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THE STATISTICAL AND ECONOMIC ANALYSIS OF THE EXPORTED LIVESTOCK IN SUDAN

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ABSTRACT

This paper describes an empirical study of analysis of the exported livestock in Sudan, by using analysis of variance and chi-square. The target of the paper is to check if there is a balance between the product and the exported number of the livestock. A sample of size 23 was obtained from ministry of animal resources in the Sudan. The data covered the period 1990-2012, and included the number of the exported livestock (cattle, sheep, goats and camels). The important result which the paper reached to that there was a balance between the product and the exported number of the livestock.

Keywords: ANOVA, Chi-Square, Export, livestock, Sudan, OIU.

1. INTRODUCTION

The export of a livestock is an important component of GDP of Sudan economy. It is an essential resource for foreign currency, it works with the stability of exchange rates and increases capital formation and promote economic development.

At 2011, livestock was estimated in Sudan by about 103.278 million heads of which 28.618 million heads of cattle and 39.296 million heads of sheep, 30.649 million heads of goats and 4.715 million camels. Table (1), shows the percentage of each variety of the livestock. It appears that, camels represent nearly 4.57 % of the total number of the livestock. There are no wide differences between the quantities of the other livestock.

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Table (1): shows the percentage of each variety of the livestock.

Livestock	Quantity	Percentage
COW	28618000	27.710
SHEEP	39296000	38.049
GOAT	30649000	29.676
CAMEL	4715000	4.565

The problem of the research is the lack of knowledge of whether there is a balance between the three exported livestock - sheep, cattle and camels. This paper aims to see if there is a balance in the exported livestock in Sudan. The importance of this paper appears in being different from previous studies that focused mostly on models or factors related to exports of livestock. This paper focused on the balance in the various exported livestock. This study is based on secondary data collected from the Sudanese Ministry of animal resources during the period 1990-2012. One way analysis of variance (ANOVA) was used in the data analysis through the statistical package SPSS. The chi-square test was also used in the analysis of the data. There is a balance between the product and the exported livestock in Sudan.

2. LITERATURE/THEORETICAL UNDERPINNING

2.1 Previous Studies:

Waad Alfadil, 2014, wrote a supplementary search to obtain the degree of Bachelor, entitled " Factors affecting the exported quantities of the live lamb in the Sudan". She used autoregressive model and reached to that, there are significant effects of the price and demand in the exported quantities of the exported live lamb in the Sudan [1]. Aldokhri Yusuf Mohamed Suleiman (2005), introduced a master thesis in administrative costs and accounting entitled "financial risks and how to hedge coverage, a case study of exporters of livestock in Sudan" [2]. Sabir Dawood Ahmed (2004), introduced a master thesis entitled "impact of investment policies on exports of livestock and meat in Sudan during (1992-2002), he reached to that a lack of funding and an insecurity were affected the investment in livestock and meat [3], also Sharif Hassan Annaier (2006), introduced a master thesis entitled "the role of bank financing in the export trade", Case Study of Al Shamal Islamic bank and reached to the same result of Sabir [4]. In 2012, Nahla Khandquaoui introduced a master thesis entitled "Study Estimating the Competitiveness of Exports from the Sudanese Red Meats to Saudi Arabia" [5].

2.2 Analysis of variance (ANOVA):

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Is a collection of statistical models used to analyze the differences among group means and their associated procedures (such as "variation" among and between groups), developed by statistician and evolutionary biologist Ronald Fisher. In the ANOVA setting, the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether or not the means of several groups are equal, and therefore generalizes the t-test to more than two groups. ANOVAs are useful for comparing (testing) three or more means (groups or variables) for statistical significance. It is conceptually similar to multiple two-sample t-tests, but is less conservative (results in less type I error) and is therefore suited to a wide range of practical problems.

2.2.1 One-way analysis of variance

In statistics, one-way analysis of variance (abbreviated one-way ANOVA) is a technique used to compare means of three or more samples (using the F distribution). This technique can be used only for numerical data [6].

The ANOVA tests the null hypothesis that samples in two or more groups are drawn from populations with the same mean values. To do this, two estimates are made of the population variance. These estimates rely on various assumptions (see below). The ANOVA produces an F-statistic, the ratio of the variance calculated among the means to the variance within the samples. If the group means are drawn from populations with the same mean values, the variance between the group means should be lower than the variance of the samples, following the central limit theorem. A higher ratio, therefore implies that the samples were drawn from populations with different mean values [7].

