SANKHYA VIGNAN
सांख्य विज्ञान

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SANKHYA VIGNAN
સંખ્યા વિજ્ઞાન

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EDITORIAL

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</div>

We are extremly happy to present this issue (NSV 14, June 2018, No.1) to our readers. We express our sincere thanks to all our contributors, evaluators, readers and well wishers for their consistent support which has helped us in achieving our goal.

This issue contains **two articles, four research articles,** one **biography, one book review** and **other items** as usual.

Under the caption of **Management Anad Statistics, first article** is an interesting conceptual presentation on research design given by **A.C.Brahmbhatt.**

Second article presented by **Dinesh S. Dave and R. L. Alexander** is an application for transshipment problem in SC Management.

First research article is an application in the field of Inventory management under stipulated conditons. It is discussed by **Viralis S. Vora and U.B.Gothi.**

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Biographical note for Prof. Amartyasen (Who was awarded **Nobel Prize and Bharat Ratna** for his distinguished and pioneering works in welfare economics) has been presented by **H.D.Budhbhatti.**

There is a **Book Review** on very famous internationally known book on econometric studies. It is given by **H.M.Dixit.**

S.V.News letter provides some useful information. This time it is presented by **D. K. Ghosh.**

Readers Forum provides readers views and suggestions. It is given by **A.M.Patel.**

We are highly indebted to our following referees who have done excellent job of evaluations for the articles / papers submitted in this issue.

(Their names are given one by one in order of their apperance in the journal.)

(1)	**J. R. Purohit**	(2)	**R. G. Bhatt**
(3)	**A. C. Brahmbhatt**	(4)	**H.M. Dixit**
(5)	**M. B. Thaker**	(6)	**P. H. Thaker**
(7)	**H. S. Mediwala**	(8)	**Shailesh Teredesai**

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Wishing you good health and seasons greetings.

WISH YOU ALL HAPPY STATISTICS DAY.

Ahmedabad

Date : 29-06-2018

FROM EDITOR'S DESK

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PHILOSOPHICAL WORLD VIEWS AS THE BASIS OF RESEARCH DESIGN

A. C. BRAHMBHATT*

ABSTRACT

This article discribes in nutshell the three basic ideologies for research design. Briefly their areas and limitations are also highlighted. These concepts can be useful for researchworkers for their research projects.

Key Words

World Views : Post Positive, Interpretivism, Pragmatic

• • •

Any study, mostly in social sciences follows a particular map or blueprint or a research design .There are three such research designs prevalent in the conduct of any study, ---qualitative, quantitative and mixed-methods. Qualitative and quantitative studies should not be viewed as the two extremes on a continuum, they are not the polar opposites. A study can be more of qualitative than quantitative or vice-versa. The mixed-method approach is somewhere in the middle of the continuum.

These three different approaches emanate from three different worldviews. The worldview means a set of assumptions that guide action. Researchers also call them as paradigms , epistemologies or ontologies. Let us understand them in a greater detail.

* Research Mentor, PDPU, Gandhinagar. email : acbpramukh@Hotmail.com

1. THE POSTPOSITIVE WORLDVIEW

The positivist approach dictates that the purpose of science is simply to stick to what we can observe or measure. But according to the Postpositivist approach as advocated by the researchers like Comte, Mill, Dirkheim in the middle part of 20th century(Smith, 1983), all observations are fallible and have errors and that all theories are revisable. Thus the problems studied by post positivists reflect the need to identify and assess the causes that influence the outcomes .The researcher begins with theory, collects data, that either supports or refutes the theory and then makes required revisions before additional analysis is carried out. This worldview holds more true for Quantitative research design or Descriptive Research Design or simply putting It, the Survey research.

Most of the studies conducted by researchers world over follow the Descriptive research design as it seems to serve almost all objectives of the studies such as i) describing demographic and psychographic profiles of the respondents under study ii) developing estimates iii) establishing interrelationship amongst the variables under study iv) testing of hypothesis v) forecasting etc. Descriptive studies could be cross –sectional, longitudinal(time series study) or Cohort study.

The same worldview also holds true for the other design viz. The Experimental or Causal Research Design under which the impact of an intervention or a treatment on an outcome is tested controlling for all possible factors that might influence the outcome. The popular amongst such designs are –Pre-post Experimental Research Design with one control group, Ex-post facto design, time series experimental deigns and also the statistical designs such as Completely Randomized Design(CRD), Randomized Block Design(RBD), Latin Square Design(LSD) and Factorial Design.

2. THE SOCIAL CONSTRUCTIVISM OR INTERPRETIVISM WORLDVIEW

This world view holds assumptions that the individuals seek understanding of the word in which they live and work.They develop subjective meanings of their experiences with regard to things or objects. It is trying to know as to how people ascribe meaning to human behavior . These meanings are varied and multiple. The surveys and the experiments fall short in uncovering the deeper patterns that explain the nature of human experience. We have to interpret these meanings, decode their messages, texts and tweeters and understand how these messages are formed through interaction with their fellow companions .This is how it is called social constructivism and interpretivism. The people are to be observed in their natural settings like villages,schools etc. These assumptions hold true more for Qualitative Research Design or Exploratory Research Design. (Lincoln and Guba,2000).It is used to develop concepts, gain familiarity with problem, dissect the problem into sub-problems, to uncover the underlying patterns of human behavior etc. This design is widely used in the field of Anthropology and Sociology. The varieties of qualitative research techniques such as Ethnographic research, Phenomenology, Grounded Theory, Discourse Analysis, Projective Techniques etc. are very popular.

3. PRAGMATIC WORLDVIEW

The Pragmatic worldview originated from the pragmatists(Morgan D, 2007). It arises out of actions, situations and consequences rather than antecedent conditions. The researcher uses all approaches , collects diverse types of data available to better understand the research problem.This worldview holds more true for Mixed-Methods wherein the researcher draws liberally from both qualitative and quantitative research like a traditional survey can be conducted followed by the focus-group discussion.

It takes three different forms—i) Sequential Exploratory Mixed Method that begins with qualitative research for exploratory purpose followed by survey with large sample so that the results can be generalized. ii) Sequential Explanatory Mixed Method that begins with quantitative research in which the theory or concept is

tested followed by in-depth interview of few respondents.iii) Concurrent Mixed Method under which both the forms of data are collected at the same time and then the two databases are compared to determine if there is convergence or difference or some combination.(Green,Caracelli, Graham ,1989). Some authors refer to this comparison as Confirmation, Disconfirmation or Corroboration.

ACKNOWLEDGEMENTS :

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TRANSSHIPMENT PROBLEM IN SUPPLY CHAIN MANAGEMENT

Dinesh S. Dave[1] and R. Lewis Alexander[2]

ABSTRACT

In both manufacturing and service industries, supply chain management is a systems approach to managing the flow of all information, materials, and services, from raw material suppliers through facilities and distribution centers to the final consumer. Previous supply chain analysts have proposed various transshipment models illustrating common practices in multi-location inventory systems. These models involve balancing strategic movement between locations while at the same keeping appropriate levels of inventory on hand. The study herein contains a network diagram presentation of a proposed transshipment model and its solution using linear programming. As clearly illustrated, with the confluence of added variables and constraints, the linear programming formulation of a once-simple transshipment model often lends itself to confusion, diminishing its problem-solving utility. Therefore, to overcome this malady, an efficient method of solving the transshipment problem using an Excel spreadsheet application is offered as an alternative.

KEYWORDS :

SCM, Transshipment Problem, Excel

(1) Chair and Professor, Dept. of CIS and SCM, John Walker College of Business, Appalachian State University, Boone, NC, 28608, USA. email:drdineshdave@gmail.com
(2) Lecturer, Dept. of CIS and SCM, JW College of Business, Applachian State Univeristy, Boone, NC, 28608, USA.

1. INTRODUCTION

Supply Chain Management (SCM) is a rapidly growing field, particularly due to economic globalization. SCM coordinates all material-related issues ranging from initial procurement and shipment, finally ending with receipt of the finished product by a (hopefully) satisfied customer. This system involves all processes, technologies, and strategies that together form the basis for working with internal and external sources of supply (Madhani, 2012). As a result, the esteemed position of Supply Chain Manager now exists. Supply Chain Management encompasses planning and management of all activities involved in sourcing and procurement, conversion, and logistics. Just as important, it involves coordination and collaboration with channel partners, including suppliers, intermediaries, third-party service providers, and customers (from Vitasek, 2013; and see also Beamon, 1998; Sumchi-Levi et al., 2008; Blackstone, 2013).

The American Production and Inventory Control Society, APICS, defines Supply Chain Management as "The design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance globally" (ww.Apics.org). Supply Chain Management is a vital part of any organization. The new, but often used phrase within the supply chain community, "supply chains compete, not companies," spotlights the necessity of excellent SCM (Christopher, 2011). The competencies, resources, and organizational-specific attributes of SCM allow companies to achieve a high market position (Halley and Beaulieu 2009).

Supply Chain Management is, by definition and practice, a broad term for what is often erroneously limited to only logistics or distribution management (Christopher, 2011). Correctly stated, the activities of Supply Chain Management include but are not strictly limited to managing the flow of materials and information, storage, physical movement of the product, as well as the unfettered accomplishment of all financial obligations within the chain. Therefore, within this broad term, logistic activity is merely a single component among many; all focusing on both external as well as internal business functions. (Christopher,

2011).

Supply Chain Management is an all-encompassing systems approach to managing the flow of information, materials, and services from raw material, through manufacturing and distribution, to final consumers. Minner (2003) reviewed multi-supply-option inventory models, transshipment models, in particular, relating to supply chain management. Herer, Tzur, and Yücesanc (2002) provide a tactical solution to achieve "*leagility*." In their study, *leagility* is coined as a term to describe supply chain design which maintains a balance of lean and agile production practices. The study introduces transshipment problems and corresponding models, which represent common practices in multi-location inventory systems involving the movement of material between locations while at the same keeping an appropriate level of inventory. The authors propose transshipment models which can be applied to enhance both agility and lean operations through a network presentation with linear programming solutions. Although linear programming formulation may become cumbersome with the inclusion of several variables and constraints, the study provides an efficient solution to this deficiency by using spreadsheets, Excel in particular.

