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An Assessment of Relationship between the Consumption Pattern of Carbonated Soft Drinks in Ilorin Emirate

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Abstract
Increased awareness about the health and other hazards of regular and uncontrolled consumption of carbonated drinks has yielded little or no result, in other words there has not been a significant change in production and sales of carbonated plants in the Ilorin Emirate.
Secondary data collected from these plants located in the emirate revealed that the first canonical variates U_1 V_1 is a girth measurement whereas the second variates U_2, V_2 can be described as a shape measurement approximately proportional to the difference of the standardized sales and quantity produced at each season. The canonical correlations reveals an essentially one dimensional and well specified by single correlation value of 0.94.
Keywords: Canonical, Carbonated, Girth, measurement

INTRODUCTION

Nigeria is among the countries with high soft drink consumption Mazariegos, Ramos (1995). Results from National bureau of statistics (NBS) survey on consumption pattern indicates that 86.5% of Nigerians consume carbonated soft drinks (NBS, 2010).

Furthermore, the average daily consumption of soft drinks for male and female adolescent aged 13 – 21 years old was 50 fl oz per day a regular can of soft drink is 12 fl oz. Adolescent studies indicated that besides school and restaurants, home was the most popular source for obtaining soft drinks Guenther (1995). To encourage this increase consumption of these soft drinks, Coca-cola alone spends ₦500,000 per day on advertising (NBC, Ilorin Plant Bulletin Vol. 4 No. 1. The high level of this soda consumption has some health consequences. First Guenther found that soft drink intake was negatively correlated with intake of milk, and the nutrients calcium, magnesium, riboflavin, vitamin A and ascorbic acid Guenther (1986).

Secondly, the high sugar acid contents of soda have consequences for teeth. Studies investigating the effect of carbonated beverages on the wear of human and animal enamel wear Shabat (1975); Harison and Roeder, 1991; Mistry and Grenby (1993). Recent studies showed that not only the refined sugar in regular soda contribute to tooth decay Birkhed (2007), but also the phosphorus acid (H_3P0_4) in it tend to cause erosive lesions Rytomaa (1998).

Thirdly, Whysak and Frisch, (1994) and Petridou, (1997) found a strong association between carbonated cola beverage consumption and bone fracture in 76 girls, 8 – 16 years old. Cola beverages were significantly associated with fractures among school age children 7 – 14 years old Whysak found an association between carbonated beverage consumption and bone fractures among teenage girls Whysak (2000). With changing lifestyle as a result of awareness of health implications and income levels can we say that people are shifting their consumption patterns and have therefore become more health conscious thus leading to a change in pattern of consuming these carbonated drinks.

This study therefore looked into the relationship between production levels and sales using canonical correlation procedure.

The hypothesis was tested on whether all canonical correlations are zero.

THEORETICAL FRAMEWORK

Neil H. Timm 2000) describe multiple correlation coefficients as the maximum correlation between the random variables Y_1 and linear combination $\beta^1 x$

Where

$$\mu = \begin{bmatrix} Y \\ X \end{bmatrix} \sim N_{p+q} \begin{Bmatrix} \mu_1 \\ \mu_2 \end{Bmatrix}, \Sigma = \begin{bmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{bmatrix}$$

Let $Y_i = [Y_1, Y_2]$

$X_i = [X_1, X_2]$ be two linear functions

$\upsilon = a^1 y$ and $V = b^1 x$ of unit variance such that the correlation between υ and V is maximum. The linear function that yields maximum correlation are termed canonical variates. The goal of canonical analysis is to find two set of weights a and b such that each canonical variates is maximally correlated.

$F_{uv} = M_{ax}\, a^1 \sum_{12} b$-------- (1)

Subject to

$$a^1 \sum_{11} a = b^1 \sum_{22} b = 1$$

$$\Rightarrow \left| \sum_{21} \sum^{-1}_{11} \sum_{12} - \lambda^2 \sum_{22} \right| = 0 \text{ where}$$

λi are called the canonical correlation between the canonical variates.