Typically, however, the one-way ANOVA is used to test for differences among at least three groups, since the two-group case can be covered by a t-test (Gosset, 1908). When there are only two means to compare, the t-test and the F-test are equivalent; the relation between ANOVA and t is given by $F = t^2$. An extension of one-way ANOVA is two-way analysis of variance that examines the influence of two different categorical independent variables on one dependent variable.

2.2.2 ASSUMPTIONS:

The results of a one-way ANOVA can be considered reliable as long as the following assumptions are met:

- Response variable residuals are normally distributed (or approximately normally distribution).

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- Variances of populations are equal.

- Responses for a given group are independent and identically distributed normal random variables (not a simple random sample (SRS)).

ANOVA is a relatively robust procedure with respect to violations of the normality assumption [8]. If data are ordinal, a non-parametric alternative to this test should be used such as Kruskal–Wallis one-way analysis of variance.

2.2.3 THE MODEL:

The normal linear model describes treatment groups with probability distributions which are identically bell-shaped (normal) curves with different means. Thus fitting the models require only the means of each treatment group and a variance calculation (an average variance within the treatment groups is used). Calculations of the means and the variance are performed as part of the hypothesis test.

The commonly used normal linear models for a completely randomized experiment are [9]:

$$Y_{ij} = \mu_i + \varepsilon_{ij} \rightarrow (1)$$

(The means model)

Or

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij} \rightarrow (2)$$

(The effects model)

where

j= 1,2,….,n is an index over experimental units

i = 1,2,….,k is an index over treatment groups

n_i is the number of experimental units in the ith treatment group

$n = \sum n_j$ is the total number of experimental units

y_{ij}s, are observations

μ_i is the mean of the observations from the i^{th} treatment group

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μ is the grand mean of the observations

α_i is the i[th] treatment effect, a deviation from the grand mean

$\sum \alpha_i = 0$

$\mu_i = \mu + \alpha_i$

$\varepsilon_{ij} \sim N(0,\sigma^2)$, are normally distributed with zero-mean random errors.

The index j over the experimental units can be interpreted several ways. In some experiments, the same experimental unit is subject to a range of treatments; j may point to a particular unit. In others, each treatment group has a distinct set of experimental units; j may simply be an index into the i[th] list. Table (2) shows ANOVA data organization, Unbalanced, Single factor.

Table (2): ANOVA data organization, Unbalanced, Single factor

	Group						**Grand Total**
Observation	**1**	**2**	**.....**	**i**	**....**	**k**	
	Y_{11}	Y_{21}	...	Y_{i1}	....	Y_{k1}	
	Y_{12}	Y_{22}	....	Y_{i2}	....	Y_{k2}	
	. .	. .	. .	. .	. .	. .	
	Y_1n_1	Y_2n_2	...	Y_in_i	....	Y_kn_k	
Total	$Y_{1.}$	$Y_{2.}$	...	$Y_{i.}$	...	$Y_{k.}$	$Y_{..}$
Mean	$\bar{Y}_{1.}$	$\bar{Y}_{2.}$	....	$\bar{Y}_{i.}$		$\bar{Y}_{k.}$	$\bar{Y}_{..}$

2.2.4 THE HYPOTHESES OF AN ANOVA:

The hypotheses of interest in an ANOVA are as follows:

- H_0: $\mu_1 = \mu_2 = \mu_3 = ... = \mu_k$
- H_1: Means are not all equal.

where k = the number of independent comparison groups.

Always the null hypothesis in the ANOVA is that there is no difference in the means. The research or alternative hypothesis is always that the means are not all equal and is usually written in words rather than in mathematical symbols. The research hypothesis doesn't capture any difference in means and includes, for example, the situation where all the k means are unequal, where one is different from the other k-1, where two are different, and so on. The alternative

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hypothesis, as shown above, capture all possible situations other than equality of, all means specified in the null hypothesis.

Table (3) shows Analysis of Variance for Single Factor.

Table (3): Analysis of Variance for Single Factor.

