Neutrosophic Sets and Systems

Volume 37 Article 43

1-1-2020

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Neutrosophic Sets and Systems
{Special Issue: Impact of Neutrosophy in solving the Latin American's social problems}, Vol. 37, 2020
University of New Mexico

Neutrosophic Statistical Analysis of the Incidence of the Facultative Vote of Young People between 16 and 18 Years Old in the Electoral Process of Ecuador

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Abstract. Youth participation in the country's electoral processes has a great impact on Ecuadorian political life. Analyzing the incidence of the facultative vote and the responsibility that the use of the right implies in electoral democracy, constitutes an important task to guarantee citizen rights. These elements can be analyzed in the scientific literature through statistical studies. The present research aims to carry out an analysis of the incidence of the facultative vote of young people between 16 and 18 years old in the electoral process of Ecuador. To model the uncertainty in the proposed analysis, the neutrosophic statistics are used to include in the study the uncertainty about the fluctuation of the youth population and the invalid votes.

Keywords: Statistical analysis; facultative vote; Ecuadorian elections; neutrosophic numbers

1. Introduction

The participation of young Ecuadorians in electoral processes has had a significant evolution in active participation in elections after the constitution of 2008, known as Montecristi. The new legal framework placed in the hands of young people a great tool for political participation, which at first would be considered as a fact of little importance for young people [1, 2]. The increase in political rights influences the participation of 16-year-old. They obtain the necessary information through mechanisms used by the National Electoral Council (NEC) from the educational institutions where are concentrated the majority of young people empowered by the Ecuadorian Constitution to vote. This is a facultative right, that is, they decide their participation in this process [3, 4].

Knowing the importance of this exercise, based on the analysis of the incidence that the voluntary vote of young people has and the responsibility that the use of their right implies in electoral democracy, constitutes an important task to guarantee the needs of this sector in the society. This research took as a reference the one carried out by the National Electoral Council in 2014, on young voters under the age of eighteen, who reckoned 577,130, between men and women nationwide. In this and other investigations, the prevalence of ignorance of respondents regarding the age to access the right to vote was noted [5, 6].

The facultative vote in Ecuador is the result of various proposals from different sectors of society, which were present in the drafting of the Constitution in Montecristi [7, 8]. The proposals for the facultative vote were developed and debated at table No. 1, in charge of "Fundamental Rights and Constitutional Guarantees", where the right to vote evolved towards universalization, with a marked expansion of voters and their integration into the decisions of general interest as an important factor to improve the substantial life of the State democracy [9, 10].

The right to vote is optional for adolescents, from sixteen years old and even before turning eighteen [11, 12]. On this point, the inclusion of adolescents in active suffrage is the full recognition of citizenship, guarantees and rights that the State accepted since the Constitution of 1998. In 2003, the Code of Childhood and Adolescence was elaborated through which developed the participation rights of children and adolescents. In 2008 adolescents became part of the right to active suffrage and enjoy the political rights contemplated in the Constitution and laws [13, 14].

In this article, neutrosophic statistics is used to study voting among Ecuadorian youth with an age range between 16 and 18 years, during 3 consecutive voting periods. Neutrosophic statistics extend the classical statistics, where some of the elements such as population, sample size, and distribution parameters are calculated as an interval instead of crisp values. This is because we consider indeterminacies of the study population, as well as the samples, due to the existence of young people who could have voted and did not do so for justified reasons, as well as invalid votes, such as blank votes. This paper expose a preliminary section where the main concepts of Neutrosophy are described, including neutrosophic statistics. Section 3 includes the results of the study. Last section states to the conclusions.

2 Preliminaries

This section describes the basic concepts that will be used in the study, specifically the concept of the neutrosophic number [15-17]. In the 1980s, the international movement called Paradoxism [18], based on contradictions in science and literature, was founded by Smarandache, who later extended it to Neutrosophy, based on contradictions and their neutrals [19, 20]. Neutrosophic sets are a generalization of a fuzzy set (spatially of a fuzzy intuitive set) [15, 21, 22]. Let U be a universe of discourse, and M a set included in U. An element x of U with respect to the set M that is denoted as x (T, I, F) belongs to M in the following way: Is t% true in the set T, i% indeterminate (unknown) in the set I, and f% false in the set F, where t varies in T, i varies in I, f varies in F [6, 9, 23].

In order to facilitate the practical application to decision-making and engineering problems, the proposal of single value neutrosophic sets (SVNS) was made [9, 24-26] which allow the use of linguistic variables, which increases the interpretability in the recommendation models and the use of indeterminacy [27-29].

Statically T, I, F are subsets of [0, 1], but dynamically T, I, F are functions or operations dependent on many unknown or known parameters[25, 30].

