاطر باستخدام مقاييس متنوعة، فقد وجد الباحث ثمة نقاط ضعف في استخدام بعض المقاييس التقليدية وعدم موضوعيتها في قياس المخاطر الحقيقية، مما دفعه إلى اقتراح مقياس جديد لتقييم المخاطر وقياسها.

وقد قام الباحث بتوصيف المقياس المقترح وتوضيح آلية عمله وتجربته من خلال عشر حالات افتراضية، وقد أظهرت نتائج تجريب المقياس وجود اختلافات كبيرة بين المقياس المقترح والمقاييس التقليدية المقارنة مثل الانحراف المعياري ومعامل الاختلاف، والتي أظهرت أن المقياس المقترح كان أكثر موضوعية في تقييم المخاطر وقياسها وإظهار المفهوم الحقيقي للمخاطر.

**الكلمات المفتاحية:** المخاطرة، مخاطر الاستثمار.

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## 1. Introduction

The relationship between return and risk is one of the important issues facing the decision-maker who seeks to achieve a trade-off between return and risk in order to maximize return and reduce risk as much as possible.

Within the framework of the logical extension of the "No Free Lunch" theory, the investment decision-maker must bear a high degree of risk when seeking to achieve high rates of return.

In this context, the investor should manage risks and deal with them in an appropriate and acceptable manner.

The basis for the risk management process is risk assessment, which includes identifying and measuring risks in order to avoid uncertainty, and to rationalize the investment decisions (Popov et. al., 2016, P53). In general, the risk measurement and management process is characterized as quantitative issues. (Saunders & Carnett, P191) (Hogg et. al., 2019, P259)

## 2. The concept of risk:

There were many perspectives of researchers and specialists, and therefore their definitions of the concept of risk, but most of them agreed on a set of key elements specific to this concept, which can be summarized in the context of the possibility of loss or damage, or uncertainty regarding future losses, or deviation from desired or expected results in the future. (Hampton, 2015, P21)

Risk is also defined as the degree of volatility in the expected returns as a result of various factors and influences from inside and outside the firm, and it is measured by the standard deviation of the returns. (Mourhij, 2010, P 49)

In this context, many methods and measures were relied upon to assess and measure the degree of risk associated with the investment decision, such as the range, variance, coefficient of variation, and beta coefficient. The standard deviation may be one of the most important and widely used measures of dispersion to measure the absolute magnitude of risk associated with expected returns in the future.

The standard deviation was used as a measure of the total risk by Carl Pearson in the year 1894, which is calculated by the square root of the variance according to the following equation: (Saunders & Carnett, P357)

$$\sigma j = \sqrt{\frac{\sum_{i=1}^{N}(X_{ij} - \bar{X}_i)^2}{N}}$$

Where:

σj: Standard deviation.

Xij: The value observed in the studied series.

$\bar{X}_i$ : Average values of observations in the studied series.

N: The number of observations in the studied series.

By assuming that investment decision-makers are rational, they will not accept any additional units of risk when the rate of return increases at decreasing rates. From this standpoint, it is necessary to estimate and measure the levels of risk for each of the decisions to be taken. (Mourhij, 2020, P70)

The risk is also defined as "the deviation in the results that may occur during a limited period at a certain time," and the deviation in the results is meant by the undesirable deviation or the opposite deviation from the expected results, while the desired deviation does not represent a risk. (brahim 2021, P3)

It is noteworthy that the use of standard deviation as a measure of absolute risk (Jorion, 2011, P5) assumes that the distribution of the returns series data follows a normal distribution, and that it is symmetrical and does not differentiate between large gains or losses (Jorion, 2011, P292), but in fact, investment returns data series may take abnormal distribution forms, meaning that there is a positive or negative skewed, and in this case we may encounter two investments with the same rate of return and the same degree of standard deviation despite the different shape of their distribution (may be one has a positive skewed and the other has a negative skewed), and thus will evaluate the two investments identically that they are the same in terms of return and risk.

Based on the foregoing, the researcher proposed a model that includes an objective scale to measure the degree of risk associated with the investment, which goes beyond the assumptions and weaknesses of the traditional quantitative measurement methods used in assessing and managing risks.

