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Neutrosophic Price Indices with an Applied Study on Pesticide Prices

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Abstract: An index is a tool for comparing a phenomenon or several phenomena dating back to different periods to know the amount of change in the phenomena or the difference between them. For example, we compare the price of a commodity in a particular year with its price in a given year, compare the prices of a group of commodities in one year with their prices in another year, or compare the price of a commodity in two different places. For example, we compare the price of a commodity in one city with its price in another city. This paper presents a study of these Indices from a neutrosophic point of view. Which allows us to study Indices with uncertain or non-well-defined price data. In addition, access to results that determine the extent of the change in prices as accurately as possible, and thus the optimal planning for the next stage and the development of appropriate solutions. An applied example was presented to study the change in the prices of pesticides used to combat the "vine stem borer" insect using the neutrosophic Indices.

Keywords: Indices, Neutrosophic Logic, Base Year, Studying Year, Comparison Year, Target Year.

1. Introduction

Neutrosophic means the study of ideas and concepts that are neither right nor wrong, but between that, and this means (neutrality, indeterminacy, ambiguity, contradiction, hesitancy), in which every field of knowledge and experience has its neutrosophic part which contains indeterminacy. The first scientist who established the neutrosophic theory was the American philosopher and mathematician F. Smarandache, he presented neutrosophic logic in 1995 as a generalization of fuzzy logic [1,2]. As an extension of this, Ahmed Salama presented the theory of classical neutrosophic sets as a generalization of the theory of classical sets [3,4]. The neutrosophic has grown significantly in recent years and many researchers have worked with it around the world because it formed a real revolution in science through its application in many disciplines and scientific and practical fields [5-12]. In this research, we highlight the study of the Indices from a neutrosophic point of view. Which allows us to study Indices with uncertain or non-well-defined price data. This matter is not available for study in the classical logic that does not recognize the existence of uncertain cases.

The neutrosophic indices are numerous because of the different ways they are created or because of the different phenomena that he compares. According to the phenomena that he compares, we find a large number of indices, for example, the neutrosophic index for wages and the neutrosophic index for agriculture...etc.

When creating the index for prices, we compare the prices of a year, which we will call the "studying year" or the "target year" (comparison year), and symbolize its prices with the symbol Np_I, with the prices of another year, which is the "base year", and symbolize its prices with the symbol Np_0. This comparison is carried out in different ways, depending on the establishment of the index of prices.

Before we start creating and applying the neutrosophic index, we must take the following three requirements into consideration:

1- Determine the base year. (It is preferable that this year be free from any abnormal circumstances).
2- Choosing the commodities that will be included in the calculation of the Neutrosophic Index of Prices. (It is preferable that these commodities are stable in quality and representative of people's habits).
3- Determining prices. (It is preferable to take them from official authorities). Here, we can take the prices in a neutrosophic way (that is, taking into account the change in the price of the commodity in the "base year" and the "studying year").

The aim of the study of the neutrosophic indices is to determine the extent of the change in prices and thus to study the economic or living ratio in the country for the sake of optimal planning for the future and for public spending. In addition to developing appropriate solutions for all problems to serve this goal.

2. The Theoretical Part of the Case Study is Supported by Applied Examples

2.1 Neutrosophic Index (NSN)

It is a tool for comparing a phenomenon or several phenomena dating back to different periods to know the amount of change in the phenomena, or between two different places, according to the neutrosophic logic which takes into account non-specific changes that occur and affect the study.

2.2 Simple Neutrosophic Ratio Indices:

It is either the neutrosophic ratio of one phenomenon value in the "comparison year" to the "base year", or the neutrosophic ratio of one phenomenon value in the "comparison place" to the "base place". Note that, the authors will be interested here in the general ways to create the neutrosophic index of prices. This Index is calculated from the following mathematical formula:

$$\text{NSN} = \frac{Np_1}{Np_0} * 100$$

Where the price in the "base year" is $Np_0 = p_{0L} + p_{0U}I$. Here, p_{0L} is denoted to the specified part of the price in the base year, while $p_{0U}I$ is denoted the undefined part of the price in the base year, the price in the "year of study" is $Np_1 = p_{1L} + p_{1U}I$. Where p_{1L} is denoted to the specified part of the price in the study year, and $p_{1U}I$ is the undefined part of the price in the study year.