Definition 1. Be a universe of discourse. An SVNS on is an object of the following form X AX [31-33]:

$$A = \{\langle x, u_A(x), r_A(x), v_A(x)\rangle : x \in X\} \tag{1}$$

Where, $u_A(x): X \rightarrow [0,1]$, $r_A(x), : X \rightarrow [0,1]$ y $v_A(x): X \rightarrow [0,1]$ con $0 \leq u_A(x) + r_A(x) + v_A(x) :\leq 3$ for all $x \in X$. The intervals $u_A(x), r_A(x)$ and $v_A(x)$ denote the true, indeterminate, and false memberships of x in A, respectively. For convenience, an SVN number will be expressed as $A = (a, b, c)$, where $a, b, c \in [0,1]$, and $0 \leq a+ b + c \leq 3$.

In order to work with neutrosophic numbers, neutrosophic statistics also have been defined. The confidence interval represents an application domain of the applied neutrosophic statistics [34-36]. The population sample neutrosophic confidence interval can be defined in the same way as the classic large sample confidence interval for the population proportion π[37-39]:

$$p \pm (Critical\ value\ Z)\sqrt{\frac{p(1-p)}{n}} \tag{2}$$

for the case when min and min,$\{np\} \geq 5\{n(1-p)\} \geq 5$

Where:

p: is the sample proportion, the number of individuals in the sample who possess the property of interest divided by the size of the sample;

n: sample size,

π: population proportion= $\frac{\text{Number of individuals in the population who own the property of interest}}{\text{Total individual of interest}}$

With the classic statistics distinction that in neutrosophic statistics the parameters p and n can be sets instead of crisp numbers z, and the critical value can also be a set (for example, it can be the confidence level) [40-42].

The neutrosophic sample statistic p, for n sufficiently large, has a neutrosophic sampling distribution, a normal curve that approximates the population mean π and its standard deviation according to formula 3.

$$std = \sqrt{\frac{\pi(1-n)}{n}} \tag{3}$$

It is necessary to include some algebraic operations between intervals:

Additionally, given and we have the following operations between them$I_1 = [a_1, b_1] I_2 = [a_2, b_2]$[43]:

$I_1 \leq I_2$ If and only if $a_1 \leq a_2 b_1 \leq b_2$

1. $I_1 + I_2 = [a_1 + a_2, b_1 + b_2]$ (Addition);

2. $I_1 - I_2 = [a_1 - b_2, b_1 - a_2]$ (Subtraction),
3. $I_1 \cdot I_2 = [\min\{a_1 \cdot b_1, a_1 \cdot b_2, a_2 \cdot b_1, a_2 \cdot b_2\}, \max\{a_1 \cdot b_1, a_1 \cdot b_2, a_2 \cdot b_1, a_2 \cdot b_2\}]$ (Multiplication),
4. $I_1/I_2 = I_1 \cdot (1/I_2) = \{a/b: a \in I_1, b \in I_2\}$, always that $0 \notin I2$ (Division).

3 Results and discussions

For the statistical analysis, the data from the National Electoral Commission for the corresponding period between 2009 and 2017 were used. The SPSS statistician was used to facilitate the calculation and analysis of the data. The electoral participation of young people between 16 and 18 years old in the presidential elections of the years 2009-2013 and 2017 shows an increase. Happening in the same way in the presidential elections to elect the president of the Republic of Ecuador in 2019. Many may be the factors that had an impact on young people, the place where they live, educational level, the non-mandatory nature, among other.

The training carried out by one of the highest organism of state functions, such as the electoral function, which through the National Electoral Council organizes according to the planning jointly with attached institutions such as the Institute of Democracy. The aforementioned institutions brought the necessary information to the educational establishments for the knowledge of the young people and the motivation to exercise their optional right. As well as the importance of choosing who would represent and govern the Ecuadorian state.

The recruitment of young people by Political Organizations who consider this electoral population interesting develops different activities and even political training schools. The non-compulsory vote of those under 18 years of age has not been any impediment to democratic expression, as it is shown in the participation of the facultative vote in 2017 was 71.70% of an optional electoral population of 676,401 voters in relation to 2009 where 64.80% corresponds to an optional electoral population of 453,882. Figure 1 shows a graph with the behavior of the corresponding period between 2009 and 2017.