**3. Description of the proposed assessment scale:**

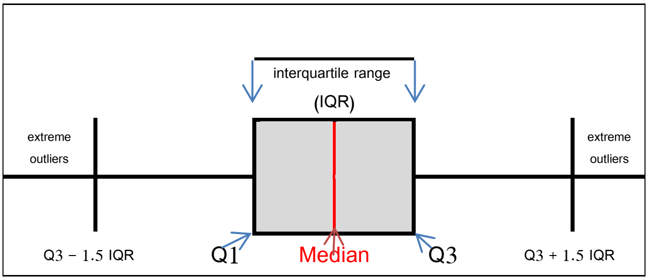
The proposed scale depends on analyzing a time series of historical data of rates of return related to a particular investment or a data series of expected rates of return for the investment concerned in the future, by analyzing the data series statistically and calculating some important values such as measures of central tendency, and then the time series data is divided into Six fields, as indicated when reviewing the action mechanism of the proposed scale.

The value of the proposed scale in the risk assessment process depends on the value of sum of the averages of differences between the two contiguous internal fields that include the lowest values (field F3) and the highest values (field F4) that are close to the median value (second quartile Q2), and on the value of sum of the averages of differences between the two non-contiguous external fields that include the lowest values (field F2) and the highest values (field F5) of the values far from the median value of the studied data series.

**4. The action mechanism of the proposed scale:**

The scale works on the assumption that there is an appropriate series of related data that represent historical past values or predicted future values of the rates of return of the respective investment, which arranged ascending in order to calculate the quartile values (Q1, Q2, Q3) and the interquartile range (IQR) which includes the largest part of the data series as shown in the following Figure 1

Fig. 1. Representative graph of quartiles and interquartile range

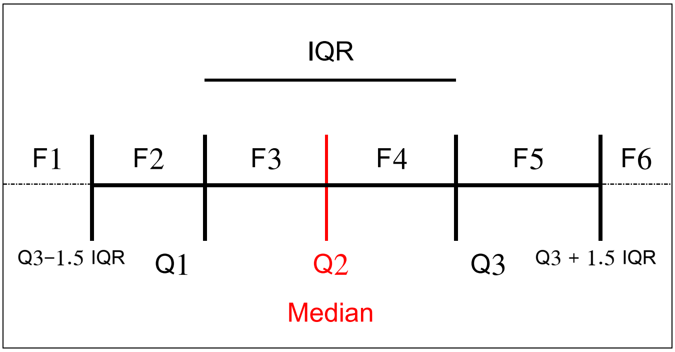



Source: Figure prepared by the researcher.

The value of the interquartile range is modified by a constant coefficient of (1.5) in order to identify the two fields of extreme outliers, if any, and to exclude them from the studied data series to ensure the objectivity of the evaluation results. (Aggarwal, 2017, P45)

Thus, the limits of the field of lowest outliers (F1) are Q1-1.5 IQR and below, and the limits of the field of highest outliers (F6) are Q3+1.5 IQR and above (Black, 2010, P79) Based on the foregoing, we have six fields as shown below in Figure 2.:

Fig. 2. The six fields of scale




Source: Figure prepared by the researcher.

Thus, the two fields F1+F2 include the lowest quarter of the values of the studied data series, and the two fields F5+F6 include the highest quarter of the values of the studied data series, while the field F3 includes a quarter of the values of the data series adjacent to the median and less than its value, and the field F4 includes a quarter of the values of the adjacent data series for the median and higher than its value.

The values of the quartiles are determined based on the location of each of them within the studied data series, as shown in the following Table 1.

Table 1. location of the quartiles

| Quartile | Location |
|---|---|
| Q1 | $\frac{(N+1)}{4}$ |
| Q2 | $\frac{2(N+1)}{4}$ |
| Q3 | $\frac{3(N+1)}{4}$ |

Source: *Maria Dolores Ugarte, et. al., Probability and Statistics With R, Tylor & Francis Group, 2008, P420.*

Thus, the value of the quartile is corresponding to its position in the studied data series arranged ascending, and in the event that the number of items in the data series (N) is even, the value of the quartile is determined as an average of the values of the two adjacent locations that border the median location (i.e. the previous value and the subsequent value).

The values of fields F1 and F2 that contain extreme outliers are excluded from the studied data series.