2. TRANSSHIPMENT MODEL: FORMULATION AND A SPREADSHEET SOLUTION

The transshipment model is an extension of transportation problem in which intermediate nodes, or transshipment nodes, are added for each warehouse or distribution center. (See Anderson, Sweeney, Williams, Camm, and Cochran, 2015) This proposes a generalized distribution problem with shipments between combinations of origin nodes, transshipment nodes, and/or destination nodes alike. In these transshipment problems, the supply available at each origin is limited and the demand at each destination is specified. The objective is to determine the number of units to be shipped from origins to transshipment nodes, and from transshipment nodes to destinations, at minimum total shipping cost, but satisfying demand at each destination. The model assumes that the total available supply is at least equal to the total demand.

Consider a transshipment problem with two production facilities (origin nodes), two warehouses (transshipment nodes), and four outlets (destination nodes). Assume that the production capacity is estimated at 6,000 units for Plant 1 and 5,000 units for Plant 2. Demand for Outlet 1, Outlet 2, Outlet 3, and Outlet 4 is estimated at 2,000 units, 2,500 units, 3,500 units, and 3,000 units, respectively. The following table provides cost per unit for the transshipment problem.

Plant	Warehouse	
	Warehouse 1	Warehouse 2
Plant 1	$20	$30
Plant 2	$30	$10

Warehouse (Transshipment Node)	Outlet (Destination)			
	Outlet 1 (D 1)	Outlet 2 (D 2)	Outlet 3 (D 3)	Outlet 4 (D 4)
Warehouse 1 (W 1)	$20	$50	$30	$45
Warehouse 2 (W 2)	$40	$40	$45	$35

The network for this transshipment problem can be shown as :
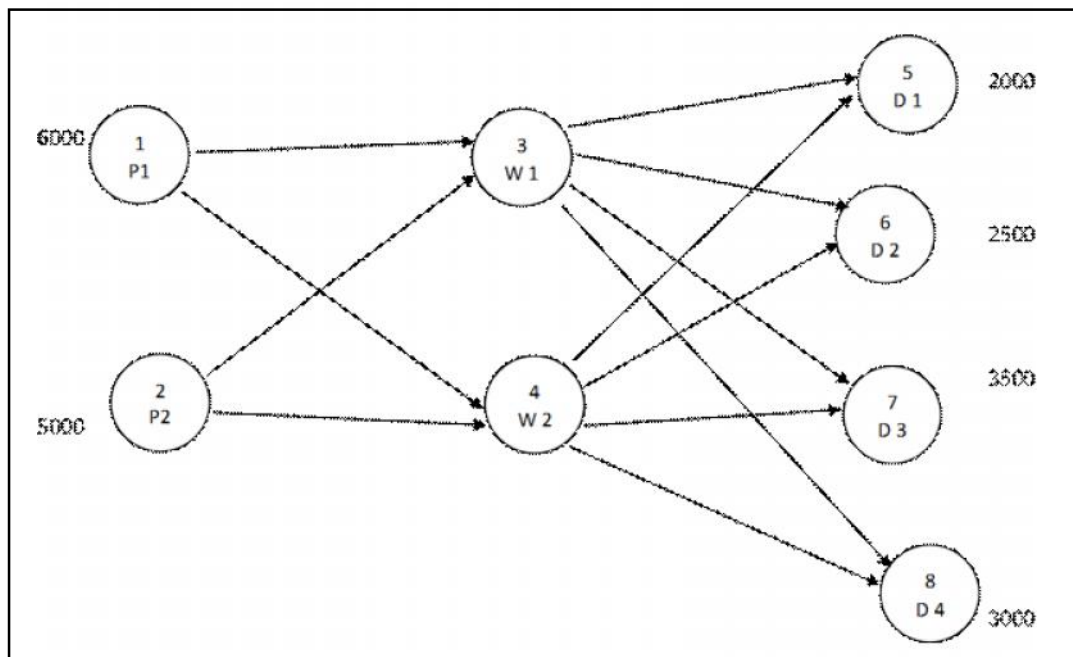
The general linear programming formulation for the transshipment model is shown below. Let,

Let X_{ij} = Number of units shipped from Origin I to Destination j

          Cij = Cost per unit of shipping from Origin I to Destination j

          S_i = Supply or capacity at Origin i

          D_j = Demand at Destination j

The model will be:

Objective Function: Min $\sum_{i=1}^{m} \sum_{j=1}^{n} Cij\ Xij$

Subject to:

$$\sum_{j=1}^{n} X_{ij} \leq Si$$

$$\sum_{i=1}^{m} X_{ij} \leq Dj$$

$$X_{ij} \geq 0$$

The LP formulation of the example problem will be:

Minimize: $20X_{13} + 30\ X_{14} + 30\ X_{23} + 10X_{24} + 20X_{35} + 50X_{36} + 30X_{37} + 45X_{38} + 40X_{45} + 40X_{46} + 45X_{47} + 35X_{48}$

Subject to:

$X_{13} + X_{14} \leq 6000$

$X_{23} + X_{24} \leq 5000$

$-X_{13} - X_{23} + X_{35} + X_{36} + X_{37} + X_{38} = 0$

$-X_{14} - X_{24} + X_{45} + X_{46} + X_{47} + X_{48} = 0$

$X_{35} + X_{45} = 2000$

$X_{36} + X_{46} = 2500$

$X_{37} + X_{47} = 3500$

$X_{38} + X_{48} = 3000$

$(X_{ij} \geq 0)$

The optimal solution will be:

$X_{13} = 5,500$

$X_{14} = 500$

$X_{23} = 0$

$X_{24} = 5,000$

$X_{35} = 2,000$

$X_{36} = 0$

$X_{37} = 3,500$

$X_{38} = 0$

$X_{45} = 0$

$X_{46} = 2,500$

$X_{47} = 0$

$X_{48} = 3,000$

Minimum Shipping Cost = \$525,000

The following spreadsheet represents the linear programming model:

	X13	X14	X23	X24	X35	X36	X37	X38	X45	X46	X47	X48			
Objective	20	30	30	10	20	50	30	45	40	40	45	35	Sumprod	RHS	Type
Constraint1	1	1	0	0	0	0	0	0	0	0	0	0	6000	6000	<=
Constraint2	0	0	1	1	0	0	0	0	0	0	0	0	5000	5000	<=
Constraint3	-1	0	-1	0	1	1	1	1	0	0	0	0	0	0	=
Constraint4	0	-1	0	-1	0	0	0	0	1	1	1	1	0	0	=
Constraint5	0	0	0	0	1	0	0	0	1	0	0	0	2000	2000	=
Constraint6	0	0	0	0	0	1	0	0	0	1	0	0	2500	2500	=
Constraint7	0	0	0	0	0	0	1	0	0	0	1	0	3500	3500	=
Constraint8	0	0	0	0	0	0	0	1	0	0	0	1	3000	3000	=
Solution	5500	500	0	5000	2000	0	3500	0	0	2500	0	3000			
Min Cost=	\$525,00														

The following spreadsheet provides the network method solution:

Arc	Cost	Solution	Node	Units In	Units Out	Net Shipment	Type	Supply
1-3	20	5500						
1-4	30	500						
2-3	30	0	1		6000	6000	$\leq$	6000
2-4	10	5000	2		5000	5000	$\leq$	5000
3-5	20	2000	3	5500	5500	0	=	0
3-6	50	0	4	5500	5500	0	=	0
3-7	30	3500	5	2000		-2000	=	-2000
3-8	45	0	6	2500		-2500	=	-2500
4-5	40	0	7	3500		-3500	=	-3500
4-6	40	2500	8	3000		-3000	=	-3000
4-7	45	0						
4-8	35	3000						
Min Cost=	$525,000							

The network method of solving transshipment problems using spreadsheets is streamlined and simpler when compared to formulating terms, variables, and constraints via linear programming. When the number of nodes increases, the linear programming formulation becomes cumbersome, with a significant increase in the number of decision variables and constraints. Therefore, a network model approach using a spreadsheet becomes the rapid, effective, and simple approach to solving complex transshipment problems.

4. CONCLUSION

Supply Chain Management is the rapidly growing field in the wake of an increasingly global competitive environment. Organizations are continuously striving to reduce cost while enhancing customer satisfaction. One of the ways to accomplish this is to make the company's logistics system as effective and efficient as possible. This study discusses a specific problem using logistics of a transshipment model. The study provides a network formulation and shows the application of a spreadsheet to solve the problem. The network formulation of the problem is quick, simple, and more efficient than the linear programming solution.

5. ACKNOWLEDGEMENTS :

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DETERMINISTIC INVENTORY MODEL FOR DETERIORATING ITEMS UNDER RAMP TYPE DEMAND RATE WITH TIME DEPENDENT HOLDING COST

Virali Vora[1] and U.B.Gothi[2]

ABSTRACT

In this paper, we have developed a time dependent deteriorating deterministic inventory model under exponential demand and when shortages are allowed to occur. Demand rate is assumed to be a ramp type function and Pareto Type-I distribution is considered for deterioration rate. To make the resultant setup more practical, the production cost is also considered and the holding cost is assumed to be a linear function of time. Derived model is illustrated by means of an application and its sensitivity analysis is carried out.

KEYWORDS

Ramp-type Demand rate, Pareto Type-I Distribution, Deterioration.

1. INTRODUCTION

The most common inventory situation faced by manufacturers, retailers, and wholesalers is that stock levels are depleted over time and then are replenished by the arrival of a stock of new units. The objective is to determine when and by how much to replenish inventory so as to minimize the sum of all costs per unit time. In case of seasonal items like vegetables or groceries, the longer these items are kept in storage, the more sophisticated the storage facilities and services needed, and therefore, the holding cost is higher.

(1) Amrut Mody School of Management, Ahmedabad University, Ahmedabad, Gujarat, India. Email : voravirali@gmail.com

(2) Head, Department of Statistics, St. Xavier's College (Autonomous), Ahmedabad, Gujarat, India. Email : ubgothi@gmail.com (rcd. April '18 / rvd. May '18)

Researchers have tried to develop a number of inventory models assuming the demand of the items increasing with time, or decreasing or linearly or exponentially increasing or decreasing. However, when some new brand of consumer goods comes to the market, for example, some kind of newly launched automobiles, fashion goods, garments, automobiles, cosmetics, etc. it is very commonly seen that the demand increases with time up to certain limit and then ultimately stabilizes and becomes constant. This type of demand is referred to as ramp type demand.

A number of researchers in recent years have expressed their interest in studying the inventory models for deteriorating items. R. Amutha and Dr. E. Chandrasekaran [10] developed an inventory model for deteriorating items with three parameter Weibull distribution and price dependent demand. Shortages were allowed and were completely backlogged. Goyal's [3] production inventory problem of a product with time varying demand, production and deterioration rates in which the shortages occur at the beginning of the cycle. In contrast, in Manna and Chaudhari [7] shortages are allowed to occur at the end of each cycle.