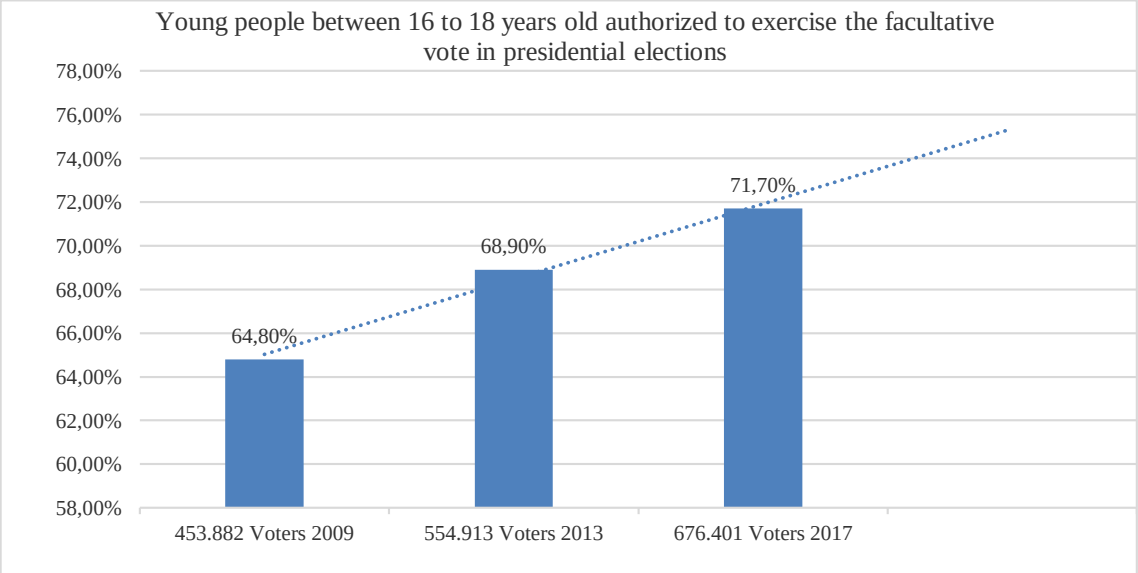

Figure 1: Scheme of the behavior of the facultative vote between 2009 and 2017.

The Ibero-American Youth Organization (IYO) states that all people between 15 and 29 years old are young [44]. Legally in Ecuador, young people are considered people whose ages are between 18 and 29 years old, it is proposed to reform the participation of young people in politics through the National Assembly to the Ecuadorian Code of Democracy.

A quota of young people not less than twenty-five percent (25%) will be incorporated into each list to be registered in the candidacies for multi-person elections. This is an indicator of improvement of the participation of young people under 18 years of age. This proves an interest of those who will administer the country and the planning of good public policies is that young people live aware of the national reality and stop being naive.

Organizational participation must be through youth collaborations where the full involvement of young people promoted in the civic, social, economic, cultural, artistic and political fields where trust and value to democracy have been created.

One characteristic of exercising the electoral vote is that it is secret and there are variants where it is exerted in a not necessarily effective way, such as a blank vote and a null vote. For greater accuracy of the results, an estimate

of invalid votes in the country was considered in this study, which is why population intervals were included in the research instead of exact sizes, the main idea is to infer with greater accuracy the voting behavior and effectiveness. To consider this, we include the neutrosophic confidence intervals as the population size.

Another reason to include intervals is in the intention of considering the real youth population, which for reasons of population dynamics does not vote, that they are traveling or another similar reason, although they could be interested in voting. This prompted us to consider the size of the youth voting population per year at the officially given size with an error of $\pm 0.1\%$. This value is the approximation given by the experts consulted that there may be young people who do not vote, but who intend to do so.

Taking into account the above-mentioned, the official youth population of voting age is estimated at$P_{2009} = [4.4934 \times 10^5,\ 4.5842 \times 10^5]$, $P_{2013} = [4.4934 \times 10^5,\ 4.5842 \times 10^5]$ y $P_{2017} = [4.4934 \times 10^5, 4.5842 \times 10^5]$.

The proportions obtained are:

$p_{2009} = [0.63975, 0.65639]$,,.$p_{2013} = [0.68218, 0.69596] p_{2017} = [0.70990, 0.72424]$

Taking z = 2.58, which means 99% confidence, we have the following neutrosophic confidence intervals:

For 2009 we have,$[0.63975, 0.65639] \times 100\%$

For 2013 we have,$[\ 0.68043, 0.69773] \times 100\%$

For 2017 it is.$[0.70818, 0.72599] \times 100\%$

An increase in the electoral vote is perceived.

Conclusions

The participation of young Ecuadorians in democratic life is fundamental since there is a positive effect on human relations with the strengthening of social integration. This participation of young people, which is optional to exercise the right to choose, produces positive effects on society.

In recent years, the participation of young people in Ecuador has developed in a quantitative way, which represents a different vision where political culture is created so that in the future they can have an active representation.

The statistical analysis of the behavior of variables related to the facultative vote constitutes an important element to guarantee the demands of all the sectors and in this sense the present investigation is framed. From the development of the research, an analysis was obtained on the behavior of the facultative vote in young people between 16 and 18 years of Ecuador.

The statistical analysis reflected that in the process of 2013, there was an increase compared to 2009 and that in turn 2017 increased compared to 2013, which shows the increase in the participation of young people. Modeling with the support of neutrosophic statistics made it possible to determine the behavior of the facultative vote with indeterminacy from the statistical tests of the confidence interval, including the indeterminate population size. These uncertainties included are due to estimates of young people who did not vote due to force majeure and who should have voted, in addition to including an estimate of invalid votes.

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Received: April 19, 2020. Accepted: August 21, 2020