The difference between each of the values within the fields F2, F3, F4, F5 and the value of the median Q2 is calculated, then the average of the differences calculated within each of the fields mentioned above is calculated separately, so we have four average values ($\overline{X}_{F2}$, $\overline{X}_{F3}$, $\overline{X}_{F4}$, $\overline{X}_{F5}$) Two of them are negative ($\overline{X}_{F2}$, $\overline{X}_{F3}$) and the other two are positive ($\overline{X}_{F4}$, $\overline{X}_{F5}$).

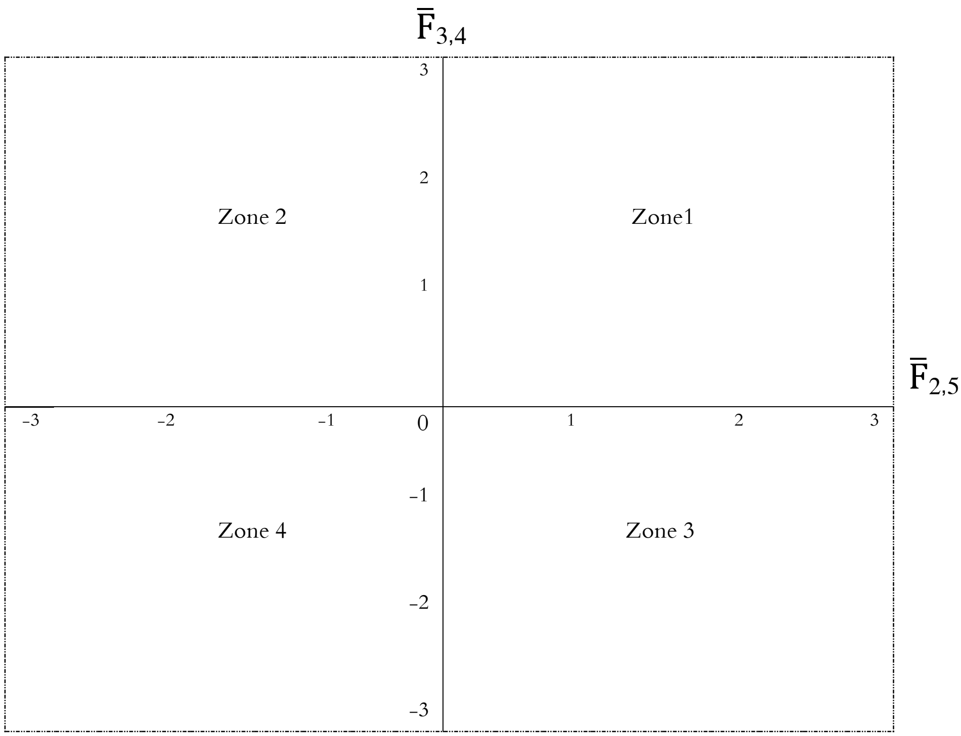
The proposed assessment scale is based on the differences of values between the corresponding fields for the second quartile Q2, where the averages of the two corresponding fields that are close (internal) ($\overline{X}_{F3}$, $\overline{X}_{F4}$) are summed together, and the averages of the two corresponding fields that are far apart (external) ($\overline{X}_{F2}$, $\overline{X}_{F5}$) are summed with each other as well.

By summing the average values of the aforementioned differences, the result of the summing is in favor of the assessed investment proposal if it is positive, which means that the differences indicate increases in the achieved or expected degrees of return, especially for the realistic values close to the median value, i.e. the value $\overline{F}_{3,4} = \overline{X}_{F3} + \overline{X}_{F4}$, while the average values of the differences are not in favor of the investment proposal if they are negative.

The same applies to the sum of the averages of the two divergent fields $\overline{F}_{2,5} = \overline{X}_{F2} + \overline{X}_{F5}$, which reflect a view different from that use of standard deviation as a measure of risk.

Based on sum of the averages of each two corresponding fields, namely: $\overline{F}_{2,5}$, $\overline{F}_{3,4}$, a spread point is determined on two coordinate axes, the horizontal axis of which is $\overline{F}_{2,5}$ and the vertical axis of it $\overline{F}_{3,4}$, according to Figure 3. shown below:

Fig. 3. Scatter plots of means of the corresponding fields




Source: Figure prepared by the researcher.