Devyani Chatterji and U. B. Gothi [1] developed an EPQ model with demand following exponential pattern and two-parameter Weibull deterioration rate was considered, with time-varying inventory holding cost being a linear function of time. Shortages were allowed and they were completely backlogged. Kun-Shan WU's [5] deterministic inventory model is depleted by time varying demand and followed Weibull distribution deterioration rate where inventory is permitted to start with shortages and end without shortages.

Recently, Kirtan Parmar and U. B. Gothi [9] analysed a production inventory model for deteriorating items with time-dependent holding cost. Three parameter Weibull distribution was taken here for time of deterioration of items. Shortages were allowed to occur. Pooja D. Khatri and U. B. Gothi [4] considered an inventory system with power demand pattern with two parameter Weibull distribution and Pareto Type-I distribution for rate of deteriorating items with varying holding cost was taken.

Dinesh Prasad, S. R. Singh & M. P. Singh [2] developed an inventory model with ramp type demand rate with inflation in which time value of money was developed. The deterioration rate followed three-parameter Weibull distribution with the concept of life time of an item. Shortages were also allowed and unsatisfied demand was partially backlogged. Manna and Chiang [8] developed an EPQ model for deteriorating items with ramp type demand. Mandal & Pal [6], developed an EOQ model with ramp type demand and constant rate of deterioration with shortage not allowed but that gave only an approximate solution for the EOQ. Kun-Shan & Ouyang [12] established an EOQ model with ramp type demand, that had constant rate of deterioration and shortages were allowed which gave an exact solution for EOQ.

So far we see that not much work has been done by researchers by taking ramp type demand. Sanjay JAIN and Mukesh KUMAR [11] explained an inventory model with ramp type demand and three parameter Weibull deterioration rate and starting with shortage. This paper is an extension of their work by adding purchasing cost and taking the inventory cost as a linear function of time. Numerical example and sensitivity analysis for the optimal solutions for major parameters is also carried out. The study is carried out with an objective to make the model more relevant in practice.

2. NOTATIONS

Following notations are used for the model under consideration.
(1) $Q(t)$: Inventory level of the product at time $t (\geq 0)$
(2) $R(t)$: Demand rate varying over time
(3) $\theta(t)$: Rate of deterioration per unit time
(4) B : Ordering cost per order during the cycle period.
(5) C_s : Shortage cost per unit.
(6) C_p : Purchasing cost per unit item.
(7) C_d : Deterioration cost per unit per unit time.
(8) T : Duration of the cycle
(9) TC: Total cost per unit time.

3. ASSUMPTIONS

The model is developed under the following assumptions.

(1)   The inventory system is considered over an infinite time horizon.

(2)   Shortages are allowed and they are completely backlogged.

(3)   Replenishment rate is infinite.

(4)   Lead time is assumed to be zero.

(5)   Replacement of the deteriorated items does not take place during the given cycle.

(6)   The inventory system involves only one item and one stocking point.

(7)   Holding cost is a linear function of time and it is $C_h = h + rt \, (h, r > 0)$

(8)   Purchasing cost, deterioration cost, shortage cost and ordering cost are known and are constants.

(9)   Inventory model is developed to start with shortages.

(10)   The demand function R(t) is taken to be a ramp type function of time such that

$$R(t) = -Ae^{b[t-(t-\mu)H(t-\mu)]}$$

where $H(t - \mu)$ is the Heaviside's function defined as,

$$H(t - \mu) = \begin{cases} 1 & t \geq \mu \\ 0 & t < \mu \end{cases}$$

Here A is the initial demand rate; b is the rate at which the demand increases exponentially.

(11)   Time to deterioration follows Pareto Type-I distribution and as explained in Appendix, deterioration rate is given by

$$\theta(t) = \frac{\alpha}{t} \quad ;$$

where $\alpha > 0$ is a shape parameter.

3. MATHEMATICAL MODEL AND ANALYSIS

The inventory system developed, as depicted by the following figure, starts with zero inventory at $t = 0$. Shortages are allowed to accumulate up to time v. At time v inventory is replenished. The quantity received at time v is partly

used to meet the shortages which has accumulated from time 0 to v, leaving a balance of S items at time v. As time passes, the inventory level S declines partly due to demand and partly due to deterioration of items during the period $[v, T]$. At time t = T, the inventory level gradually falls to zero. The above cycle as explained is illustrated by means of its graphical presentation as expressed by the following figure 1.
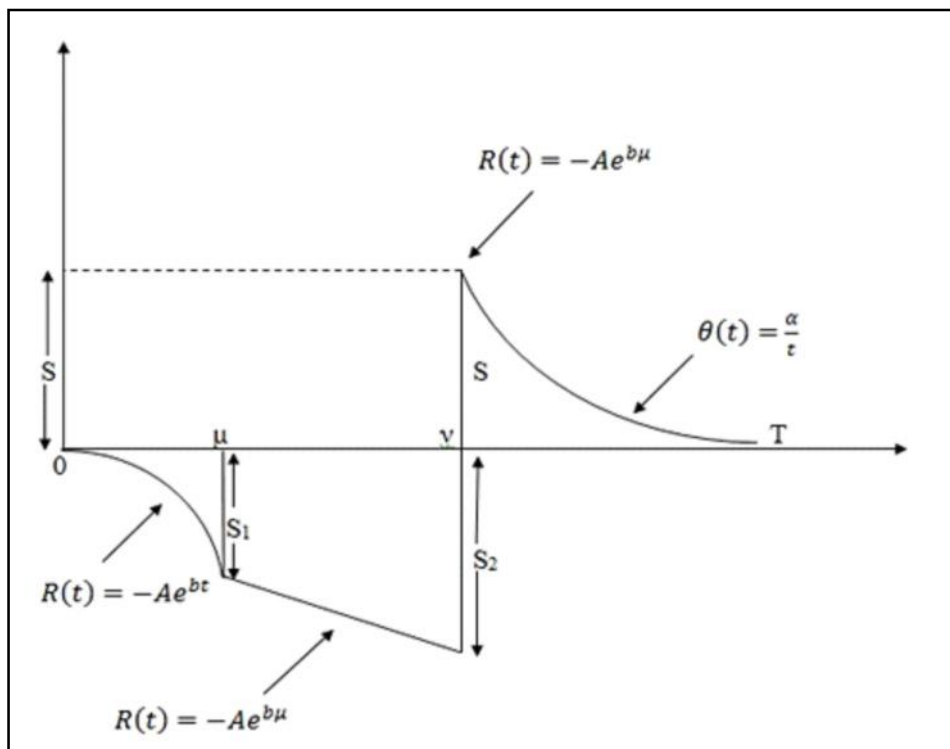

Figure 1: Graphical Presentation for Inventory level-time relationship

The differential equations describing the inventory level of the system at any time over the period $[0, T]$ are given by:

$$\frac{dQ(t)}{dt} = -Ae^{bt} ; \qquad\qquad 0 \leq t \leq \mu \qquad\qquad (1)$$

$$\frac{dQ(t)}{dt} = -Ae^{b\sim} ; \qquad\qquad \mu \le t \le v \qquad\qquad (2)$$

$$\frac{dQ(t)}{dt} + \frac{r}{t}Q(t) = -Ae^{b\sim} ; \qquad\qquad v \le t \le T \qquad\qquad (3)$$

Under the boundary conditions, $Q(0) = 0, Q(\mu) = -S_1$ and $Q(T) = 0$, the solutions of the differential equations $(1), (2)$ and (3) are:

$$Q(t) = \frac{A}{b}[1 - e^{bt}] ; \qquad\qquad 0 \le t \le \sim \qquad\qquad (4)$$
$$Q(t) = -[(S_1 - Ae^{b\sim}.\sim) + Ae^{b\sim}.t] ; \qquad \sim \le t \le v \qquad\qquad (5)$$

$$Q(t) = \frac{Ae^{b\sim}}{r+1}[T^{r+1}.t^{-r} - t] ; \qquad\qquad v \le t \le T \qquad\qquad (6)$$

Inserting $Q(\mu) = $ -S_1 in equation (4),

$$Q(t) = \frac{A}{b}[1 - e^{bt}] ; \qquad\qquad\qquad (7)$$

Inserting in equation (5),

$$Q(t) = -[(S_1 - Ae^{b\sim}.\sim) + Ae^{b\sim}.t] \qquad\qquad (8)$$

Inserting in equation (6),

$$Q(t) = \frac{Ae^{b\sim}}{r+1}[T^{r+1}.t^{-r} - t] \qquad\qquad (9)$$

COST COMPONENTS

If the inflation and time value of money are considered, the total cost function consists of the following elements.

1) Ordering Cost

Over the period, , the ordering cost (OC) is given by   (10)

OC = B

2) Shortage Cost

The shortage cost (SC) over the period [o, v] is given by

$$SC = -C_s \int_0^{\in} Q(t).dt$$

Using equations in (4) and (5), we get

$$SC = -C_s \left[\int_0^{\sim} \frac{A}{b}(1 - e^{bt})dt - \int_{\sim}^{\in}[(S_1 - Ae^{b\sim}.\sim) + Ae^{b\sim}.t]dt \right]$$

$$SC = -C_s \left[\frac{A}{b}\{\sim - \frac{1}{b}(e^{b\sim} - 1)\} - (S_1 - Ae^{b\sim}.\sim)(\in - \sim) - Ae^{b\sim}\frac{(\in^2 - \sim^2)}{2} \right] \tag{11}$$

3) Purchase Cost

The purchase cost (PC) is given by

$$PC = C_p[S + S_2]$$

Using equations in (8) and (9), we get

$$PC = C_p \left[\frac{Ae^{b\sim}(T^{r+1}\in^{-r} - \in)}{r+1} + \frac{A(e^{b\sim} - 1)}{b} - Ae^{b\sim}\sim + Ae^{b\sim}\in \right] \tag{12}$$

4) Deterioration Cost

Over the period [v, T] , the deterioration cost (DC) is given by

$$DC = C_d \int_{\in}^{T} \frac{r}{t} Q(t)dt$$

Using equation (6), we get

$$DC = C_d \frac{Ae^{b\sim}}{r+1} \left[\frac{rT^{r+1}}{-r}(T^{-r} - \in^{-r}) - r(T - \in) \right] \tag{13}$$

