Simulating the fade-away impact of promotional activities over the firm's revenue using Autoregressive Models and NetLogo

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Abstract— **The importance of Marketing function in the business is increasing day by day mainly by the fact that today's business world is very competitive. In this competitive business world, service/ product differentiation and positioning defines the success or the failure of businesses. Promotions Mix (Advertising, Sales Promotions, Personal Selling, Direct Marketing and Public Relations) is the key aspect of Marketing function because it is through the promotions that the marketers bridge firm with the customers. Even though promotional activities can boost firm's revenue, it comes with a greater cost too. This has made senior personnel in marketing function to be questioned of the impact of the promotions activities over the revenue of the firm. The impact of promotional activities can be divided into 2 main categories, tangible benefits (increase in revenue, gross margins and net margins) and intangible benefits (brand value, customer value, and brand equity). In general, the tangible benefits are assumed to behave according to the efficient market hypothesis i.e the tangible benefits of promotional activities is completely occurred / absorbed in the same period and it will not have a fade-away impact on the forth coming periods. Using Autoregressive model the researcher proves in this paper that the impact of promotional activities have a fade-away effect where the impact will not only be on the same period which the promotions were executed but will be there for the immediate forthcoming period also. (It was proved that the 1st order autoregressive model is not zero by testing hypotheses). Then the researcher tests the basic equation derived for the relationship between the revenue (dependent variable) and the promotions budget (independent variable) using different distributions as the inputs. It was found in the research that the profit was maximized when Random Normal Distribution and Random Poisson Distributions were used as the inputs/ independent variable.**

Introduction

The businesses are becoming aggressively competitive day by day. Today, for a given need of a customer there are many players in the market who are giving competitive offerings. This has made 'service differentiation/ products differentiation' an important aspect of business which makes one seller's offering conspicuous from the rest of the offerings. The main function in business which is responsible of 'differentiation' is the Marketing Function. According to Sri Lanka Institute of Marketing [1], 'Marketing is a corporate philosophy and central business function of an organization that creates values for its customers and other stakeholders through competitive, profitable and sustainable exchange process.' Marketing function has the ability to make or break a business as it stands as the interfaces which connects the business with the most important stakeholder of the business, customer. By proper service/ product differentiation and positioning, Marketing function creates brands which can demand premium prices from the customer for the superiority of the products/ services.

Though Marketing function can bring many benefits to the firms, it comes with a cost too. In general, businesses considers marketing function as one of most expensive functions as it accounts for expenses which are incurred for advertising, sales promotions, personal selling, direct marketing and public relations related activities. This has made the Marketing Managers at the spot light of the board meetings because they are always expected to come up with solid evidence of the positive impact of marketing activities over the revenue/ financial performance of the firm.

A. The fade-away impact of promotional activities over the revenue

The general practice is that to reduce the promotions related costs from the same period which it has occurred. This method assumes the promotional activities as a cost and the impact of the same only lies in the same period. In this research, the researcher proves that the impact of the promotional activities has a **fade-away impact** where the impact not only lies in the same period which the promotional activities occurred but it has an impact on the forth coming periods also. The researcher tests the autoregressive models in 3 orders to see the significance of it.

B. Building the relationship between the promotions and the revenue/ financial performance

Using the Autoregressive Models, the researcher comes up with a basic y= mx + c type equation which shows the relationship between the revenue and the promotions budget. This is done by testing the data sets for following 2 hypotheses.

H_0- *n*th order auto regression is zero
H_1- *n*th order auto regression is not zero

If p-Value > 0.05 (at 5% significance level), don't reject the null hypotheses. If not reject the null hypothesis and accept the alternative hypothesis.

The above mentioned hypothesis is tested for different orders and then the coefficient and the intercept of the equation which shows the relationship between the promotions budget (x) and the revenue (y).

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When tested with the data, it was found that the 3rd order and 2nd order auto regressive models were zero and only the 1st order autoregressive model was not zero. (p-Value = 0.0213 > 0.05; reject the null hypothesis). From the 1st order auto regressive model, the m_value and c_value of the basic equation was found.

C. Testing the basic equation with NetLogo

The basic equation built through the autoregressive model is tested with different distributions using the above applet created using NetLogo. The m_value and the c_values are taken from the basic equation and it is tested with different distributions as follows.