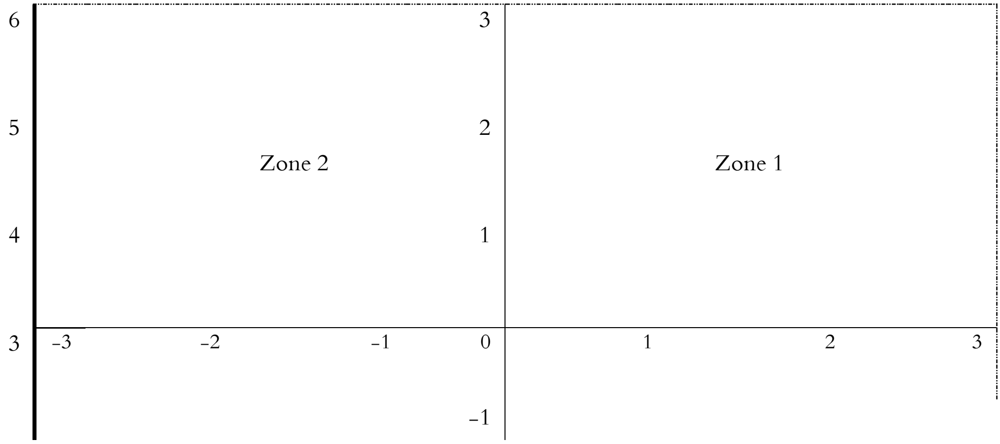
## 5. Analysis and discussion:

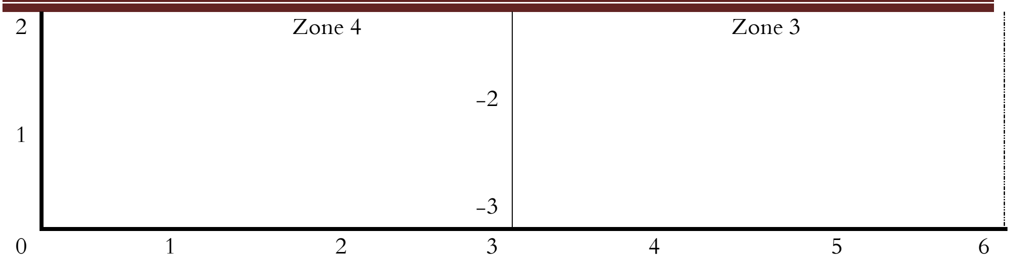
The proposed scale was tested by studying 10 different cases, each case separately, using the Excel package, where 999 random values were generated within the range [10,100] representing virtual prices or returns values using the RANDBETWEEN(10,100) function, then arranging the random data series ascending and calculating the locations of the quartiles, interquartile range, interquartile deviation, and determine the six fields for each of the ten cases (F1, F2, F3, F4, F5, F6), and make the necessary calculations to determine the two values that represent the coordinates of the point representing each case on the two coordinate axes shown in Figure 3. above.

The proposed scale depends in assessing the studied investment on a quantitative value that indicates the status of the studied investment, ranging between zero and the correct one [0,1], which is determined according to the following:

The coordinates of the point representing the studied case are determined on two (YZ) coordinate axes that intersect at a point that represents the starting point of the new graphic. Each axis is divided into positive values ranging from zero to twice the maximum positive value represented on each of the axes of the coordinates of Figure 3. above , so that the two new coordinate axes include the entirety of Figure 3. as shown in the following Figure 4.:

Fig. 4. Scatter plots of status of the studied investment






Source: Figure prepared by the researcher.

The new coordinates are determined for each point represented on the previous figure, and for each axis separately, through the following:

The new coordinates of the point on Figure 4. = the previous coordinates on Figure 3. + 3, therefore, the area enclosed by the relevant point at the new Figure 4. is:

$$AC(\text{Area of Case}) = (\overline{F}_{2,5} + 3) \;*\; (\overline{F}_{3,4} + 3)$$

The ratio of this area to the total area of the new Figure 4. is:

$$RI(\text{Risk Level}) = \frac{(\overline{F}_{2,5} + 3) \;*\; (\overline{F}_{3,4} + 3)}{M\text{^}2}$$