2.2.2 Example

This study is dedicated to evaluating the change in the prices of one of the pesticides (aluminium phosphide) used to Combat the “vine borer” insect, as its price in 2020 was equal to 20 $ (with an unspecified amount [0,2]). while its price in 2022 was $30 (with an unspecified amount [0,5]), it is worth mentioning that the unspecified prices are appearing due to price instability in these years. So, the neutrosophic index for the price in 2022 compared to the year 2020:

$$NSN = \frac{Np_1}{Np_0} * 100$$

$$Np_0 = p_{0L} + p_{0U}I = 20 + [0.2] = [20.22]\ Np_1 = p_{1L} + p_{1U}I = 30 + [0.5] = [30.35]NSN = \frac{[30.35]}{[20.22]} * 100 = [150.159]\%$$

That is, the price of the pesticide increased by [50.59] % compared to its price in 2020.

Explanation:

To analyze the values of the neutrosophic index $NSN = [NSN_L, NSN_U]$, we have the following cases:

1- If $NSN = [NSN_L, NSN_U] = [100.100]$, that is, the value of the phenomenon has not changed compared to the base year or place of the f base.

2- If $NSN_L > 100$ or $NSN_U > 100$, that is, the value of the phenomenon has increased compared to the base year or place of base, and the percentage of rise is the difference between the index and 100.

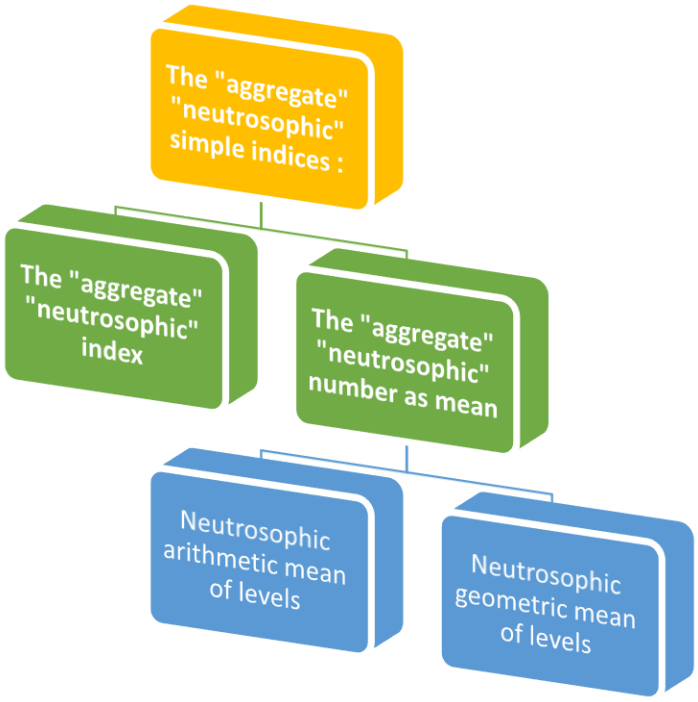
3- If $NSN_L < 100$ or $NSN_U < 100$, that is, the value of the phenomenon decreased compared to the base year or the place of base, and the percentage of decline is the difference between the index and 100.

4- The same interpretation is done in the case if $NSN_U > 100$ and $NSN_L < 100$. Or vice versa (but here we explain each side separately).

For example if we had $NSN = [75.159]\%$, the result explanation is that, at the beginning of the year, the prices were down by 25% compared to 2020, then until the end of the year the prices had increased by 59% compared to 2020 and so on.

2.3 The Aggregate Neutrosophic Simple indices:

The below flow chart illustrates the types of the aggregate neutrosophic simple indices which are divided into two types, the aggregate neutrosophic index, and the aggregate neutrosophic mean number, which is also can be divided into two categories the neutrosophic arithmetic mean of the levels, and the neutrosophic geometric mean of the levels.



2.2. 1. The Simple and Assembly Neutrosophic Number:

We express here the neutrosophic index of prices as the ratio of the sum of the neutrosophic prices of commodities in the comparison year to the sum of the neutrosophic prices of the commodities in the base year, multiplied by 100. Note that we use this number when the required is to compare more than one commodity at the same time

$$NSN_s = \frac{\sum Np_1}{\sum Np_0} * 100$$

Here, $\sum \mathrm{Np}_1 = \sum[\ \mathrm{p}_{1\mathrm{L}} + \ \mathrm{p}_{1\mathrm{U}}\mathrm{I}]$ represents the sum of the neutrosophic prices for commodities in the comparison year. While, $\sum Np_0 = \sum[\ p_{0L} + \ p_{0U}I]$ represents the sum of the neutrosophic prices for commodities in the base year.