5) Inventory Holding Cost

The inventory holding cost (IHC) over the period [0, T] is given by

$$IHC = \int_{\in}^{T} C_h Q(t)dt$$

Using equation in (6), we get

$$IHC = \int_{\epsilon}^{T} (h + rt) \frac{Ae^{b\sim}}{r+1} [T^{r+1}.t^{-r} - t]dt$$

$$IHC = \frac{Ae^{b\sim}}{r+1} \left[\begin{array}{l} h\left\{\dfrac{T^{r+1}}{-r+1}\left(T^{-r+1} - \epsilon^{-r+1}\right) - \dfrac{(T^2 - \epsilon^2)}{2}\right\} \\[4mm] + r\left\{\dfrac{T^{r+1}}{-r+2}(T^{-r+2} - \epsilon^{-r+2}) - \dfrac{1}{3}(T^3 - \epsilon^3)\right\} \end{array} \right] \qquad (14)$$

Hence the total cost per unit time is given by

$$TC = \frac{1}{T}(OC + PC + SC + DC + IHC) \qquad (15)$$

$$TC = \frac{1}{T}\left[\begin{array}{l} B + C_p\left\{\dfrac{Ae^{b\sim}\left(T^{r+1}\epsilon^{-r} - \epsilon\right)}{r+1} + \dfrac{A(e^{b\sim} - 1)}{b} - Ae^{b\sim}\sim + Ae^{b\sim}\epsilon\right\} \\[5mm] + \dfrac{Ae^{b\sim}\left\{h\left(\dfrac{T^{r+1}(T^{-r+1} - \epsilon^{-r+1})}{-r+1} - \dfrac{1}{2}T^2 + \dfrac{1}{2}\epsilon^2\right) + r\left(\dfrac{T^{r+1}(T^{-r+2} - \epsilon^{-r+2})}{-r+2} - \dfrac{1}{3}T^3 + \dfrac{1}{3}\epsilon^3\right)\right\}}{r+1} \\[5mm] + \dfrac{C_d Ae^{b\sim}\left\{-T^{r+1}(T^{-r} - \epsilon^{-r}) - r(T - \epsilon)\right\}}{r+1} \\[5mm] - C_s\left\{\dfrac{A\left(\sim - \dfrac{e^{b\sim} - 1}{b}\right)}{b} - \dfrac{A(\epsilon - \sim)\left(e^{b\sim}(\epsilon - \sim) - 1\right)}{b(\epsilon - \sim)} \right. \\[5mm] \left. + A(\epsilon - \sim)e^{b\sim}(\epsilon - \sim)\sim(\epsilon - \sim) - Ae^{b\sim}\left(-\dfrac{1}{2}\sim^2 + \dfrac{1}{2}\epsilon^2\right)\right\} \end{array} \right]$$

$$(16)$$

The optimum values of v and T are taken as v^* and T* respectively. These values minimize the cost function TC. Our objective is to determine these values which are the solutions of equations $\dfrac{dTC}{d\epsilon} = 0$ and $\dfrac{dTC}{dT} = 0$ satisfying the conditions

$$\left[\frac{d^2TC}{dv^2}\right]_{v=v^*,T=T^*} > 0 \quad \text{and} \quad \left[\left(\frac{d^2TC}{dv^2}\right)\left(\frac{d^2TC}{dT^2}\right)-\left(\frac{d^2TC}{dvdT}\right)^2 > 0\right]_{v=v^*,T=T^*} \tag{17}$$

The optimal solution for cost function given in (16) can be obtained by using appropriate software.

5. NUMERICAL EXAMPLE

Let us consider the following example to illustrate the above developed model. We take B=200, h=3, r=0.9, b=0.8, A=1.2, α=0.7, μ=0.5 (with appropriate units of measurement), C_d = 2.5, C_p = 2.1, C_s = 1.5

Using equation (16) and conditions given in (17), solution is obtained. We obtain the values T*=12.36221307, v*=11.22183884, Q*=22.04524363, tc*=34.90491638 units by using appropriate software. (Note that Q* is in thousand units and TC* is in thousand rupees.)

6. SENSITIVITY ANALYSIS

In order to study how the input in the changes of the parameter values affects the optimal solution of the model, we carry out an important technique known as partial sensitivity analysis. Here, we study the effects of changes in the system parameters C_d, C_p , C_s, a, μ, h, r, b, A on the optimal value T*, optimal order quantity Q* and optimal average total cost per unit time TC* in the model.

The sensitivity analysis is performed by changing the given values of each of the parameters by -10%, -20%, +10%, and +20%; taking one parameter at a time and keeping all the other parameters unchanged. The results are presented in the table.

Table: Partial Sensitivity Analysis

Parameters	% Change	Q^*	P^*	B^*	TC^*	% Change in Q^*	% Change in TC^*
C_d	-20	12.36382	11.20699	22.05029	34.89753	0.02290	-0.02
	-10	12.36307	11.21447	22.04785	34.90130	0.01184	-0.01
	10	12.36126	11.22908	22.04246	34.90839	-0.01263	0.01
	20	12.36020	11.23620	22.03951	34.91172	-0.02603	0.02
C_p	-20	12.36302	11.22053	22.04696	34.15594	0.00780	-2.15
	-10	12.36262	11.22119	22.04611	34.53043	0.00391	-1.072883905
	10	12.36181	11.22249	22.04438	35.27940	-0.00393	1.072877029
	20	12.36140	11.22313	22.04351	35.65389	-0.00788	2.145747584
C_s	-20	13.74344	12.79764	22.04611	32.17499	0.00391	-7.821043031
	-10	12.99265	11.94754	23.15875	33.48727	5.05099	-4.061439869
	10	11.82418	10.59246	21.09891	36.22218	-4.29270	3.773853247
	20	11.35893	10.03964	20.28453	37.45137	-7.98681	7.295388312
a	-20	12.36105	11.19952	22.03077	34.89046	-0.06567	-0.041421758
	-10	12.36166	11.21098	22.03814	34.89786	-0.03221	-0.020224286
	10	12.36272	11.23216	22.05210	34.91168	0.03110	0.01937197
	20	12.36319	11.24201	22.05874	34.91818	0.06121	0.037992814
μ	-20	12.86540	11.70810	21.23097	33.45727	-3.69366	-4.147412256
	-10	12.61160	11.46271	21.63654	34.17369	-1.85393	-2.09490721
	10	12.11711	10.98538	22.45674	35.65110	1.86659	2.137759512
	20	11.87617	10.75320	22.87065	36.41238	3.74416	4.318771469
h	-20	12.35555	11.16542	22.04009	34.84456	-0.02338	-0.172927072
	-10	12.35913	11.19445	22.04299	34.87539	-0.01021	-0.084582984
	10	12.36485	11.24772	22.04692	34.93321	0.00760	0.081069583
	20	12.36709	11.27223	22.04808	34.96036	0.01287	0.158850774
r	-20	12.43599	11.10623	22.20403	34.67116	0.72028	-0.669691018
	-10	12.39500	11.16710	22.11575	34.79681	0.31983	-0.309730208
	10	12.33554	11.27117	21.98800	34.99890	-0.25966	0.269260264
	20	12.31354	11.31577	21.94086	35.08134	-0.47351	0.505447107
b	-20	12.86202	11.70483	21.20155	33.44895	-3.82710	-4.17123486
	-10	12.60966	11.46083	21.61943	34.16873	-1.93154	-2.109106041
	10	12.11957	10.98775	22.47911	35.65790	1.96806	2.157241295
	20	11.88163	10.75846	22.92114	36.42810	3.97320	4.363806672
A	-20	13.79771	12.61167	19.68993	30.98198	-10.68398	-11.23892032
	-10	13.02018	11.85788	20.89975	32.99031	-5.19610	-5.485199475
	10	11.79592	10.67594	23.13570	36.73966	4.94646	5.256401448
	20	11.30177	10.20084	24.17834	38.50529	9.67599	10.31481443

7. GRAPHICAL PRESENTATION

Graphical presentation of the above sensitivity analysis is shown in Fig. 2.
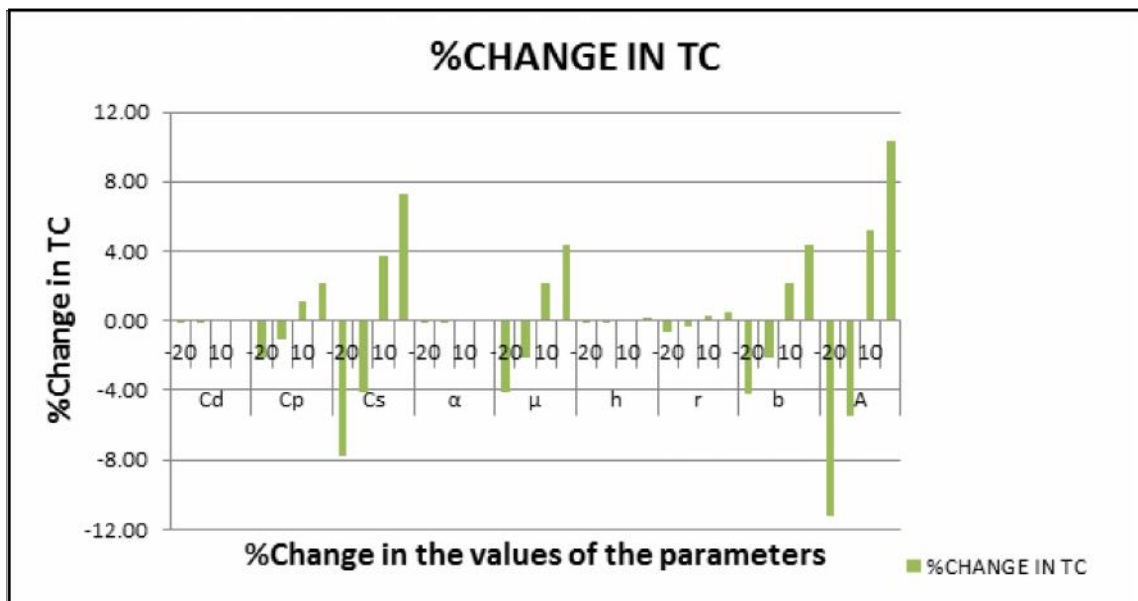

Figure-2: Graphical Presentation

8. CONCLUDING REMARKS

This paper studies an inventory model with ramp type demand allowing shortages. It is also considered that holding cost is linearly increasing function of time. From partial sensitivity analysis, we may conclude that as shape parameter α, initial demand rate A, rate at which the demand increases exponentially b, linear constants of inventory holding cost h and r, deterioration cost C_d, purchasing cost C_p and shortage cost C_s increase, the average total cost TC increases.