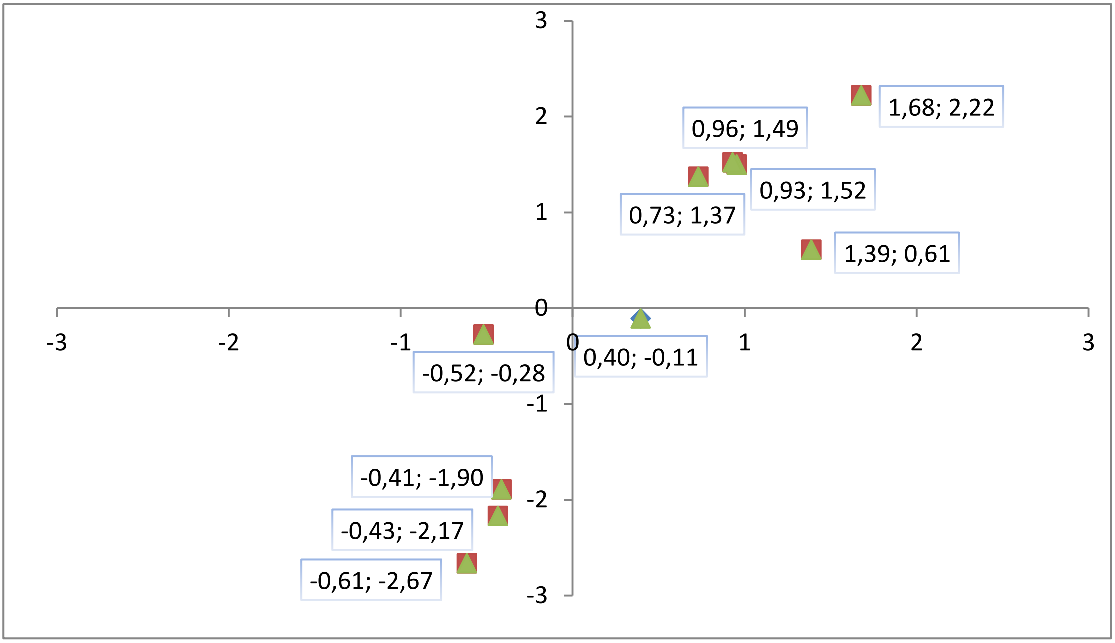
So that M denotes the maximum value represented on each of the coordinates axes of the new Figure 4. $\overline{F}_{2,5}+3$, $\overline{F}_{3,4}+3$, and by assuming that (M=6) according to the ten cases studied, RI = AC/36.

Accordingly, the studied investment is evaluated through the RI value that ranges between zero and the correct one, and the closer this value is to the correct one, the better the studied investment according to the proposed point of view of risk, and in the event that there are several investments, they are arranged according to preference based on the RI value of each of them.

## 6. Scale running:

Returning to the ten cases through which the proposed scale was tested, which included the generation of 999 random values representing rates of return within the range [10,100]. Each of these cases was represented by two coordinate points on the axes of Figure 3., with Ci: $_{i=1,\ldots,10}$, as shown in the following Figure 5.:

