MEASURING THE EFFECTIVENESS OF MARKETING INVESTMENTS USING THE METHOD OF SNEDECOR'S F DISTRIBUTION

Nikola Vojvodic, PhD
PIM University of Banja Luka, 78000 Banja Luka, Republic of Srpska, Bosnia and Herzegovina
+38765-549-858, nikola62@teol.net
Boro Vojvodic, PhD
City of Prijedor, 79101 Prijedor, Republic of Srpska, Bosnia and Herzegovina
borovojvodic@teol.net
Drazen Vrhovac, Mr
City of Prijedor, 79101 Prijedor, Republic of Srpska, Bosnia and Herzegovina
drazen.vrhovac@fondpiors.org
Momcilo Komljenovic, PhD
Foreign Trade Chamber of Bosnia and Herzegovina, 78000 Banja Luka, Republic of Srpska, Bosnia and Herzegovina, +38765-625-220, momokomljenovic@hotmail.com

Abstract: The environment in which insurance companies operate is all the more complex and turbulent which requires a systemic approach to business and adaptation to the constant changes on the insurance market. In order to create or maintain the competitive advantage it is necessary to study marketing in insurance as a new, scientific, meaningful, technologically more advanced and profitable approach in this field. It includes applying tools of the marketing mix and implementing the activity of analysis of: environment (external and internal), formulating the strategy of market performance, implementation of the strategy as well as its estimate and control, promotion and adequate channels of insurance products distribution.

Key words: Marketing investments, insurance, measuring, effectiveness, competitiveness, Snedecor's F distribution.

INTRODUCTION

A special position and significance appertain to the marketing measuring, that is, the metrics representing a system for measuring which quantifies the trend, dynamics or characteristics of the investment in marketing. In reality, all disciplines practically use the metrics to explain phenomena, diagnoses and causes, to share the acquired knowledge and to design results of the future events. The managers used to admit that half the money they spent on advertising was wasted. But those days of uncontrolled increase of the budget are over as measuring and liability are introduced. The elements which are to be measured include margin, price, variable and fixed marketing expenses, sales extent before and after the marketing investment, brand attractiveness, impressions, exposure, viewership, average expenses of gaining and keeping an insurer, the sales manager's performance, etc.

Planning the return on marketing investment (ROMI) will be presented on the example of a successful insurance company using the method of the Snedecor's *F* distribution.

1. STATISTICAL ANALYSIS

The statistical analysis has been done on the example of an insurance company which planned its propaganda expenses using the percentage of insurance sales method.

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As the propaganda expenses were slowly increasing, the insurance premium was also increasing because the propaganda effect was delayed, that is, the actual propaganda effects did not deliver results until the following year.

The analysis has been done by the econometric model $Y = a + bX$, whose rated model is as follows $\hat{Y} = \hat{a} + \hat{b}X$ or $\hat{Y} = \hat{a} + \hat{b}X + e$. The model parameters ($a, b$) are rated ($\hat{a}, \hat{b}$) by the method of the least squares. Determining the validity of the model rating $\hat{Y} = \hat{a} + \hat{b}X$ is best done using the coefficient of determination (R^2), which measures the impact of the change in the independent variable X on the change in the dependent variable Y.

$$\hat{F} = \frac{R^2}{(1 - R^2)} * (n - 2)$$

R^2 can be seen as the relation when explaining the independent variable Y, i.e. how many percents are explained by X, and how many by excluded factors. The significance of R^2 is tested by the method of the **Variance analysis**, which can be represented as follows: $\hat{F}$ is compared to the table values of the Snedecor's *F* distribution with 1 and n-2 of degrees of freedom $F_{n-2}^1(a)$. If $\hat{F} > F_{n-2}^1(a)$, then Y statistically significantly depends on the factor X. That is, we set the hypotheses:
H_0: the X variable has no significant impact on the Y variable;

H_1: the X variable has a significant impact on the Y variable.

H_0 hypothesis is accepted if $\hat{F} \leq F_{n-2}^1(a)$, and H_1 hypothesis is accepted if $\hat{F} > F_{n-2}^1(a)$. „a" represents the risk level, that is, the possibility of making a mistake in

percents. We have calculated with a =0.5%. The scale on the Y-axis of the charts in the paper is logarithmic for better visibility and legibility of the data.

In the following table the propaganda expenses and total revenue of an insurance company are presented in order to prove the above mentioned hypotheses, that is, whether the investment in propaganda significantly affects the insurance premium increase of the insurance company.