$U_i = a_i\, Y$ and $V_i = b_i^1\, X$

For i = 1 ---------- $P \leq q$ and

b_i is given by $\sum_{21} a_i = \lambda_1 \sum_{22} bi$

The set of canonical variates U_i and V_i are clearly uncorrelated and have unit variance

$$CoV(U_i, U_j) = CoV(V_i\, V_j) = \begin{cases} 1 & i = j \\ 0 & i \neq j \end{cases}$$

Therefore $\lambda^2{}_1$ is an eigen value of $\sum^{-1}_{11} \sum_{12} \sum^{-1}_{22} \sum_{21}$ and α is its corresponding eigen vector, while $\lambda^2{}_2$ is an eigen value of $\sum^{-1}_{22} \sum_{21} \sum^{-1}_{12}$ and β is its corresponding eigen vector, since $\lambda = \alpha^1 \sum_{12}{}^{\beta}$ the quantity that we set out to maximize, then the required eigen value of each of these matrices must be the largest eigen value.

MATERIALS AND METHOD

The study was carried out with some selected carbonated soft drinks plant in Ilorin the Kwara State Capital of Nigeria. The Ilorin Emirate is a traditional state based on the city of Ilorin, it is considered to be one of the Banza Bakwai or copy cats of the Hausa Kingdom (http://en.wikipedia.org/wiki/Ilorin Emirate).

The Emirate consist of about 5 local governments viz Ilorin West, Ilorin South, Ilorin East, Moro and Asa local governments, and have the major plants of carbonated industries located in them.

Both primary and secondary data was used in this study. The secondary data comprises of data obtained from the monthly report of carbonated soft drinks plant which includes sales and quantity produced at the two different season of the years between 2007 and 2013. Data were analysed using descriptive statistics and canonical correlation analysis.

Results and Discussion

$$R = \begin{pmatrix} 1 & & & \\ 0.6 & 1 & & \\ 0.93 & 0.73 & 1 & \\ 0.7 & 0.84 & 0.79 & 1 \end{pmatrix}$$

$$\left| R^{-1}_{11} R12\, R^{-1}_{22} R_{21} - \lambda I \right| = 0$$

$$= (0.72 - \lambda)(0.49 - \lambda) - 0.2 \times 0.34 = 0$$

$$= \lambda 2 - 1.21\lambda + 0.2848 = 0 \Rightarrow \lambda = 0.89 \text{ or } 0.32$$

Hence the canonical correlations are

$R_1 = 0.94$ and $R_2 = 0.56$

The canonical variates coefficient

$Y^1 = (Y_1, Y_2)$ of sales are given by the eigen vectors of

$R^{-1}{}_{11} R_{12} R^{-1}{}_{22} R_{21}$ which are $\alpha_1 = \begin{bmatrix} 0.062 & \alpha_2 & 0.1532 \\ 0.083 & & -0.1607 \end{bmatrix}$

The canonical variate coeffient bi for the quantity produced

$X^1 = (X_3, X_4)$ are given by the eigen vectors of

$R^{-1}{}_{22} R_{21} R^{-1}{}_{11} R_{12}$ which gives

$\Lambda = 0.62$ or 0.1208

Hence $R_2 = 0.79$ or 0.34 and

$$b_1 \begin{pmatrix} 0.0611 \\ 0.0737 \end{pmatrix}, b_2 = \begin{pmatrix} 0.182 \\ -0.321 \end{pmatrix}$$

The corresponding eigen vectors are

Thus the canonical variates are

$U_1 = 0.062Y_1 + 0.083Y_2$

$V_1 = 0.0611X_3 + 0.0733X_4$
$U_2 = 0.1532Y_1 - 0.1607Y_2$
$Y_2 = 0.182X_3 - 0.321X_4$

HYPOTHESIS TEST

The test that all population canonical correlation are zero is a test of no association between two sets of variables Y_1 and Y_2 which in turn is equivalent to the test that $\sum_{12} = 0$. If the sample and population covanance matrixes are partitioned in the usual way containing P_1 and P_2 element respectively and we wish to test whether the variates in Y_1 are independent of those in Y_2. Where canonical correlation is denoted by R_1 -------------- R_s (whose S = min (P > q) for Pq elements in Y_1 and Y_2 respectively.