From graphical analysis presented in Figure-2, for the changes in the values of C_s and A, the average total cost is highly sensitive; it is moderately sensitive for the changes is the values of C_p, μ and b; and less sensitive to the changes ....$_d$, α, h and r.

9. ACKNOWLEDGEMENTS

APPENDIX

In the model that we have considered, the random variable is the time to deteriorate and it follows Pareto type –I distribution. The probability density function for Pareto Type –I distribution is taken as

$$f(t) = \frac{r}{\in}\left(\frac{t}{\in}\right)^{-r-1} ; t \geq \in$$

where, $\alpha > 0$ is a shape parameter and $v > 0$ is a scale parameter.

The instantaneous rate of deterioration $\theta(t)$ can be obtained from $''(t) = \frac{f(t)}{1 - F(t)}$,

where $F(t) = 1 - \left(\frac{t}{\in}\right)^{-r}$ is the cumulative distribution function for the Pareto type-I distribution.

In this paper, we have considered a deterministic inventory model for a single commodity and a time dependent demand rate $R(t) = -Ae^{bt}$.

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IMPACT OF ADVERTISING EXPENDITURE ON SALES FOR SOME FMCG COMPANIES

Sanjay G Raval[1] and Vernal R. Damor[2]

ABSTRACT

Industrial growth of a company depends upon its VAM based upon sales growth along with other respective parameters of the company. Sales growth is partially influenced by advertising efforts made by the company to boost up its growth. Thus it seems that there is a reasonable impact of advertising on sales growth of the company. In this paper an attempt is made to understand about such an impact in the case of four selected FMCG companies (viz. HUL, MARICO, GODREJ and ITC) based upon the data during the years 2007 – 2017. Statistical building approach signifies such an impact at a very reasonable level.

KEYWORDS

Prior Analysis, Model Building, Regression, ANOVA

1. INTRODUCTION

What will be a customer's behaviour when heis purchasing his daily/monthly required goods? Whether he will ask for the toothpaste made by Colgate or patanjali, for soap he will ask for Lux by HUL company or Patanjali soap, for detergent powder he will ask for products of HUL or TATA, for biscuits he will ask for products of Parle or Britania or Amul, for chocolates he will ask for products of Amul, Cadbury, for teahe will ask for products of HUL and so on. All these

(1) Head of Statistics Department, Som - Lalit Commerce Collage, Gujarat University. Email: drsgraval@gmail.com

(2) Research Scholar at Department of Statistics, Gujarat university.
Email: damorvernal8@gmail.com
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are the consumer goods with different brands and they all are recognized as FMCG (Fast Moving Consumer Goods).

What is the logic for such a consumer behaviour? There are different products made by different companies, but why the consumer prefers to take the products of any particular brand? This is due to their knowledge about the company's product, their quality, their quantity, comparable competitive prices, reputation and past records of the company etc. Due to very stiff competition, there is hardly much difference between product A and similar product B made by two different companies. If we study the customer's psychology that why he is asking for any product of the particular company then the first thing that he thinks is Advertisement he has seen in newspaper, TV, videos, posters etc. In today's life all these things are almost hammered to all of us at every moment by massive advertisement efforts. Company's promo (promotional video) for advertising plays a leading role for gaining the trust of customers for that product.

Thus what we can observe is that the role of advertising is very much significant and prominent in today's life. It can be considered as a road to transfer the information between marketers and consumers, between sellers and buyers. Company's net profit (value added by manufacturer – VAM) depends upon many factors such as market price, demand and sales of the product, salesman's performance, market behavior, cost reduction efforts for its input factors of production as well as company's extensive advertising efforts to highlight its products in the market.

Advertising can reach the consumers through different sources such as Newspapers, TV, Posters, Radio, Magazines, Digital Media, Animation etc. Advertising can play a significant role to boost up the products and sales. Let us look at an illustration; Annual report of Godrej states that in financial year 2015-2016 it had total sale of 8836.96cr on spending Rs.838.83cr on advertising and in financial year 2016-2017 it had total sale of 9684.1cr on spending Rs.920.91cr on advertising. Thus we can observe here that advertising efforts definitely have an impact upon company's growth in its business sales. There are

many research works carried out in this direction to explore the company's growth potential and performance in terms of the various marketing situations and the efforts made by the company in this direction. These research efforts are increasing by leaps and bounds at every moment.

In this research paper we want to highlight the influence of advertising expenditure on the sales of the company. It is often argued that advertising expenditure is only a small portion as compared to the overall expenditure pattern, but this factor cannot be negligible. In this study to examine the significance of advertising on sales growth, we have considered four leading FMCG companies. The choice is based upon various parameters of the company's performance. The companies are; (**1**) HUL (Hindustan Unilever) (**2**) MARICO (**3**) GODREJ (**4**) ITC (Imperial Tobacco Company)

We have used published reports of these FMCG companies and statistics presented for the years 2007 to 2017. Our objective of the study is to examine the impact of advertising expenditure upon the sales growth of these FMCG companies. This study may highlight the significance of advertising upon the gross sales and there by explore what minimum amount can be spent for advertisement to explore for its maximum sales (and thereby profit) of the company.

Section 2 of this study gives a brief account of the methodology used for our analysis.

Section 3 contains the data analysis, graphical presentation and concluding remarks (taken company wise).

Section 4 summarizes these study findings in nutshell as overall conclusions.

2. METHODOLOGY

A. Prior Analysis

Since, we have 10 years' data for the concerned variables, we can find Fixed Based Indices for Sales and Advertising Expenditure. Also, Annual Growth Rate (AGR) gives the prior information regarding the growth structure (here, 2007 is taken as the base year for constructing the indices).

B. Model Building Approach

For Model Building Econometrics methods are used as Data Analysis Technique. Data are collected for Sales and Advertising Expenditure for all the four selected FMCG companies. For the data analysis based upon 10 years' period (2007 – 2017) we define,

Y = Total Sales in Crores Rs.

X = Advertising Expenditure in Crores Rs.

As per suitability of Econometric Model we consider here below two models

MODEL 1

LOG – LOG MODEL

$$\ln Y = \alpha + \beta \ln X + U \qquad \qquad ...(1)$$

(ln represents logarithmic value to the natural based e. α is the intercept term and β is the slope coefficient, U is the disturbance term.)

Under the usual normality assumptions, the model is fitted using OLS method to find $\hat{r}$ and $\hat{s}$ and then the estimated value of $\hat{y}$ for the given X can be obtained from

$$\ln \hat{Y} = \hat{r} + \hat{s} \ln X + U \qquad \qquad …(2)$$

The output for Regression and ANOVA for testing the model has been done with Excel.

MODEL 2

LOG - LIN MODEL

$$\ln Y = \alpha + \beta X + U \qquad \qquad …(3)$$

(ln represents logarithmic value to the natural based e. α is the intercept term and β is the slope coefficient, U_i is the disturbance term.)

Here, α and β are estimated using OLS method, $\hat{Y}$ can be obtained from

$$\ln \hat{Y} = \hat{r} + \hat{s} X + U \qquad \qquad …(4)$$

The output for Regression and ANOVA for testing the model has been done with Excel.

3. DATA ANALYSIS

3.1. HUL (Hindustan unilever)

3.1.1 Data for HUL company:

Table 3.1.1				
YEAR	Sales (Y)	Fixed Base Indices(Y)	Advertising (X)	Fixed Base Indices(X)
2007-08	14715	100	1436.96	100
2008-09	21650	147.1287802	2153.81	149.8865661
2009-10	18220	123.8192321	2423.04	168.6226478
2010-11	20285	137.8525314	2796.45	194.6087574
2011-12	22800	154.9439348	2696.96	187.685113
2012-13	26680	181.3115868	3289.97	228.9534851
2013-14	28947	196.7176351	3674.66	255.7245852
2014-15	32086	218.0496092	3943.59	274.4397896
2015-16	32929	223.7784574	4595.18	319.7848235
2016-17	33895	230.3431872	3542	246.4925955
AGR	13.03431872 %		14.64925955 %	

3.1.2 Graphical Presentation

3.1.3 Regression Analysis and ANOVA

Hypothesis:

Sales are not related with advertising expenditure.

Here, Model 1 is fitted for Data Analysis.

Table 3.1.3		
Model 1:ln Y= $\hat{r}$ + $\hat{s}$ ln X + U		
	$\hat{r}$	$\hat{s}$
Coefficients	3.999917564	0.764938788
Standard Error	0.860017999	0.107728448
t Stat	4.650969594**	7.100620125**
R Square = 0.863057797	F = 50.41880615**	

Conclusion

Here almost 86.31% of the variation is explained by the model. Both the coefficients are statistically significant and ANOVA also suggests that model proposed may be considered to be appropriate one.

3.1.4 Estimated Sales

Table 3.1.4		
YEAR	Actual Y	Estimated Y
2007-08	14715	14203.4561
2008-09	21650	19357.1648
2009-10	18220	21182.1876
2010-11	20285	23636.6297
2011-12	22800	22990.6427
2012-13	26680	26765.7036
2013-14	28947	29128.2921
2014-15	32086	30745.3335
2015-16	32929	34560.4496
2016-17	33895	28320.4412

3.2   MARICO

3.2.1 Data of MARICO company:

YEAR	Sales (Y)	Fixed Base Indices(Y)	Advertising (X)	Fixed Base Indices(X)
		Table 3.2.1		
2007-08	1488.78	100	207.45	100
2008-09	2249.27	151.0814224	242.59	116.9390215
2009-10	2500.09	167.9287739	351.12	169.2552422
2010-11	3156.21	211.9997582	345.95	166.7630754
2011-12	4040.85	271.4202233	448.99	216.4328754
2012-13	4303.8	289.0823359	570.7	275.1024343
2013-14	4744.4	318.6770376	561.2	270.5230176
2014-15	5791.9	389.0366609	649.8	313.2321041
2015-16	6225.4	418.154462	786.1	378.9346831
2016-17	6033.2	405.2445627	659.5	317.9079296
AGR	30.52445627%2		1.79079296%	

3.2.2 Graphical Representation
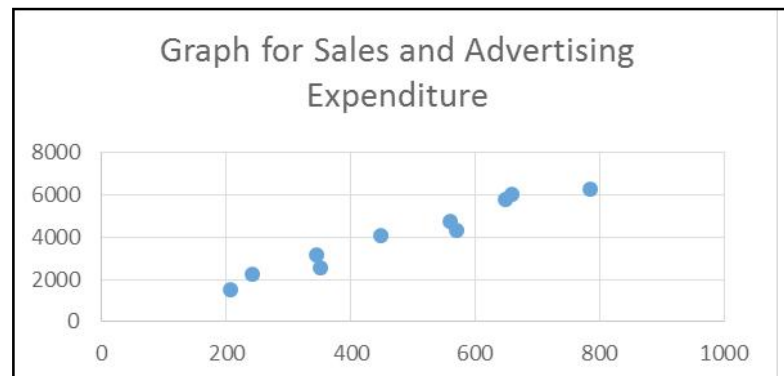
3.2.3 Regression Analysis and ANOVA

Hypothesis: Sales and advertising expenditure are statistically independent.
Here, Model 1 is fitted for Data Analysis.