Table 1 Business revenue, propaganda expenses and % of the propaganda expenses in the total revenue

Month	Total revenue	Propaganda expenses	Participation of the propaganda expenses in the total revenue
I	600,000	3,720	0.62%
II	700,000	3,850	0.55 %
III	1,100,000	5,280	0.48 %
IV	1,200,000	3,240	0.27%
V	1,500,000	12,300	0.82%
VI	3,200,000	30,720	0.96%
VII	2,800,000	24,360	0.87%
VIII	1,500,000	3,900	0.26%
IX	1,100,000	2,420	0.22%
X	600,000	1,620	0.27%
XI	500,000	1,100	0.22%
XII	700,000	3,920	0.56%
Total	15,500,000	96,430	0.62%

Year of 2013
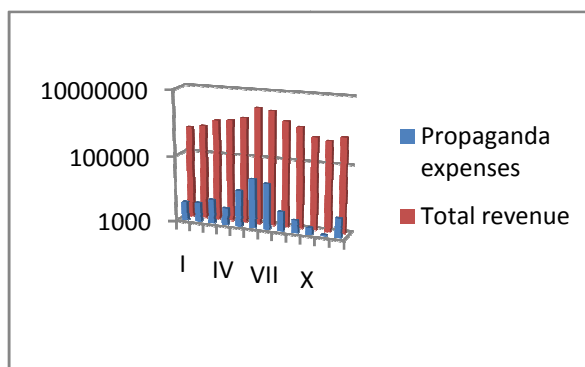
If we mark the total revenue with Y, as the dependent variable, and the propaganda expenses with X, as the independent variable, we can calculate R^2, according to the formula $R^2 = \dfrac{(\Sigma xy)^2}{\Sigma x^2 \Sigma y^2}$. We calculate x

and y from the relation $X - \overline{X}$, that is, $Y - \overline{Y}$, and prior to it we must calculate $\overline{X} = \dfrac{\Sigma X}{n}$ i $\overline{Y} = \dfrac{\Sigma Y}{n}$, so that:

$$\hat{Y} = \frac{\Sigma Y}{n} = \frac{15,500,000}{12} = 1,291,166.66$$

$$X = \frac{\Sigma X}{n} = \frac{96,430}{12} = 8,035.83$$

$x = X - X = 96,430 - 8,035 = 88,395$

$y = Y - \overline{Y} = 15,500,000 - 1,291,167 = 14,208,833$

Then we calculate for each month
$x = X - \overline{X}$, S $x = 0$ i $y = Y - \overline{Y}$, S $y = 0$, and finally, we calculate the sums xy, x^2 and y^2 and insert them in the formula:

$x^2 = 7,813,499,236$

$y^2 = 2.018909 \times 10^{14}$

$xy = 88,395 \times 14,208,833 = 1.255975 \times 10^{12}$

$(xy)^2 = 1.577474 \times 10^{24}$

$$R^2 = \frac{(\Sigma xy)^2}{\Sigma x^2 \Sigma y^2} = \frac{1.577474 \times 10^{24}}{1.57748 \times 10^{24}} = 0.999$$

$$\hat{F} = \frac{R^2}{(1 - R^2)} * (n - 2) = \frac{9.99}{0.001} = 9,990$$

$F^1_{10} = 55.552$

As $\hat{F} \geq F^1_{10}$ (a = 0.5 %), the hypothesis H_1 is accepted: the X variable significantly affects the Y variable, that is, with certainty of 99.5% we can assert that the investment in propaganda in 2013 affected the total revenue of the insurance selling.
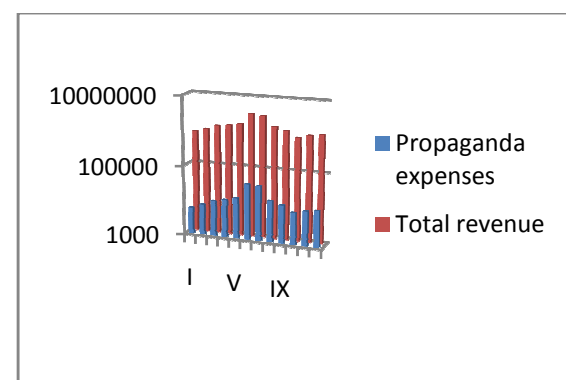
Year of 2014

Table 2 Business revenue, propaganda expenses and % of the propaganda expenses in the total revenue

Month	Total revenue	Propaganda expenses	Participation of the propaganda expenses in the total revenue
I	800,000	5,760	0.72%
II	1,000,000	7,600	0.76%
III	1,300,000	10,530	0.81%
IV	1,400,000	12,320	0.88%
V	1,600,000	14,720	0.92%
VI	3,300,000	40,260	1.22%
VII	3,000,000	38,100	1.27%
VIII	1,600,000	15,680	0.98%
IX	1,300,000	12,610	0.97%
X	900,000	8,370	0.93%
XI	1,100,000	10,010	0.91%
XII	1,200,000	11,280	0.94%
Total	18,500,000	187,240	1.01%