The likelihood ratio test statistic X is given by

$$- \quad 2 \log_e \lambda_1 = \sum^{s}_{i=1} \log_e (1 - R_i^2)$$

and has an asymptotic χ^2 distribution with pq degrees of freedom, also the χ^2 approximation may be improved this time by replacing n by

$$n^1 = n - ½ (p + q + 3)$$

$$Ho: \sum_{12} = 0 \quad Vs \quad \sum_{12} \neq 0$$

For the first set of canonical correlation p = q = 2

$$n^1 = 30 - ½ (2 + 2 + 3) = 30 - 3.5 = 26.5$$

$$- \quad 2\log_e{}^{\lambda} = n^1 \sum \log_e (1 - R^2)$$
$$= -26.5 (-2.207274 + -038588248)$$
$$= 68.713$$
$$\lambda^2 \; 4, 0.095 = 9.49$$

Hence we reject the null hypothesis that both population canonical correlations are zero and conclude that some association exist between the two sets of measurement (i.e. sales of carbonated soft drinks during the dry season are not independent of the quantity produced).

Also to test

$$Ho: \lambda_1 = 0, \lambda_2 = 0 \quad Vs \quad H_1: \text{ not } H_0$$
$$\lambda = \ldots\ldots\ldots (1 - r_i^2) = (1 - 0.32) = 0.68$$
$$X = - \{(30 - 1) - ½ (2 + 2 + 1)\} \ln 0.68$$
$$= - [29 - 5/2)] \ln 0.68$$
$$= 10.22$$

===

Hence, we clearly reject the null hypothesis that both population canonical correlations are zero and conclude that some association exist between the two sets of measurements that is sales at the dry season are not independent of the quantity produced at the same period.

Similarly when $R^2_i = 0.62$ and 0.1208

$$-2 \log_e{}^{\lambda} = -n \sum^{s}_{i=1} \log_e (1 - R_i^2)$$
$$= -26.5 (-0.96758 + -0.12874)$$
$$= 29.05$$
$$\chi^2_{4,\, 0.095} = 9.49$$

Which clearly indicates that some association exists between the quantities produced at any one particular season.

INTERPRETING ASSOCIATIONS

The canonical correlations found from the eigen values of the matrices.

$$\left| R^{-1}_{11} R_{12} R^{-1}_{22} R_{21} - \lambda I \right| = 0$$
$$\left| R^{-1}_{22} R_{21} R^{-1}_{11} R_{12} - \lambda I \right| = 0$$

Implies that

$$\lambda_1 = 0.89, \; \lambda_2 = 0.32, \; \lambda_3 = 0.62 \text{ and } \lambda_4 = 0.12$$

Also the eigen vectors corresponding to these eigen values are as follows

$$\lambda_1 = 0.89 \quad \alpha_1 \begin{bmatrix} 0.062 \\ 0.083 \end{bmatrix}, \quad b_1 = \begin{bmatrix} 0.0611 \\ 0.0733 \end{bmatrix}$$

$$\lambda_2 = 0.32 \quad \alpha_2 \begin{bmatrix} 0.182 \\ -0.1607 \end{bmatrix}, \quad b_2 = \begin{bmatrix} 0.182 \\ -0.321 \end{bmatrix}$$

The first canonical variates U_1, V_1 can therefore be interpreted as a girth measurement (being approximately proportional to the sum of the standardized sales and quantity produced at each season); while the second canonical variates U_2, V_2 can be interpreted as shape measurement being approximately proportional to the difference of the standardized sales and quantity produced at each season.

From the canonical correlations $R_1 = 0.94$ and $R = 0.656$. It is evident that the association between Y_1 and Y_2 is thus essentially one dimensional and well specified by the single correlation value of 0.94. (This value is larger than any of the entries R_{12}). It only remains to check that this value represent a genuine association.

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