Table 3.2.3		
Model 1: ln Y = $\hat{r}$ + $\hat{s}$ ln X + U		
	$\hat{r}$	$\hat{s}$
Coefficients	1.862808	1.042100898
Standard Error	0.496243	0.081216877
t Stat	3.753823*	12.83108806*
R Square = 0.95366	F = 164.6368**	

Conclusion

Here almost 95.37% of the variation is explained by the model. Estimated co-efficients are statistically significant. ANOVA states that R^2 is highly significant. Proposed model can be considered to be appropriate for the data.

3.2.4 Estimated Sales

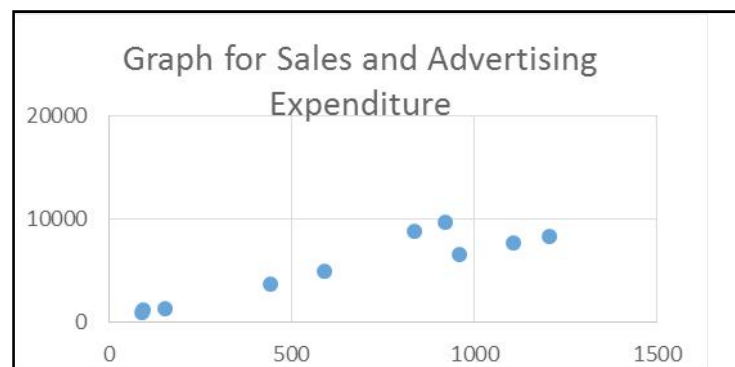| Table 3.2.4		
YEAR	Actual Y	Estimated Y
2007-08	1488.78	1672.880166
2008-09	2249.27	1969.180115
2009-10	2500.09	2894.86816
2010-11	3156.21	2850.462506
2011-12	4040.85	3740.291673
2012-13	4303.8	4802.444734
2013-14	4744.4	4719.165858
2014-15	5791.9	5498.035188
2015-16	6225.4	6704.822239
2016-17	6033.2	5583.590133

3.3   GODREJ

Data are preferted in table 3.3.1 as shown below.

3.3.1 Data of GODREJ company:

YEAR	Sales (Y)	Fixed Base Indices(Y)	Advertising (X)	Fixed Base Indices(X)
Table 3.3.1				
2007-2008	896.2983	100	90.0606	100
2008-2009	1133.1482	126.425343	93.3824	103.6884054
2009-2010	1318.486	147.1034811	154.8883	171.9823097
2010-2011	3693.6	412.0949465	443.93	492.9236536
2011-2012	4866.16	542.917464	590.54	655.7140414
2012-2013	6475.22	722.4402858	958.89	1064.716424
2013-2014	7602.41	848.2008724	1108.52	1230.86011
2014-2015	8276.36	923.3934729	1206.56	1339.720144
2015-2016	8836.96	985.9396141	838.83	931.4061865
2016-2017	9684.1	1080.455023	920.91	1022.54482
AGR	8.04550226%		92.25448198%	

3.3.2   Graphical Representation

3.3.3 Regression Analysis and ANOVA

Hypothesis:

Sales do not depend upon the advertising expenditure

Here, Model 1 is fitted for Data Analysis.

<table>
<tr><td colspan="3">Table 3.3.3</td></tr>
</table>

Table 3.3.3		
Model 1: ln Y= + ln X + U		
	$\hat{r}$	$\hat{s}$
Coefficients	2.878506834	0.8828967
Standard Error	0.356574442	0.057640985
t Stat	8.072667287**	15.31716876**
R Square = 0.967026036	**F** = 234.6156589**	

Conclusion

About 96.70% of the variation is explained by the model. Both the coefficients are statistically significant. ANOVA justifies for the suitability of the model.

3.3.4 Estimated Sales

Table 3.3.4		
YEAR	**Actual Y**	**Estimated Y**
2007-2008	896.2983	945.740509
2008-2009	1133.1482	976.4727526
2009-2010	1318.486	1526.440363
2010-2011	3693.6	3867.451415
2011-2012	4866.16	4975.612091
2012-2013	6475.22	7633.319838
2013-2014	7602.41	8675.882331
2014-2015	8276.36	9349.944024
2015-2016	8836.96	6782.998506
2016-2017	9684.1	7365.753988

3.4 ITC (Imperial Tobacco Company)

3.4.1 Data of ITC company:

Table 3.4.1

YEAR	Sales (Y)	Fixed Base Indices(Y)	Advertising (X)	Fixed Base Indices(X)
2007-08	21966.84	100	377.54	100
2008-09	23678.46	107.7918353	502.3	133.0455051
2009-10	26874.34	122.3404914	511.97	135.6068231
2010-11	31423.23	143.0484767	623.59	165.1719023
2011-12	34871.86	158.7477307	682.69	180.8258728
2012-13	41809.82	190.3315179	806.65	213.6594798
2013-14	46712.62	212.6506134	795.89	210.8094507
2014-15	49964.82	227.4556559	754.98	199.9735127
2015-16	51582.45	234.819619	871.27	230.775547
2016-17	55001.69	250.3850804	792.44	209.8956402
AGR	15.03850804%		10.98956402%	

3.4.2 Graphical Presentation

Graph for Sales and Advertising Expenditure
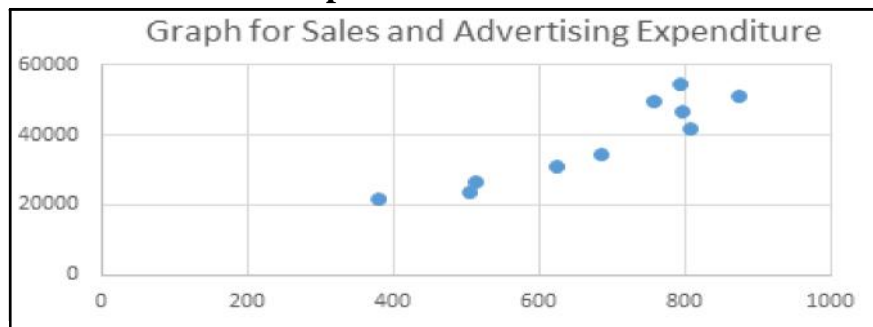
3.4.3 Regression Analysis and ANOVA

There is no influence of advertising expenditure on sales.

Here, Model 2 is fitted for Data Analysis.

Table 3.4.3

Model 2: $\ln Y = \hat{r} + \hat{s} X + U$		
	$\hat{r}$	$\hat{s}$
Coefficients	9.17458515	0.001981631
Standard Error	0.1529905	0.00022191
t Stat	59.9683325**	8.929881906**
R Square = 0.90882442	**F** = 79.7427909**	

Conclusion

Both the fitted coefficients are statistically significant. About 90.88% of the value is explained by the model. ANOVA suggests F to be highly significant. Thus, model appears to be suitable for these data.

3.4.2 Estimated Sales

Table 3.4.4		
YEAR	**Actual Yi**	**Estimated Yi**
2007-08	21966.84	20388.57563
2008-09	23678.46	26106.98684
2009-10	26874.34	26612.08252
2010-11	31423.23	33200.16888
2011-12	34871.86	37325.22374
2012-13	41809.82	47718.17158
2013-14	46712.62	46711.47886
2014-15	49964.82	43074.07991
2015-16	51582.45	54237.10442
2016-17	55001.69	46393.2191

4. CONCLUDING REMARKS

On the basis of our above analysis we may conclude that there is significant relationship between advertising expenditure and sales growth for all the FMCG companies considered here.From AGR we can suggest the FMCG companies to get the maximum sales by spending reasonable amount on advertising expenditure According to AGR for both the series for sales and advertising expenditure, We observe that;

(1)   14.69% increase per year in advertising expenditure gives 13.03% sales per year for HUL company

(2)   21.79% increase per year in advertising expenditure gives 30.52% sales per year for MARICO company

(3)   92.25% increase per year in advertising expenditure gives 98.04% sales per year for GODREJ company

(4)   10.99% increase per year in advertising expenditure gives 15.03% sales per year for ITC company

These fitted models can be useful for sales prediction of future period if advertising expenditures are known.

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EDUCATIONAL VIABILITY FOR SECONDARY AND HIGHER SECONDARY EDUCATION IN GUJARAT STATE

H. M. Dixit[1], S. N. Jaiswal[2] and P. M. Parmar[3]

ABSTRACT

Education is backbone of sustainable development for any nation. Education system and quality education together make it possible. Due to long legacy of British rule, India has adopted British model for education. In classroom teaching number of students and number of teachers are one of the affecting factors on quality of education. In welfare state like Gujarat, government is supposed to provide atleast basic education to the people at affordable rate. It requires sufficient amount for fund allocation in budget also. Being in financial crunch or lack of priority, sometimes government fails to do so. In this paper an attempt is made to establish trend models for different educational factors, multiple regression analysis between number of teachers and number of students including trend component is also worked out. Projections based on fitted models also highlighted.

KEY WORDS :

ST Ratio, Log Level Model, Educational Factor, Multiple Regression

1.   INTRODUCTION

Education, education system and quality of education play an indispensable role

1.   Arts, Commerce and Science College, PILVAI. (dixithm13@gmail.com)
2.   R.L. Mehta Science and C.L. Parikh Commerce College, Palanpur, (jaiswalsn1964@gmail.com)
3.   H.L. College of Commerce, Ahmedabad. (parmarpm2004@gmail.com)

in building of any nation. After independence India was to face many challenges. Education was one of them. Due to long British rule, India has adopted British education system. And still today it is prevailing in many disciplines. Education in India is provided by the public sector as well as the private sector, with control and funding coming from three levels : Central, State and Local. Under various articles of the Indian constitution, free and compulsory education is provided as a fundamental right to children, between the ages of 6 and 14. The ratio of public schools to private schools in India is 7:5.