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F_c
B.Groups	k-1	SSB	MSB	$F = \frac{MSB}{MSW}$
W.Groups	n-k	SSW	MSW	
Total	n-1	SSTo		

2.2.5 ANALYSIS SUMMARY:

The core ANOVA analysis consists of a series of calculations. The data are collected in tabular form. Then

- Each treatment group is summarized by the number of experimental units, two summations are, a mean and a variance. The treatment group summaries are combined to provide totals for the number of units and the sums. The grand mean, and grand variance are computed from the grand sum. The treatment and grand means are used in the model.

- The three degrees of freedom (DF) and sum of squares (SS) are calculated from the summaries. Then the mean sums of of squares (MS) are calculated and a ratio determines F.

- A computer typically determines a p-value from F which determines whether treatments produce significantly different results. If the result is significant, then the model provisionally has validity.

If the experiment is balanced, all of the njs terms are equal, so the SS equations simplify.

In a more complex experiment, where the experimental units (or environmental effects) are not homogeneous, raw statistics are also used in the analysis. The model includes terms dependent on j. Determining the extra terms reduces the number of degrees of freedom available [10].

2.2.6 COMMENT:

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Fc is compared with 5% F(k-1, n-k) or 1% F(k-1, n-k), if Fc is less than 5% F(k-1, n-k), H_0 is accepted so, all the means of the groups are equal. 5% F(k-1, n-k). If Fc is greater than 5% F(k-1, n-k), H_0 is rejected so, a further test is needed to determine the difference between the means. If Fc is greater than 5% F(k-1, n-k), H_0 is rejected, so the test is highly significant.

2.3 PEARSON'S CHI-SQUARE TEST:

(χ^2) is a statistical test applied to sets of categorical data to evaluate how likely it is that any observed difference between the sets arose by chance. It is suitable for unpaired data from large samples[11]. It is the most widely used of many chi-squared tests (e.g., Yates, likelihood ratio, portmanteau test in time series, etc.) –statistical procedures whose results are evaluated by reference to the chi-squared distribution. Its properties were first investigated by Karl Pearson in 1900[12]. In contexts where it is important to improve a distinction between the test statistic and its distribution, names similar to Pearson χ-squared test or statistic is used.

It tests a null hypothesis stating that the frequency distribution of certain events observed in a sample is consistent with a particular theoretical distribution. The events considered must be mutually exclusive and have total probability 1. A common case for this is where the events each cover an outcome of a categorical variable.

Pearson's chi-squared test is used to assess two types of comparison: tests of goodness of fit and tests of independence.

A test of goodness of fit establishes whether or not an observed frequency distribution differs from a theoretical distribution.

A test of independence assesses whether unpaired observations on two variables, expressed in a contingency table, are independent of each other [13].

The procedure of the test includes the following steps:

1- Calculate the chi-squared test statistic, χ^2, which resembles a normalized sum of squared deviations between observed and theoretical frequencies (see below).

2- Determine the degrees of freedom, (df), of that statistic, which is essentially the number of categories reduced by the number of parameters of the fitted distribution.

3- Select a desired level of confidence (significance level, p-value or alpha level) for the result of the test.

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4- Compare χ^2 to the critical value from the chi-squared distribution with (df) degrees of freedom and the selected confidence level (one-sided since the test is only one direction, i.e. is the test value greater than the critical value?), which in many cases gives a good approximation of the distribution of χ^2.

5- Accept or reject the null hypothesis that the observed frequency distribution is different from the theoretical distribution based on whether the test statistic exceeds the critical value of χ^2. If the test statistic exceeds the critical value of χ^2, the null hypothesis H_0 = there is no difference between the distributions) can be rejected with the selected level of confidence and the alternative hypothesis H_1= there is a difference between the distributions) can be accepted with the selected level of confidence.

In a test of an independence, an "observation" consists of the values of two outcomes and the null hypothesis is that the occurrence of these outcomes is statistically independent. Each observation is allocated to one cell of a two-dimensional array of cells (called a contingency table) according to the values of the two outcomes. If there are r rows and c columns in the table, the "theoretical frequency" for a cell, given the hypothesis of independence, is as in equation (3):

$$E_{ij} = NP_{i.}P_{.j} \rightarrow (3)$$

where N is the total sample size (the sum of all cells in the table), and

$$P_{i.} = \frac{O_{i.}}{N} = \sum_{j=1}^{c} \frac{O_{ij}}{N}, P_{.j} = \frac{O_{.j}}{N} = \sum_{i=1}^{r} \frac{O_{ij}}{N}$$

The value of the test-statistic is as in equation (4):

$$\chi_c^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \rightarrow (4)$$

Fitting the model of "independence" reduces the number of degrees of freedom by p = $r + c - 1$. The number of degrees of freedom is equal to the number of cells $r.c$, minus the reduction in degrees of freedom, p, which reduces to $(r - 1).(c - 1)$.

