Multivariate Analysis of Advertising and Sales in Nigeria
ANALYSE MULTIDIMENSIONNELLE DE LA PUBLICITE ET DES VENTES AU NIGERIA

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Abstract
It is an established fact by marketing researchers that locally made products impact a lot on the economy of any nation, this they opined encouraged economic growth and expand job opportunities for the citizenry. Despite these benefits this products also suffer a great deal of setbacks to include poor channel of dissemination of information outside the shore of Nigeria. This handicap has been of great concern to the market researchers and many have even proposed the use of some forms of advertising techniques to achieve their goals. In this paper emphasis is placed on the use of selected advertising techniques, to achieve increase in the sales of some locally made products in Nigeria. A random sample of one hundred observations forms the target population. Multiple regression analysis and the tested hypothesis revealed that greater sales of locally made products are influenced by mode of advertising.

Key words: Multivariate; Advertising; Regression; Hypothesis

INTRODUCTION
Advertising is one of the communication or promotional tools employed by marketing oriented establishment, to reach their target markets. So many definitions have been advanced by many authors. According to Patti and Frazer (1988.4), advertising is a marketing communications element that is persuasive, non-personal, paid for by an identified sponsor, and disseminated through mass channels of communication to promote the adoption of goods, services, persons and ideas. Peter & Donnelly (2003.118) see advertising as a paid form of non-personal communication about an organization, its products or its activities that is transmitted through a mass medium to a target audience. The mass medium may be television, radio, newspaper, magazine, outdoor displays, car-cards or directories. Advertising generally could be said to be a
A new form of advertising that is growing rapidly is electronic advertising. It is online advertising with a focus on social network sites; this is a relatively matured market because it has shown a lot of promise as advertisers are able to take advantage of the demographic information the users have provided to the social network site. Friendvertising is a more precise advertising term in which people are able to direct advertising towards others directly using electronic advertising (Martin, 2006).

### 1. METHODOLOGY

This describes the methods adopted for the purpose of collecting information and sources from which the information used were collected. Research designs and methodology are typically classified according to the nature of the research objectives or type of research. However for this research a descriptive research design was used, first to portray the characteristics of the problem at hand and also determine the degree of which each advertising technique positively affects sales of some locally made products in Nigeria. It is necessary to mention here that questionnaires and personal interviews were used for data collection in this research, the two were used to collect the primary data for 10 locally made product in Nigeria. At each state, one hundred people were interviewed and the number of people who came by the product through the various form of advertisement is shown in Table 1 below.

<table>
<thead>
<tr>
<th>Product</th>
<th>Radio advert</th>
<th>Newspaper</th>
<th>Electronic advert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close Up</td>
<td>6</td>
<td>60</td>
<td>34</td>
</tr>
<tr>
<td>Eva soap</td>
<td>9</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>Eva wine</td>
<td>36</td>
<td>61</td>
<td>03</td>
</tr>
<tr>
<td>3 Crowns matches</td>
<td>39</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td>Candle</td>
<td>90</td>
<td>7</td>
<td>03</td>
</tr>
<tr>
<td>Chalk</td>
<td>64</td>
<td>26</td>
<td>10</td>
</tr>
<tr>
<td>Klin detergent</td>
<td>81</td>
<td>17</td>
<td>02</td>
</tr>
<tr>
<td>Bournvita</td>
<td>77</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Plantain powder</td>
<td>90</td>
<td>08</td>
<td>02</td>
</tr>
</tbody>
</table>

Multivariate Linear Regression Model:

Let \( Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + e \)

The term linear refers to the fact that the mean is a linear function of the unknown parameters \( \beta_0, \beta_1, \beta_2, \ldots, \beta_n \).

The predictor variable may or may not enter the model as first order term with \( n \) independent observation on \( y \) as the associated values of \( x \), the complete model becomes:

\[
Y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_n x_{in} + e_i
\]

Where the error terms are assumed to have the properties \( \text{E}(e_i) = 0 \)

\( \text{Var}(e_i) = \sigma^2 \)

\( \text{Cov}(e_i, e_j) = 0, i \neq j \)

In matrix notation, we can write the above model as:

\[
Y = \begin{bmatrix}
Y_1 \\
Y_2 \\
\vdots \\
Y_n
\end{bmatrix} = \begin{bmatrix}
1 & X_{11} & X_{12} & \cdots & X_{1n} \\
1 & X_{21} & X_{22} & \cdots & X_{2n} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
1 & X_{n1} & X_{n2} & \cdots & X_{nn}
\end{bmatrix} \begin{bmatrix}
\beta_0 \\
\beta_1 \\
\beta_2 \\
\vdots \\
\beta_n
\end{bmatrix} + \begin{bmatrix}
e_1 \\
e_2 \\
\vdots \\
e_n
\end{bmatrix}
\]

OR \( Y = \beta x + e \) And the error property becomes

\( \text{E}(e) = 0 \)

\( \text{Cov}(e) = \sigma^2 I \)