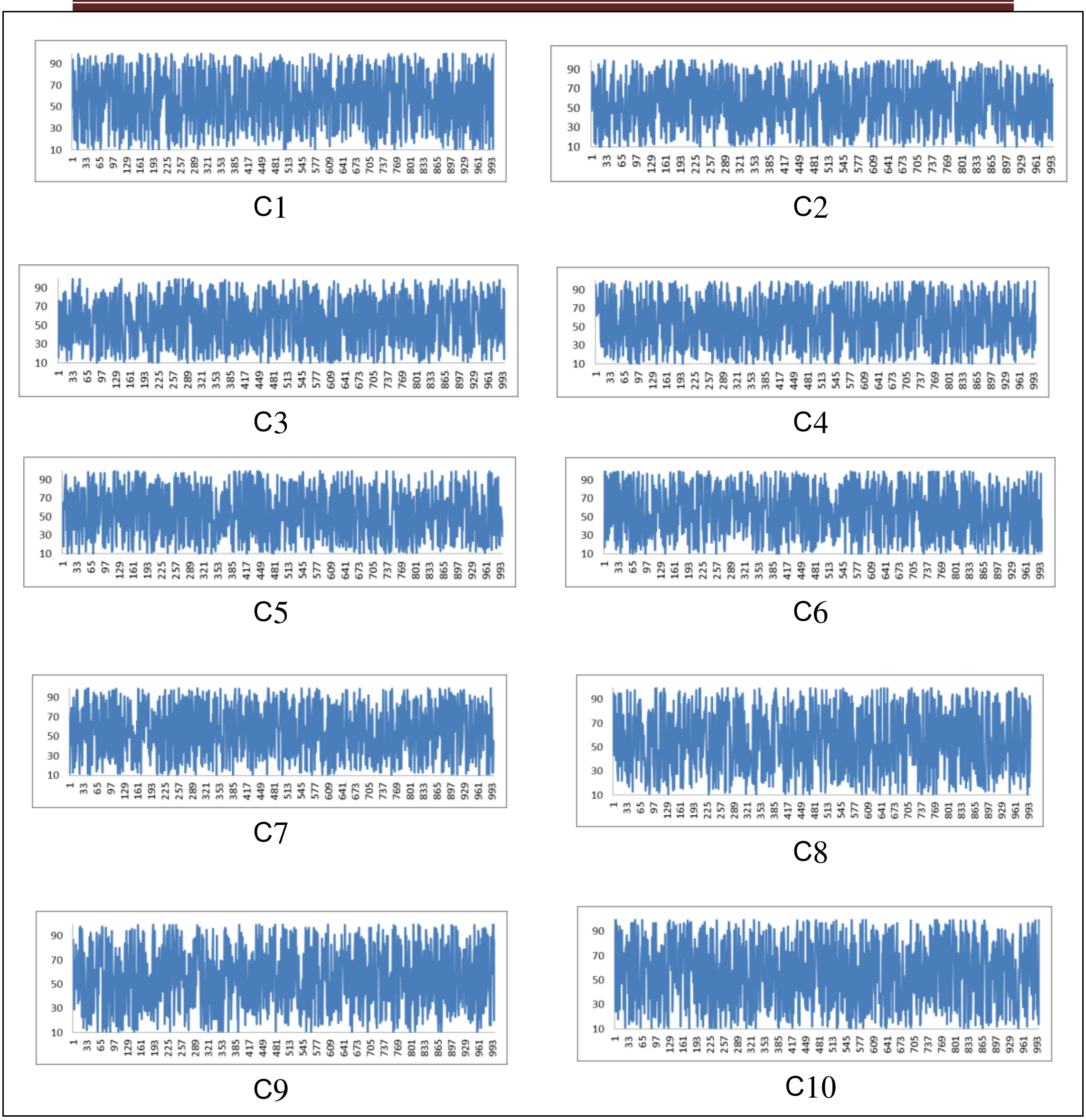
Fig. 5. Scatter plots of studied cases.




Source: Figure prepared by the researcher using the Excel package.

The shape of the scatter of observations for each of studied ten cases is also represented as shown below in Figure 6.:

Fig. 6. Graphical representation of the observations of the studied cases over time.




Source: Figure prepared by the researcher using the Excel package.

The values of the mean, standard deviation, and coefficient of variation were calculated for the time series representing the ten virtual cases according to the traditional quantitative method for risk measurement. The results were as shown in the following Table 2.:

Table 2. Return and risk of virtual studied cases.

| Case / Scale | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 55.07 | 53.80 | 55.18 | 53.61 | 56.50 | 54.97 | 56.42 | 55.61 | 55.53 | 55.35 |
| Standard deviation | 26.36 | 25.71 | 25.30 | 26.30 | 26.93 | 26.17 | 26.25 | 26.18 | 25.76 | 26.80 |
| Coefficient of variation | 0.48 | 0.48 | 0.46 | 0.49 | 0.48 | 0.48 | 0.47 | 0.47 | 0.46 | 0.48 |

Source: Table prepared by the researcher using the Excel package.

The necessary calculations were also made for the proposed scale and for each case separately. The results were as shown in the following Table 3.:

Table 3. The proposed scale values for the studied virtual cases.

| Case / Value | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|
| F3,4 | 0.40 | -0.52 | -0.61 | 0.96 | 1.39 | 1.68 | -0.41 | 0.93 | 0.73 | -0.43 |
| F2,5 | -0.11 | -0.28 | -2.67 | 1.49 | 0.61 | 2.22 | -1.90 | 1.52 | 1.37 | -2.17 |
| Y | 3.40 | 2.48 | 2.39 | 3.96 | 4.39 | 4.68 | 2.59 | 3.93 | 3.73 | 2.57 |
| Z | 2.89 | 2.72 | 0.33 | 4.49 | 3.61 | 5.22 | 1.10 | 4.52 | 4.37 | 0.83 |
| AC | 9.81 | 6.76 | 0.80 | 17.78 | 15.83 | 24.41 | 2.86 | 17.76 | 16.30 | 2.12 |
| RI | 0.27 | 0.19 | 0.02 | 0.49 | 0.44 | 0.68 | 0.08 | 0.49 | 0.45 | 0.06 |

Source: Table prepared by the researcher.