In 2014 we have the following situation:

$x^2 = 2.945925 \times 10^{10}$
$y^2 = 2.875850 \times 10^{14}$
$xy = 88,395 \times 14,208,833 = 2.91067 \times 10^{12}$
$(xy)^2 = 8.471999849 \times 10^{24}$

$$R^2 = \frac{(\Sigma\, xy)^2}{\Sigma x^2 \Sigma y^2} = \frac{8.471999849 \times 10^{24}}{8.4720384 \times 10^{24}} = 0.999995449$$

$$\hat{F} = \frac{R^2}{(1-R^2)} *(n-2)$$

$$\hat{F} = \frac{0.999995449}{(1-0.999995449)}(12-2) = 2,197,309$$

As $\hat{F} > F^1_{10}$ (a = 0.5 %), that is, 2,197,309>55.552, we reject H_0 and accept H_1: the X variable statistically has a significant impact on the Y variable, which means that the investment in propaganda delivered positive effects on the total revenue. In 2014 the investment in propaganda increased from 96,430 to 187,240 BAM and the total revenue for even 3,000,000 BAM.
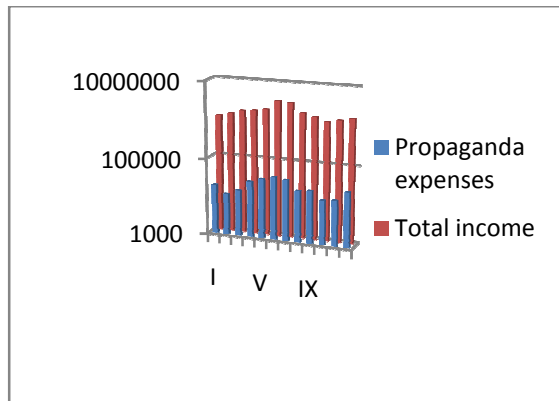
Year of 2015

Table 3 Business revenue, propaganda expenses and % of the propaganda expenses in the total revenue

Month	Total revenue	Propaganda expenses	Participation of the propaganda expenses in the total revenue
I	1,100,000	19,360	1.76%
II	1,300,000	11,830	0.91%
III	1,600,000	15,680	0.98%
IV	1,700,000	28,560	1.68%
V	1,900,000	36,480	1.92%
VI	3,300,000	43,560	1.32%
VII	3,100,000	39,680	1.28%
VIII	1,800,000	21,960	1.22%
IX	1,500,000	23,700	1.58%
X	1,200,000	14,520	1.21%
XI	1,400,000	15,540	1.11%
XII	1,600,000	27,360	1.71%
Total	21,500,000	298,230	1.39%

It can be noted that the percentage of the investment in propaganda increased from average 0.62% of the total revenue in 2013 to 1.39 % in 2014, whereas the total revenue of 15,500,000 BAM, achieved in 2013, increased to 21,500,000 BAM in 2015. Therefore, it can be concluded that the slow increase of propaganda expenses has a delayed impact on the insurer's awareness so that they insure their property exactly at this insurance company, which caused the increase of the total revenue. If we analyse the data:

$$\overline{Y} = \frac{\Sigma Y}{n} = 1{,}791{,}667 ; \qquad \overline{X} = \frac{\Sigma X}{n} = 24{,}852.50.$$

x = X – X = 298,230 – 24,852.50 = 273,377.50

y = $Y - \overline{Y}$ = 21,500,000 – 1,791,667 = 19,708,833

$x^2 = 7.473525751 \times 10^{10}$
$y^2 = 3.884183896 \times 10^{14}$
xy = 273,377.50 × 19,708,833 =
= $5.387814805 \times 10^{12}$
$(xy)^2 = 2.902854837 \times 10^{25}$

$$R^2 = \frac{(\Sigma xy)^2}{\Sigma x^2 \Sigma y^2} = \frac{2.902854837 \times 10^{25}}{7.473525751 \times 10^{10} \times 3.884183896 \times 10^{14}} = 0.999999742$$

$$\hat{F} = \frac{R^2}{(1-R^2)} *(n-2)$$

$$\hat{F} = \frac{0.999999742}{(1 - 0.999999742)}(12 - 2) = 38{,}759{,}679$$

As $\hat{F} > F^1_{10}$ (a = 0.5 %), that is, 38,759,679>55.552, we reject H_0 and accept H_1: the X variable statistically has a significant impact on the Y variable.

At the end, it can be concluded that as the investment in propaganda increases, the revenue of the insurance selling also increases, that is, the marketing investment is completely justified.

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