Where \( \beta \) and \( \sigma \) are unknown

Now the regression equation of \( Y \) on \( X_1, X_2, X_3, \ldots \) is

\[
\bar{Y} = \beta_0 + \beta_1 \bar{X}_1 + \beta_2 \bar{X}_2 + \beta_n \bar{X}_n
\]

equation (I)

The value of the coefficients \( \beta_i, i = 0, \ldots, 3 \) can be obtained by solving the following normal equations:

\[
\sum Y = n \beta_0 + \beta_1 \sum X_1 + \beta_2 \sum X_2 + \beta_n \sum X_n
\]

\[
\sum X_1 Y = \beta_0 \sum X_1 + \beta_1 \sum X_1 X_1 + \beta_2 \sum X_1 X_2 + \beta_n \sum X_1 X_n
\]

\[
\sum X_2 Y = \beta_0 \sum X_2 + \beta_1 \sum X_1 X_2 + \beta_2 \sum X_2 X_2 + \beta_n \sum X_2 X_n
\]

\[
\sum X_3 Y = \beta_0 \sum X_3 + \beta_1 \sum X_1 X_3 + \beta_2 \sum X_2 X_3 + \beta_n \sum X_3 X_n
\]

equation (II)
The table below gives the required values:

<table>
<thead>
<tr>
<th></th>
<th>X_1</th>
<th>X_2</th>
<th>X_3</th>
<th>X_1X_2</th>
<th>X_1^2</th>
<th>X_2^2</th>
<th>X_1Y</th>
<th>X_2Y</th>
<th>X_3Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>6</td>
<td>30</td>
<td>16</td>
<td>180</td>
<td>360</td>
<td>1800</td>
<td>90</td>
<td>360</td>
<td>555</td>
</tr>
<tr>
<td>3.3</td>
<td>8</td>
<td>33</td>
<td>63</td>
<td>264</td>
<td>624</td>
<td>2055</td>
<td>1089</td>
<td>3969</td>
<td>746.4</td>
</tr>
<tr>
<td>109.2</td>
<td>11</td>
<td>36</td>
<td>64</td>
<td>396</td>
<td>704</td>
<td>2304</td>
<td>121</td>
<td>1296</td>
<td>4096</td>
</tr>
<tr>
<td>120.0</td>
<td>16</td>
<td>39</td>
<td>65</td>
<td>624</td>
<td>1040</td>
<td>2535</td>
<td>1521</td>
<td>4225</td>
<td>1920</td>
</tr>
<tr>
<td>118.6</td>
<td>19</td>
<td>43</td>
<td>67</td>
<td>817</td>
<td>1273</td>
<td>2881</td>
<td>361</td>
<td>1849</td>
<td>4489</td>
</tr>
<tr>
<td>120.0</td>
<td>21</td>
<td>46</td>
<td>68</td>
<td>966</td>
<td>1428</td>
<td>3128</td>
<td>441</td>
<td>2116</td>
<td>4624</td>
</tr>
<tr>
<td>133.0</td>
<td>25</td>
<td>49</td>
<td>69</td>
<td>1225</td>
<td>1725</td>
<td>3381</td>
<td>625</td>
<td>2401</td>
<td>4761</td>
</tr>
<tr>
<td>136.5</td>
<td>26</td>
<td>53</td>
<td>70</td>
<td>1378</td>
<td>1820</td>
<td>3841</td>
<td>756</td>
<td>2809</td>
<td>5262</td>
</tr>
<tr>
<td>134.0</td>
<td>27</td>
<td>55</td>
<td>73</td>
<td>1485</td>
<td>20255</td>
<td>4075</td>
<td>9175</td>
<td>4075</td>
<td>7980</td>
</tr>
<tr>
<td>140.0</td>
<td>29</td>
<td>57</td>
<td>75</td>
<td>1653</td>
<td>22195</td>
<td>4015</td>
<td>9175</td>
<td>7234.5</td>
<td>9555</td>
</tr>
<tr>
<td>1197.1</td>
<td>188</td>
<td>441</td>
<td>674</td>
<td>8988</td>
<td>13000</td>
<td>54186.4</td>
<td>81336.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This can be represented in matrix form as:

\[
\begin{bmatrix}
10 & 188 & 441 & 674 & \vdots & \beta_0 & 1197.7 \\
188 & 4149 & 8988 & 13000 & \beta_1 & 23748 \\
441 & 8988 & 20255 & 30108 & \beta_2 & 54186.4 \\
674 & 13000 & 30108 & 45618 & \beta_3 & 81336.9
\end{bmatrix}
\]

Putting in augmented form, we have:

\[
\begin{bmatrix}
10 & 188 & 441 & 674 & \vdots & 1197.7 \\
188 & 4149 & 8988 & 13000 & 23748 \\
441 & 8988 & 20255 & 30108 & 54186.4 \\
674 & 13000 & 30108 & 45618 & 81336.9
\end{bmatrix}
\]