For the test of independence, also known as the test of homogeneity, a chi-squared probability of less than or equal to 0.05 (or the chi-squared statistic being at or larger than the 0.05 critical point) is commonly interpreted by applying workers as justification for rejecting the null hypothesis that the row variable is independent of the column variable [14]. The alternative

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hypothesis corresponds to the variables having an association or relationship where the structure of this relationship is not specified.

The chi-squared test, when used with the standard approximation that a chi-squared distribution is applicable, has the following assumptions:

1-Simple random sample:

The sample data is a random sampling from a fixed distribution or population where every collection of members of the population of the given sample size has an equal probability of selection. Variants of the test have been developed for complex samples, such as where the data are weighted. Other forms can be used such as purposive sampling [15].

2-Sample size (whole table):

A sample with a sufficiently large size is assumed. If a chi squared test is conducted on a sample with a smaller size, then the chi squared test will yield an inaccurate inference. The researcher, by using the chi squared test on small samples, might end up committing a Type II error.

3-Expected cell count:

Adequate expected cell counts. Some require 5 or more, and others require 10 or more. A common rule is 5 or more in all cells of a 2-by-2 table, and 5 or more in 80% of cells in larger tables, but no cells with zero expected count. When this assumption is not met, Yates's correction is applied.

4-Independence:

The observations are always assumed to be independent of each other. This means chi-squared cannot be used to test correlated data (like matching pairs or panel data). In those cases you might want to turn to McNemar's test.

A test that relies on different assumptions is a Fisher's exact test; if its assumption of fixed marginal distributions is met it is substantially more accurate in obtaining a significance level, especially with a few observations. In the vast majority of applications this assumption will not be met, and Fisher's exact test will be over conservative and not have correct coverage [16].

3. RESULTS/FINDINGS

The data were obtained from the Ministry Animal Resources in the Sudan and are analyzed to have information about the balance between the produced quantities and the exported quantities of livestock.

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Table (4) shows the homogeneity of the error variance because P-value (Sig.) is greater than 5%. So, ANOVA is possible.

Table (4): Levene's Test of Equality of Error Variancesa.

Levene's Test of Equality of Error Variances[a]			
Dependent Variable: QUANTITY			
F	df1	df2	Sig.
2.397	3	88	.074
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.			
a. Design: Intercept + VARIETY			

Table (5) shows the normality of the data, and the measures of the central tendency and dispersion.

Table (5): Measures of a normality of the data, and the measures of the central tendency and dispersion.

Statistics			
		VARIETY	QUANTITY
N	Valid	92	92
	Missing	0	0
Mean			30357.42
Median			33102.00
Mode			4751[a]
Skewness			3.949
Std. Error of Skewness			.251
Kurtosis			28.093
Std. Error of Kurtosis			.498
Range			212412
a. Multiple modes exist. The smallest value is shown			

Table (6) shows ANOVA of the quantity of the exported livestock. There are significant differences between the quantity of the exported livestock because, P-value (Sig.) is greater than 5%.

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Table (6): ANOVA of the quantity of the exported livestock.

Tests of Between-Subjects Effects								
Dependent Variable: QUANTITY								
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	22607676908.554[a]	3	7535892302.851	17.399	.000	.372	52.196	1.000
Intercept	84784733170.533	1	84784733170.533	195.747	.000	.690	195.747	1.000
VARIETY	22607676908.554	3	7535892302.851	17.399	.000	.372	52.196	1.000
Error	38115744431.913	88	433133459.454					
Total	145508154511.000	92						
Corrected Total	60723421340.467	91						
a. R Squared = .372 (Adjusted R Squared = .351)								
b. Computed using alpha = .05								

Table (7) shows Multiple Comparisons of the quantity of the exported livestock. There are significant differences between the quantity of the exported camels and the quantity of the other exported livestock because, P-value (Sig.) is greater than 5%. There are no significant differences between the exported quantity of the sheep, goats, and cattle.