After inception of separate state of Gujarat, the education department of the state has been paying special attention to the improvement of elementary education in Gujarat. The State government has also launched the district primary education programme for making compulsory and free education for all students upto a certain age limit. It has also taken up several measures for checking the drop out rate at schools in Gujarat. The same uniform structure of $10 + 2$ education is followed in the schools of Gujarat. Apart from both government schools and private schools operating in Gujarat, one can also come across schools run by municipal corporations in major cities of Gujarat. The government of Gujarat also gives special importance to education of women in the state, and also provides mid-day meal to attract children in schools, whose parents are financially not capable to provide education to their children.

In the light of the above discussion, the following analysis and conclusions are carried out. Accordingly we have made an attempt to study the economic viability for secondary and higher secondary education in Gujarat State. For this we have considered the published data for basic educational system pertaining to the years 1990-91 to 2015-2016. Statistical methodology is adopted to carry out our analysis by means of model building approach. Conclusions based upon the

statistical analysis are presented which can be useful for future predictions.

2. METHODOLOGY AND ANALYSIS

For the secondary data published in STATISTICAL ABSTRACT OF GUJARAT STATE – 2016, we consider for our analysis log-level trend model and multiple regression model corresponding to certain different educational factors (EF) like total boys students, total girls students studying in secondary / Higher secondary schools and total male teachers, total female teachers, total teachers teaching in secondary/Higher Secondary schools in Gujarat State.

The trend model and multiple regression model are represented by the following relationship, followed by analysis.

Model – A $\quad L_n\left(EF_j\right)_i = L_n \propto + \beta t_i + U_i$

Where EF is the jth educational factor at the given point of time t_i year. U_i is the disturbance term for the ith year. α and β are the parameters of the model.

$(i = 1,2,3,\dots 13)$ and $(j = 1,2,\dots,6)$ stands for the specific educational factor such as –

Model $A - 1$ $(EF_1)i$ = Total no. of boys students

Model $A - 2$ $(EF_2)i$ = Total no. of girls students

Model $A - 3$ $(EF_3)i$ = Total no. of students

Model $A - 4$ $(EF_4)i$ = Total no. of male teachers

Model $A - 5$ $(EF_5)i$ = Total no. of female teachers

Model $A - 6$ $(EF_6)i$ = Total no. of teachers

The unknown parameters   and   are to be estimated under the usual assumptions.

Model – B The multiple regression model is represented by the following relationship.

$$L_n(EF_4)_i = L_n \Gamma_0 + \Gamma_1 L_n(EF_3)_i + \Gamma_2 t_i + U_i$$

Where $(EF_3)_i$ = Total no. of students at the given point of time t_i and $(EF_4)_i$ = Total no. of teachers at the given point of time t_i. Here Γ_0, Γ_1 and Γ_2 are the structural parameters of the model and OLS estimates of these parameters can be obtained which can be tested for their statistical significance. Once the parameters are estimated for the respective models, usual statistical testing can be done for significance and projections on the basis of fitted models can be given for further periods.

Table – 1 and Table – 2 given below show the regression output for both the models with conclusions.

Table – 3 gives the projections based upon the fitted models for the next 3 years and Table – 4 indicates student / Teacher ratio (ST Ratio) for the period under study.

Table – 1

Model	Dependent variable	Constant	Co-efficient of Independent variable
A – 1	Male Teachers	3.8186 t=68.342* S.E. = 0.0558	0.0090 t=3.211* S.E. = 0.0028
		$R^2 = 0.4839$, F=10.31*, $n = 13$	
A – 2	Female Teachers	2.5268 t = 10.733* S.E. = 0.0620	0.0311 t = 9.943* S.E. = 0.0031
		$R^2 = 0.8999$, F=98.87*, $n = 13$	
A – 3	Total Teachers	4.0500 T=84.0240* S.E. = 0.0482	0.0154 T = 6.3210* S.E.=0.0024
		$R^2 = 0.7841$, F=39.95*, $n = 13$	
A – 4	Boys Students	7.0238 t= 82.7090* S.E. = 0.0849	0.0176 t = 4.1090* S.E. = 0.0042
		$R^2 = 0.6055$, F=16.89*, $n = 13$	
A – 5	Girls Students	6.5285 t = 77.906* S.E. = 0.0838	0.0243 t = 5.738* S.E. = 0.0042
		$R^2 = 0.7495$, F=32.92*, $n = 13$	
A – 6	Total Students	7.4990 t = 89.462* S.E.=0.0838	0.0203 t=4.793* S.E.=0.0042
		$R^2 = 0.6762$, F=22.98*, $n = 13$	

Table – 2

Model	Dependent variable	Constant	Independent variable	
			Total Students	Time
B	Total Teachers	2.2705 t = 1.8270* S.E. = 1.2430	0.2373 t = 1.4330 S.E.=0.0040	0.0105 t=2.5860* S.E. = 0.1656
		$R^2 = 0.8209$, F= 22.91*, $n = 13$		

3. CONCLUSIONS

1. For the above regression Model A – 1, pertaining to male teachers, it is found that model is statistically significant. About 48.39% variation is explained by the model. Elasticity is 0.0090 which indicates that due to unit change in time, number of male teachers increases by about 0.9% per year.

2. Regression Model A – 2 for female teachers suggests that 89.99% variation is explained by the model. It seems that unit change in time accounts for 3.11% increase in number of female teachers every year.

3. Regression Model A – 3 for number of total teachers is found to be statistically significant. On an average the logarithmic value of regressand (No. of total teachers) increases by 1. 54% with unit change in regressor (i.e. time) and about 78.41% variation is explained by the model.

4. Model A – 4 pertaining to number of students is found to be significant. 60.55% variation is explained by the model and with unit change in time (i.e. year) accounts for 1.76% increment in number of boys students.

5. Model A – 5 for number of girls students shows that every year number of girls students increases by about 2.43%. is 0.7495 which is satisfactory.

6. Regression output for total no. of students shows that with upward unit change in time total no. of students increases by 2.03%, and the explained variation is 67.62%.

7. Model – B shows statistical significance of relationship between time and total no. of teachers. All partial regression coefficients except for total students are found to be significant. The value of shows that about 82.09% variation is explained by the model. Theoretically there should be positive relationship between number of students and number of teachers which is atleast justified by the above model.

4. PROJECTIONS BASED ON TREND ANALYSIS

Table – 3			
EF	**2016-17**	**2017-18**	**2018-19**
Total Male teachers	58.18	58.71	59.25
Total Female teachers	29.05	29.97	30.92
Total teachers	87.04	88.39	89.76
Total Boys students	1808.75	1840.95	1873.73
Total Girls students	1319.57	1352.05	1385.33
Total students	3126.66	3190.84	3256.34

(All the figures above are in thousands)

5. STUDENT / TEACHER RATIO (ST RATIO)

Table – 4						
Year	1990-91	2000-01	2005-06	2006-07	2007-08	2008-09	2009-10
ST Ratio	28.50 (100)	35.07 (123.05)	35.19 (123.47)	35.09 (123.12)	35.24 (133.64)	35.42 (124.28)	35.09 (123.12)
Year	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	**AGR= 0.94%**
ST Ratio	41.44 (145.40)	38.57 (135.33)	31.11 (109.15)	34.74 (121.89)	32.56 (114.24)	32.01 (112.31)	

6. ACKNOWLEDGEMENT

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STASTISTICAL STUDY OF DEBT ANALYSIS FOR INDIAN ECONOMY[#]

*Paresh M. Prajapati

ABSTRACT

For any economy of a country it is very much essential to know about liabilities and debt situation. This can enhance and focus on the economic growth of the country. In this paper an attempt is made to consider both – liabilities as well as debts of Government of India. Basic terms are defined and statistical as well as graphical presentations are carried out. Some suggestions are made on the basis of this analysis which may be useful for our country.

KEY WORDS

Liabilities, Debt Analysis, Percentage Debt of GDP.

1. INTRODUCTION

The economy of India is considered to be a rapidly developing economy and has significant role in the world economy. It is the sixth-largest economy of the world by nominal GDP and the third-largest economy by purchasing power parity. After economic reforms in 1991, India achieved 6-7% average GDP growth annually. Demonetisation and Goods and Services Tax (GST) were the two major steps taken by the Government to boost up the economy in the recent time.

*   Dept. of Statistics, L.D. Arts College, Ahmedabad-380009 (India)
     Email : pmprajapati@yahoo.co.in

In spite of the various steps taken by the government of India to raise the economic growth, different sectors affecting the economy face various challenges. Along with the assets it is also necessary to reduce the liabilities because Government's liabilities are not matched by its assets. This can be considered as a matter of serious concern. Liabilities are classified into two categories- (1) Internal liabilities and (2) External debt (outstanding). It is necessary to study the tendency of both the types of liabilities as per passage of time and their impact on economic growth.

In this paper an attempt is made to analyse the data based on Liabilities of the government by means of various statistical methods and conclusions are derived on its basis. Second part of this paper contains database, third part expresses the methodology, fourth part is about the analysis and graphical representation of the data. Conclusions derived on the basis of analysis are presented in fifth part of this paper.

2. DATABASE

For the analysis work secondary data have been considered which are being published year to year by Government of India by means of Economic Surveys. Projections are made on the basis of appropriate methods wherever needed.

Table 2.1 gives the date, base for the study undertaken this paper.

Table 2.1   Source   Union Budget documents and   CAA&A

Outstanding Liabilities of the Central Government (End-March) (₹ crore)

	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17(RE)	2017-18(BE)
1. Internal liabilities#	3036132	3395877	3781135	4347164	4893303	5484848	6045007	6691709	7215739	7722082
(a) Internal debt	2019841	2328339	2667115	3230622	3764566	4240767	4738291	5304835	5731392	6180027
i) Market borrowings	1338194	1746619	2072033	2516953	2984309	3441641	3891734	4298784	4647492	5006718
ii) Others	681647	581720	595082	713669	780257	799126	846557	1006051	1083900	1173309
(b) Other Internal liabilities	1016291	1067538	1114020	1116542	1128737	1244081	1306716	1386874	1484347	1542055
2. External debt (outstanding)*	123046	134083	157639	170088	177289	184581	197514	210262	225135	240924
3. Total outstanding liabilities (1+2)	3150178	3529960	3938774	4517252	5070592	5669429	6242521	6901971	7440874	7963006
4. Amount due from Pakistan on account of share of pre-partition debt	300	300	300	300	300	300	300	300	300	300
5. Net liabilities (3-4)	3158878	3529660	3938474	4516952	5070292	5669129	6242221	6901671	7440574	7962706
Memorandum items										
(a) External debt@	264059	249306	278877	322897	332004	374483	366191	406586	408118	423907
(b) Total outstanding liabilities(adjusted)	3300191	3645183	4060012	4670061	5225307	5859331	6411198	7098295	76238857	8145989
(c) Internal liabilities (Non-RBI)##	2707846	3087360	3464858	3904022	4396810	4984590	5540570	6139580	6646470	7161810
(d) Outstanding liabilities (Non-RBI)##	2971905	3336666	3743735	4226919	4728814	5359073	5906761	6546166	7054588	7585717
(e) Contingent liabilities of Central Government	113335	137460	151292	190519	233769	249503	294700	343762	n.a.	n.a.
(f) Total assets	1569043	1607544	1794504	1927143	2080649	2253627	2464424	2773756	3022919	3275837

3. METHODOLOGY

In this section, different terms used for the study are defined and the statistical technique applied is discussed.