Example

In this example, we recorded the prices in USD for three pesticides used to combat the "vine stem borer" insect. They are (chlorpyrifos - diflubenzuron - aluminium phosphide) in both the "base year" and the "comparison year". Where each of these commodities had a fixed price p_L with an unspecified amount that expresses the price change within one year $p_U I$, with assuming that the base year is 2010, and the comparison year is 2022, then the recorded price table is as follow:

Pesticides	**The price in the base year** Np_0	**The price in the study year** Np_1
Chlorpyrifos	1.2 + [0, 0.8]	24.2 + [0, 0.8]
Diflubenzuron	1.6 + [0, 0.5]	28.6 + [0, 0.4]
Aluminum phosphide	0.8 + [0, 0.1]	30 + [0, 1.5]
sum	[3.6, 5]	[82.8, 85.5]

$$NSN_s = \frac{\sum Np_1}{\sum Np_0} * 100$$

$$NSN_s = \frac{[82.8\ ,\ 85.5]}{[3.6,\ 5]} * 100 = [2300, 1710]\%$$

To analyze the above result, it is clear that the prices in the comparison year 2022 increased by a very large percentage compared to the base year 2010, and this explains and shows the significant inflation that occurred in prices between the comparison year and the base year. Again to make another comparison the prices of these pesticides between 2020 and 2022:

pesticides	**The price in the base year** Np_0	**Price in the study year** Np_I
Chlorpyrifos	14.2 + [0, 0.8]	24.2 + [0, 0.8]
Diflubenzuron	18.8 + [0, 1.3]	28.6 + [0, 0.4]
Aluminum phosphide	20.8 + [0, 2.1]	30 + [0, 1.5]
sum	[53.8, 58]	[82.8, 85.5]

$$NSN_s = \frac{\sum Np_1}{\sum Np_0} * 100$$

$$NSN_s = \frac{[82.8,\ 85.5]}{[53.8,\ 58]} * 100 = [147, 154\ ]\ \%$$

That is, pesticide prices in 2022 increased by $[47, 54]$ % over their prices in 2020.

2.2.2 The Simple Neutrosophic Average of Ratios:

As seen from the previous section, the assembly method to compare neutrosophic prices has a defect when we use it to compare a large number of commodities. This section is dedicated to overcoming this defect, where the average of a large number of ratios of commodities is used, either by using the neutrosophic arithmetic mean or by using the neutrosophic geometric mean.

i. **Neutrosophic Arithmetic Mean of ratios:**

The following mathematical formula is precisely derived for the above-mentioned purpose

$$M(NSN) = \frac{\sum \frac{Np_{1i}}{Np_{0i}}}{n} * 100$$

ii. Neutrosophic Geometric Mean of Ratios:

It is clear that the bellow formula service the same aim of this section as we previously stated:

$$M(NSN) = \sqrt[n]{\frac{Np_{11}}{Np_{01}} . \frac{Np_{12}}{Np_{02}} \dots \frac{Np_{1n}}{Np_{0n}}} . 100$$

Again, the mathematical statement $Np_0 = p_{0L} + p_{0U}I$ represents the price in the base year. While the formula $Np_1 = p_{1L} + p_{1U}I$ represents the price in the studying year. The symbol n denotes to the number of commodities.

Example

The below data table contains the price of pesticides A and B in both the base year and comparison year. The neutrosophic index, as an arithmetic mean and as a geometric mean, have been calculated in the same table, Given that pesticide A represents the diflubenzuron pesticide, and pesticide B is the aluminium phosphide pesticide. Also, suppose that the base year is 2020, and the comparison year is 2022.