Table (7): (Post Hoc Tests) Multiple Comparisons of the quantity of the exported livestock

Multiple Comparisons						
Dependent Variable: QUANTITY						
LSD						
(I) VARIETY	(J) VARIETY	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
COW	SHEEP	611.87	6137.082	.921	-11584.29-	12808.03
	GOAT	7526.78	6137.082	.223	-4669.38-	19722.94
	CAMEL	38265.57*	6137.082	.000	26069.40	50461.73
SHEEP	GOAT	6914.91	6137.082	.263	-5281.25-	19111.07
	CAMEL	37653.70*	6137.082	.000	25457.53	49849.86
	COW	-611.87-	6137.082	.921	-12808.03-	11584.29
GOAT	SHEEP	-6914.91-	6137.082	.263	-19111.07-	5281.25
	CAMEL	30738.78*	6137.082	.000	18542.62	42934.94
	COW	-7526.78-	6137.082	.223	-19722.94-	4669.38
CAMEL	SHEEP	-37653.70-*	6137.082	.000	-49849.86-	-25457.53-

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	GOAT	-30738.78-*	6137.082	.000	-42934.94-	-18542.62-
	COW	-38265.57-*	6137.082	.000	-50461.73-	-26069.40-
Based on observed means. The error term is Mean Square(Error) = 433133459.454.						
*. The mean difference is significant at the .05 level.						

Table (8): Descriptive Statistics of the Exported Livestcok

Descriptive Statistics				
Dependent Variable: QUANTITY				
VARIETY	Mean	Mean %	Std. Deviation	N
COW	41958.48	34.55	38371.690	23
SHEEP	41346.61	34.05	13106.718	23
GOAT	34431.70	28.36	9354.639	23
CAMEL	3692.91	03.04	923.003	23
Total	30357.42		25831.964	92

Table (9) shows an actual percentage data for calculating a chi-square for testing the balance of exporting livestock in the Sudan.

Table (9): The actual data of calculating a Chi-Square.

Livestock	Quantity	Exported Mean	Quantity%	Mean %	Raw total "R"
COW	28618000	41958.48	27.71	34.55	62.26
SHEEP	39296000	41346.61	38.05	34.05	72.10
GOAT	30649000	34431.70	29.68	28.36	58.04
CAMEL	4715000	03692.91	04.56	03.04	07.60
Column total "C"			100	100	200.0

Table (10) shows an expected percentage data for calculating a chi-square for testing the balance of exporting livestock in the Sudan.

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Table (10): The expected data for calculating a Chi-Square.

Livestock	Quantity%	Mean %	Raw total "R"
COW	31.13	31.13	62.26
SHEEP	36.05	36.05	72.10
GOAT	29.02	29.02	58.04
CAMEL	03.80	03.80	07.60
C	100	100	200.0

$\chi^2 = [(27.71-31.13)^2/31.13 + (34.55-31.13)^2/31.13 + (38.05-36.05)^2/36.05 + (34.05-36.05)^2/36.05 + (29.68-29.02)^2/29.02 + (28.36-29.02)^2/29.02 + (4.56-3.8)^2/3.8 + (3.04-3.8)^2/3.8] = 0.376+0.376+0.111+0.111+0.015+0.015 + 0.152 + 0.152= 1.21$

$\chi^2_{(3,\ 0.05)} = 7.81$

Since the computed chi-square is 1.21, which is less than the tabulated one (7.81), therefore, the test is insignificant. The result means that there is a balance between the produced quantities and the exported quantities of livestock.

4. CONCLUSION

1. There is a balance between the produced quantities and the exported quantities of livestock.

2. The whole livestock in Sudan divided as 27.71 % cattle, 38.05 % sheep, 29.68 goats and 4.56 % camels.

3. The exported livestock in Sudan divided as 34.55 % cattle, 34.05 % sheep, 28.36 goats and 3.04 % camels.

5. RECOMMENDATION

According to the above results, we recommend that to preserve the balance between the produced quantities and the exported quantities of livestock.

6. FURTHER RESEARCH

To make similar studies of others produced and exported commodities.

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