Let's assume for a given data set, the m_value and c_value of the basic equation as follows.
m_value – 5.5
c_value – -449000

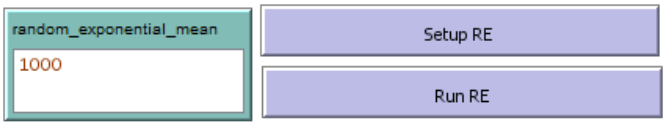
D. Testing the basic equation using a Random Exponential Distribution for revenue/profit maximizing

The continuous random variable X follows an **exponential distribution** if its probability density function is:

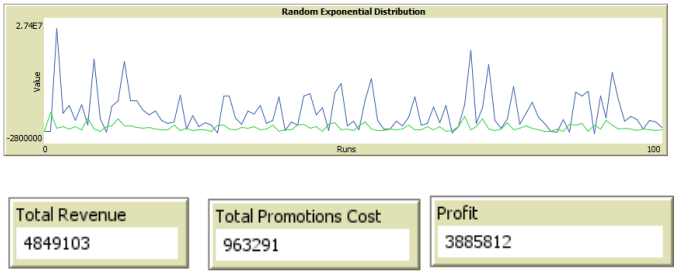
$$f(x)=1\theta e-x/\theta f(x)=1\theta e-x/\theta$$

for $\theta > 0$ and $x \geq 0$.

Input interface
A random exponential distribution with a mean of 1000 was used as the inputs for the independent variable.



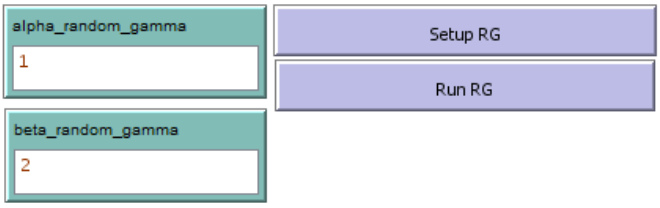
Output interfaces



E. Testing the basic equation using a Random Gamma Distribution for revenue/profit maximizing

Input Interface

A random gamma distribution with an alpha value of 1 and beta value of 2 was used as the inputs for the independent variable.



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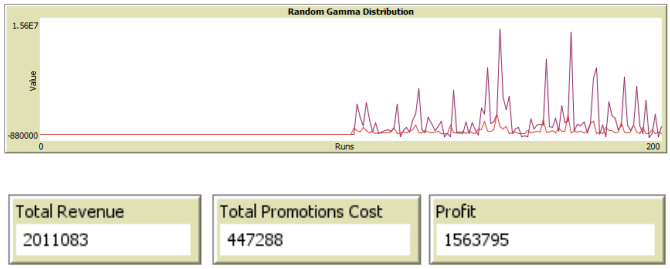


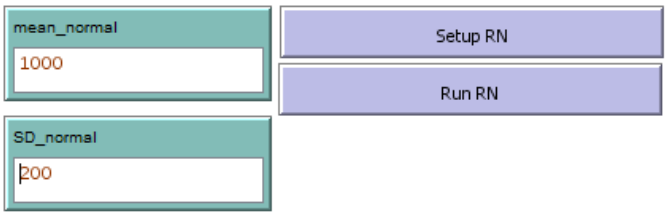
F. Testing the basic equation using a Random Normal Distribution for revenue/profit maximizing

A normal distribution in a variant x with mean μ and variance σ^2 is a statistic distribution with probability density function

$$P(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/(2\sigma^2)}$$

Input interface

A random normal distribution with a mean of 1000 and a standard deviation of 200 was used as the inputs for the independent variable.



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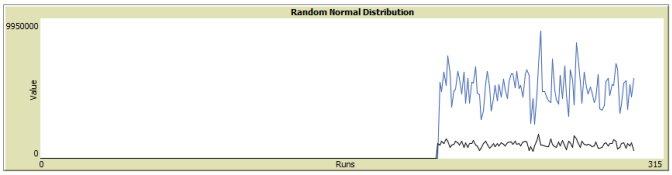
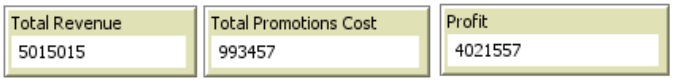