Subtracting times first row from second row; times first row from third row; times first row from fourth row; finally we subtract time 3rd row from 4th row to have

\[
\begin{bmatrix}
10 & 188 & 441 & 674 & \vdots & 1197.7 \\
0 & 614.4 & 697.2 & 328.8 & \vdots & 1231.2 \\
0 & 0 & 16.0 & 11.6 & \vdots & 28.9 \\
0 & 0 & 0 & 6.1 & \vdots & 25.9
\end{bmatrix}
\]

Detaching the right hand column back to its original place, we have

\[
\begin{bmatrix}
10 & 188 & 441 & 674 & \vdots & 1197.7 \\
0 & 614.4 & 697.2 & 328.8 & \vdots & 1231.2 \\
0 & 0 & 16.0 & 11.6 & \vdots & 28.9 \\
0 & 0 & 0 & 6.1 & \vdots & 25.9
\end{bmatrix}
\]

Then by backhand substitution starting from the last row, we have

\[
\begin{align*}
6.1\beta_1 &= 25.9 \\
\beta_1 &= 4.25 \\
16\beta_2 + 16\beta_3 &= 28.9 \\
16\beta_2 &= 28.9 \quad (11.6 \times 4.25) \\
\beta_2 &= -1.28 \\
614.4\beta_0 + 697.2\beta_2 + 16\beta_3 &= 1231.2 \\
614.4\beta_0 &= 1231.2 - (697.2 \times [-1.28] + 328.8 \times 4.25) \\
&= 1231.2 - [-892.42 + 1397.4] \\
&= 1231.2 - 504.98
\end{align*}
\]

\[
\beta_0 = 1.18 \\
10\beta_0 + 188\beta_1 + 441\beta_2 + 674\beta_3 = 1197.7 \\
10\beta_0 = 1197.7 - (188 \times 1.18 + 441 \times (-1.28) \times 674 \times 4.25) \\
&= 1197.7 - (221.84 - 564.48 + 28645) \\
&= 1197.7 - 2521.86 \\
&= -1324.16 \\
\beta_0 &= -132.48
\]

We now have,

\[
\begin{bmatrix}
\beta_0 \\
\beta_1 \\
\beta_2 \\
\beta_3
\end{bmatrix} = \begin{bmatrix}
-132.42 \\
1.18 \\
-1.28 \\
4.5
\end{bmatrix}
\]

Substituting with the regression equation, we have

\[
\bar{Y} = -132.42 + 1.18\bar{X}_1 - 1.28\bar{X}_2 + 4.5\bar{X}_3
\]

The above equation is the required regression equation of the effect of the advertising technique on the sales of some locally made products in Nigeria. While drawing statistical inference using multiple regressions, it should be noted that the regression coefficient for highly inter-correlated independent variables tends to be unreliable, this is because in highly inter-correlated independent variables, it is extremely difficult to separate the individual influence of each variable. There is a great deal of concern in fields such as econometrics and applied statistics with the problem of inter-correlation among independent variables, often referred to as multi-co linearity, as suggested by Morris Hamburg (2009) that one of the solutions to this problem is to merely discard one of the variables.

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### 2. Hypothesis Testing

Having given a careful analysis of the response, the null and alternative hypothesis related to this work can now be formulated and tested using the likelihood ratio test for the regression parameters.

H0: U_1 = U_2 = U_3 = 0; the greater number of sales of these locally made products is influenced by mode of advertising.

H1: U_1 ≠ U_2 ≠ U_3 ≠ 0; the greater number of sales of...
these locally made products is not influenced by mode of advertising.

**ANOVA TABLE**

<table>
<thead>
<tr>
<th>SOURCE OF VARIATION</th>
<th>SUM OF SQUARES</th>
<th>DEGREE OF FREEDOM</th>
<th>MEAN SQUARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between samples</td>
<td>11818.7</td>
<td>2</td>
<td>5909.35</td>
</tr>
<tr>
<td>Within samples</td>
<td>1612.9</td>
<td>27</td>
<td>59.74</td>
</tr>
<tr>
<td>Total</td>
<td>13431.6</td>
<td>29</td>
<td></td>
</tr>
</tbody>
</table>

The confidence interval for this research is given at $\alpha = 99\%$ since 100 questionnaire were distributed and 99 persons returned on record.

The 99 responses represent 99% response rate while the unreturned one represent 1% non-response rate; hence the decision to accept or reject the null hypothesis shall be based on the $F$ - ratio test ($F_{\alpha}$).

Therefore, $F(2, 27)_{\alpha} = 5.49$

Our rejection rule is to reject $H_0$ if $F_{cal} > F_{tab}$

$F_{cal} = 98.92$

$F_{tab} = 5.49$

We observe that $F_{cal} > F_{tab}$ which falls within the rejection region. Hence we do not have enough statistical evidence to accept $H_0$, so we accept $H_1$ and draw conclusion that the greater sales of these locally made product is influences by mode of advertising.

**CONCLUSION**

It can be deduced from our findings that the mode of advertising of these products actually influence the number of sales of the products. This could be traced to the fact that the coefficient of regression in radio advertising is higher than that of newspaper and electronic advertising.

The analysis of variance and the statistical hypothesis also confirm this assertion.

**REFERENCE**