Pesticides	**the price**		$\frac{Np_1}{Np_0}$
	Np_1	Np_0	
A	28.6 + [0,1.4]	18.8 + [0,0.2]	[1.52,1.57]
B	29 + [0,2.2]	20 + [0,1.2]	[1.45,1.47]
The sum	[57.6, 61.2]	[38.8,40.2]	[2.97,3.04]
Neutrosophic arithmetic mean of ratios		M(NSN)=[148.5, 152]%	
Neutrosophic geometric mean of ratios		M(NSN)=[148.45, 151.9]%	

i. Neutrosophic Arithmetic Mean of Ratios:

$$M(NSN) = \frac{\sum \frac{Np_{1i}}{Np_{0i}}}{n}.100 = \frac{[2.97, 3.04]}{2}.100 = [148.5, 152]\%$$

The neutrosophic arithmetic mean of the ratios indicates that the prices of pesticides increased between $[48.5, 52]\%$ between the base year and the comparison year.

ii. **Neutrosophic geometric mean of ratios**:

Here we have $n = 2$

$$M(NSN) = \sqrt[n]{\frac{Np_{11}}{Np_{01}}.\frac{Np_{12}}{Np_{02}}}.100 = \sqrt[2]{[1.52, 1.57].[1.45, 1.47]}\,.100 =$$

$$\sqrt[2]{[2.204, 2.308]}\,.100 = [148.45, 151.9]\%.$$

We notice that the neutrosophic geometric mean of the ratios indicates that the prices of pesticides increased by a range between $[48.45, 51.9]\%$ between the base year and the comparison year. However, the neutrosophic arithmetic mean of the ratios and the neutrosophic geometric mean of the ratios are very close and give almost the same amount of increase in prices that occurred in the prices of pesticides, and this confirms the reliability of this amount as an increase. Especially since we know that the arithmetic mean is easier to use, but the geometric mean is the best for this purpose.

3. Conclusion:

We conclude from this study that the generalization of classical indices to neutrosophic indices provides a more general and clear view in uncertain environments. In addition, it gave us better results in terms of determining the extent of the change in prices more precisely. Thus, the cost of the insect control process changes on the farms. This helps us in optimal planning for the next stage and developing appropriate solutions that serve this goal.

In the near future, we look forward to studying the neutrosophic indices for the weighted ratios, which gives each commodity its importance in terms of the number of units sold**.**

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References

[1] Smarandache, F, Neutrosophy and Neutrosophic Logic, First International Conference on Neutrosophy , Neutrosophic Logic, Set, Probability, and Statistics University of New Mexico, Gallup, NM 87301, USA,2002.

[2] Smarandache, F. A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability. American Research Press, Rehoboth, NM, 1999.

[3] A. A. Salama, F. Smarandache Neutrosophic Crisp Set Theory, Educational. Education Publishing 1313 Chesapeake, Avenue, Columbus, Ohio 43212, (2015).

[4] A. A. Salama and F. Smarandache. "Neutrosophic crisp probability theory & decision making process." Critical Review: A Publication of Society for Mathematics of Uncertainty, vol. 12, p. 34-48, 2016.

[5] R. Alhabib, M. Ranna, H. Farah and A. A Salama, "Foundation of Neutrosophic Crisp Probability Theory'', Neutrosophic Operational Research, Volume III , Edited by Florentin Smarandache, Mohamed Abdel-Basset and Dr. Victor Chang (Editors), pp.49-60, 2017.

[6] R. Alhabib, A. A Salama, "Using Moving Averages To Pave The Neutrosophic Time Series'', International Journal of Neutrosophic Science (IJNS), Volume III, Issue 1, PP: 14-20, 2020.

[7] Jdid .M, Alhabib. R ,and Salama A.A., The static model of inventory management without a deficit with Neutrosophic logic, International Journal of Neutrosophic Science (IJNS), Volume 16, Issue 1, PP: 42-48, 2021.

[8] Jdid .M, Alhabib. R and Salama. A.A., Fundamentals of Neutrosophical Simulation for Generating Random Numbers Associated with Uniform Probability Distribution, Neutrosophic Sets and Systems, 49, 2022

[9] Alhabib .R, M. Ranna, H. Farah and A. A Salama . Some neutrosophic probability distributions. Neutrosophic Sets and Systems, 22, 30-38, 2018.

[10] Jdid .M, Alhabib R. , Huda E. Khalid, and Salama. A.A, the Neutrosophic Treatment of the static model for the inventory management with safety reserve, International Journal of Neutrosophic Science (IJNS), Volume 18, Issue 2, PP: 262-271, 2022.

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