G. Testing the basic equation using a Random Poisson Distribution for revenue/profit maximizing

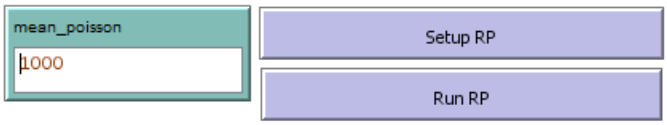
When the average number of successes within a given region is μ. Then, the Poisson probability is:

$$P(x; \mu) = (e\text{-}\mu)\ (\mu x) / x!$$

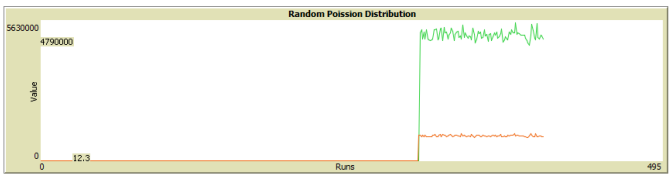
x is the actual number of successes that result from the experiment, and e is approximately equal to 2.71828.

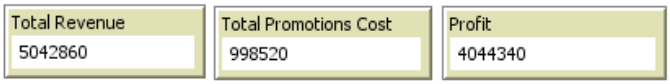
Input interface

A random Poisson distribution with a mean of 1000 was used as the inputs for the independent variable.



Output interfaces





I. Figures

The above Auto Regressive Model and the NetLogo applet were tested using the below empirical data set.

Month	Revenue	Promotions Budget
M1	2,100,000.00	524,000.00
M2	2,142,000.00	550,200.00
M3	2,249,100.00	577,710.00
M4	2,316,573.00	606,595.50
M5	2,362,904.46	618,727.41
M6	2,481,049.68	649,663.78
M7	2,580,291.67	682,146.97
M8	2,709,306.25	695,789.91
M9	2,763,492.38	716,663.61
M10	2,901,667.00	730,996.88
M11	3,104,783.69	752,926.78
M12	3,291,070.71	805,631.66

II. Citing Previous Work

Promotions have 2 main types of effects on the organization; Tangible Effects and Intangible Effects. [2].The tangible impact refers to the increase in Revenue, Gross Profit and Net Profit etc. The intangible benefits generally refers to the brand value/ brand equity which is created from promotional activities.

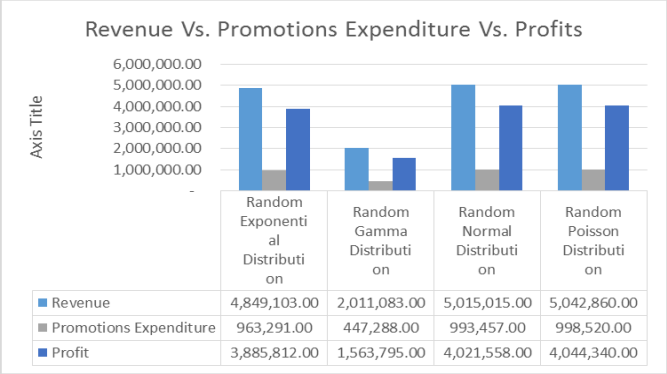
In most of the marketing literature which focuses on the effects of promotional activities on the financial performance, the studies were done under the Efficient Market Hypothesis [3]. It states that the current stock prices contains all available information about the future expected profits of a firm. This hypothesis presumes that the impact of promotional activities will only be in the same period of time, but will not have any impact on the forth coming periods. The marketing activities such as new product introductions contain information that takes several weeks to be fully incorporated to the firm [4]. This finding signals the early idea of the existence of fade-away-impact from the promotional activities on firm's revenue.

III. Conclusion

According to this study, it was proven that the 1st order auto regression is not zero. (At 1st order auto regression, the null hypothesis was rejected and hence the alternative was accepted.)This means that the impact of a particular month's promotional activities will not be in the same month, but the impact will be there for next immediate month also. This proves that the promotional activities have a fade-away impact over the financial performance of the organization (specifically on the firm' revenue).

A summary of the Revenue, Promotions Expenditure and the Profits generated from the basic equation using different distributions are as follows.

Distribution	Revenue	Promotions Expenditure	Profit
Random Exponential Distribution	4,849,103.00	963,291.00	3,885,812.00
Random Gamma Distribution	2,011,083.00	447,288.00	1,563,795.00
Random Normal Distribution	5,015,015.00	993,457.00	4,021,558.00
Random Poisson Distribution	5,042,860.00	998,520.00	4,044,340.00



According to above illustration it is clear that the profit is highest when Random Normal Distribution and Random Poisson Distributions were used as the input distributions for the promotions budget/ expenditure (independent variable).

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