## 7. The results:

Returning to Figure 6., there is an obvious difference between the forms of observations of the ten studied cases, were generated randomly.

By analyzing the data of Table 2. it is clear that there is a convergence in the values of the coefficients of difference (CV) that link the return and the risk and calculated by dividing the standard deviation by the average return, as the values ranged between [0.46,0.49], and thus it was found that there is a convergence in the results in assessing the studied cases. The standard deviation values calculated and representing the absolute risk degrees according to the most well-known traditional risk measures, also showed convergence, as their values ranged between [25.30,26.93], which also indicates the convergence of the degrees of risk of the virtual cases studied, this despite that the values representing each of which were randomly generated within the range [10,100].

By analyzing the results of the proposed scale values for the studied virtual cases shown in Table 3., the extent of the variation in the shape and size of the risks associated with each of the studied cases becomes clear, as the scale results showed a clear discrepancy in the values that ranged between [0.02,0.68].

In order to compare the degree of dispersion between the traditional measure that can be used to arrange the studied cases according to preference in regard to the value of the coefficient of difference of each case, and the proposed scale, the relative interquartile deviation value of the values of the results of each measure was calculated, and the results were as follows:

Relative Interquartile Range (RIR):

$$\text{RIR} = \frac{\text{Q3} - \text{Q1}}{\text{Q2}} \times 100$$

Returning to the standard deviation (σ) values in Table 2., we find:

$$\text{RIR}_{\text{SD}} = \frac{\text{Q3} - \text{Q1}}{\text{Q2}} \times 100 = \frac{26.58 - 25.78}{0.48} \times 100 = 3.13\%$$

For the values of the coefficients of variation (CV), we find:

$$\text{RIR}_{\text{CV}} = \frac{\text{Q3} - \text{Q1}}{\text{Q2}} \times 100 = \frac{0.48 - 0.47}{0.48} \times 100 = 3.22\%$$

Returning to the values of the proposed scale (RI) in Table 3., we find:

$$\text{RIR}_{\text{RI}} = \frac{\text{Q3} - \text{Q1}}{\text{Q2}} \times 100 = \frac{0.49 - 0.07}{0.36} \times 100 = 118.31\%$$

By comparing the resulting values of the relative interquartile deviation of the three aforementioned measures, it is clear that there is a low degree of dispersion for the standard deviation measure (3.13%) and for the coefficient of difference measure (3.22%), which indicates that there are no significant differences in assessment of the studied cases with regard to the degrees of risk associated with each of them.

While there is a large degree of dispersion according the scale proposed by the researcher (118.31%), which indicates the existence of large variations in the degrees of risk associated with each of the studied cases, and this was clear by tracking the graphical representation of observations of each case, as shown in Figure 6.

By arranging the studied cases according to their preference in terms of the degree of risks associated with each of them according to the three aforementioned measures, the following is evident through Table 4.:

Table 4. Arranging the studied cases according to preference in terms of the degree of risk

| Preference / Scale | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **SD** | C3 | C2 | C9 | C6 | C8 | C7 | C4 | C1 | C10 | C5 |
| **CV** | C3 | C9 | C7 | C8 | C1 | C2 | C5 | C6 | C10 | C4 |
| **RI** | C6 | C4 | C8 | C9 | C5 | C1 | C2 | C7 | C10 | C3 |

Source: the Table prepared by the researcher.

It is clear from the previous Table 4. the difference in assessing the risk scores of the studied cases among the three scales used (SD, CV, RI), especially for the scale proposed by the researcher, compared to the other two scales that matched them in assessing only one case (C10).

## 8. Conclusion:

Based on the foregoing, it becomes clear to the researcher that the use of standard deviation or the coefficient of variation may not give a realistic picture of the degree of risk associated with the investment, as the dispersion in any direction in relation to the return is assessed as a risk that threatens the desired results of the investment, while the proposed scale by the researcher assesses the risk associated with the investment more objectively, and may reveal a new type of risk that lies in the inaccuracy in estimating the expected rates of return, and thus assessing the high rates of return as a type of risk associated with the investment.

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