3.1 Liability

In Economy, a liability is defined as the future sacrifices of economic benefits that the entity is obliged to make to other entities as a result of past transactions or other past events, the settlement of which may result in the transfer or use of assets, provision of services or other yielding of economic benefits in the future.

"**Any type of borrowing from the other countries, international organisations, banks etc. for improving a business or national economy that is payable during short or long time"** is called a liability.

3.2 Asset

An asset is an economic resource. Anything tangible or intangible that can be owned or controlled to produce value and that is held by a country to produce positive economic value is an asset. Simply stated, assets represent the value of ownership that can be converted into cash (although cash itself is also considered an asset).

One can classify assets into two major asset classes **tangible assets** and **intangible assets**.

(1) **Tangible assets** contain various subclasses, including current assets and fixed assets. Current assets include inventory, while fixed assets include such items as buildings and equipment.

(2) **Intangible assets** are nonphysical resources and rights that have a value to the firm because they give the firm some kind of advantage in the marketplace. Examples of intangible assets include goodwill, copyrights, trademarks, patents and computer programs and financial assets, including such items as accounts receivable, bonds and stocks.

3.3 Contingent Liabilities

Contingent liabilities are liabilities that may be incurred by an entity depending on the outcome of an uncertain future event such as the outcome of a pending lawsuit. These liabilities are not recorded in the accounts and shown in the balance sheet when both probable and reasonably estimable as 'contingency' or 'worst case' financial outcome. We construct statistical Indicators (Indices) for internal as well as external dues and liabilities.
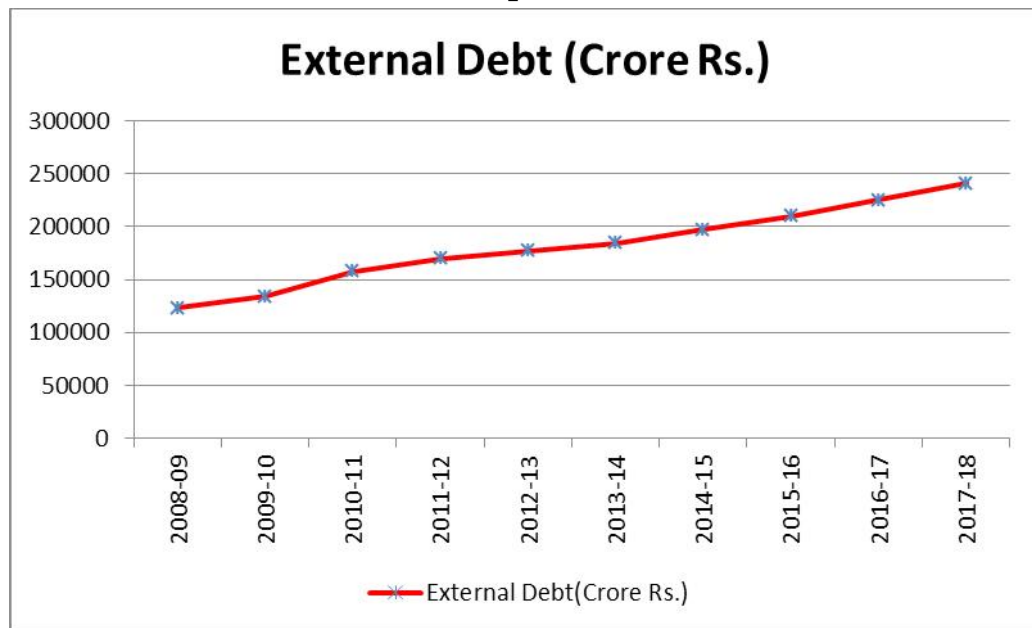
4. ANALYSIS AND GRAPHICAL PRESENTATION

Table 4.1						
Year	Internal Liabilities (Crore Rs.)	External dues (Outstanding)	Index (Internal Debt)	Index (external dues)	Internal Debt (%)	External dues (%)	Total Debt (Crore Rs.)
2008-09	3036132	123046	100	100	96.11	3.89	3159178
2009-10	3395877	134083	112	109	96.20	3.80	3529960
2010-11	3781135	157639	111	118	96.00	4.00	3938774
2011-12	4347164	170088	115	108	96.23	3.77	4517252
2012-13	4893303	177289	113	104	96.50	3.50	5070592
2013-14	5484848	184581	112	104	96.74	3.26	5669429
2014-15	6045007	197514	110	107	96.84	3.16	6242521
2015-16	6691709	210262	111	106	96.95	3.05	6901971
2016-17	7215739	225135	108	107	96.97	3.03	7440874
2017-18	7722082	240924	107	107	96.97	3.03	7963006

Graph-4.1

Internal Liabilities (Crore Rs.)

Graph-4.2

External Debt (Crore Rs.)

Graph-4.3

Total Out Standing (Crore Rs.)
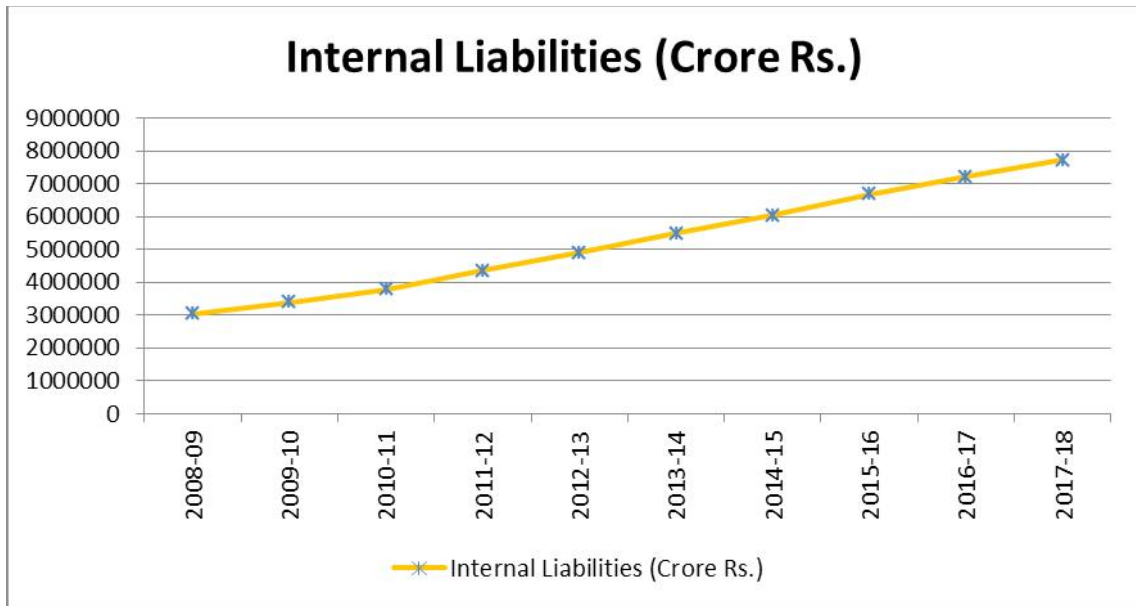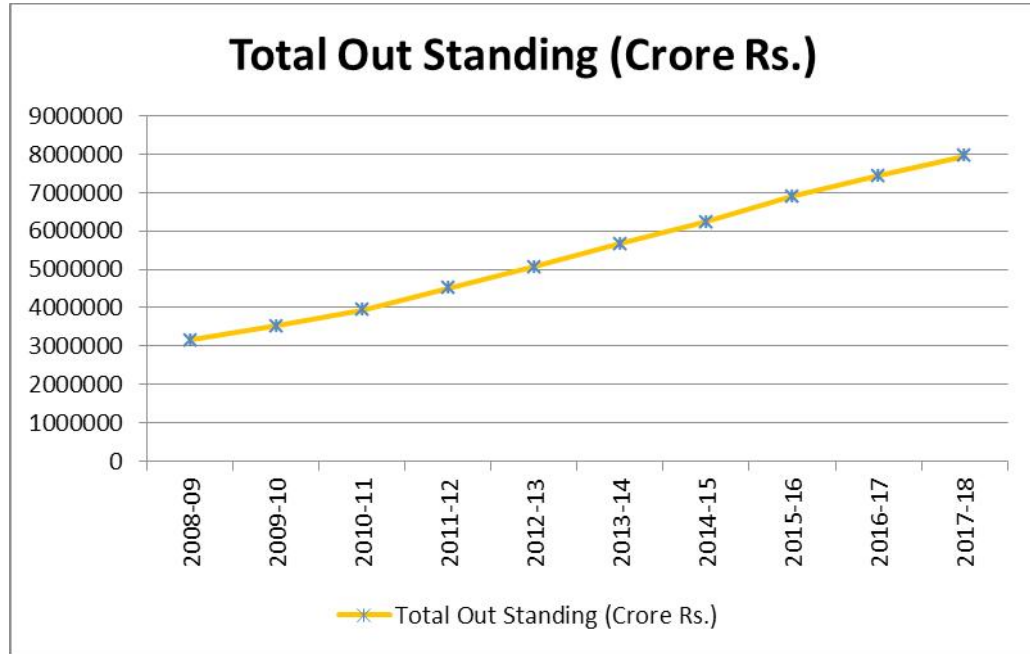
Table 4.2 Per Capita Debt.(Rs.)

Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Per Capita Debt.(Rs.)	27397	30186	33216	37584	41788	46138	50181	54817	58410	61801

Graph-4.4

Per Capita Debt.

Graph-4.5

Rate of Per Capita Debt. (Compared to Previous Year)
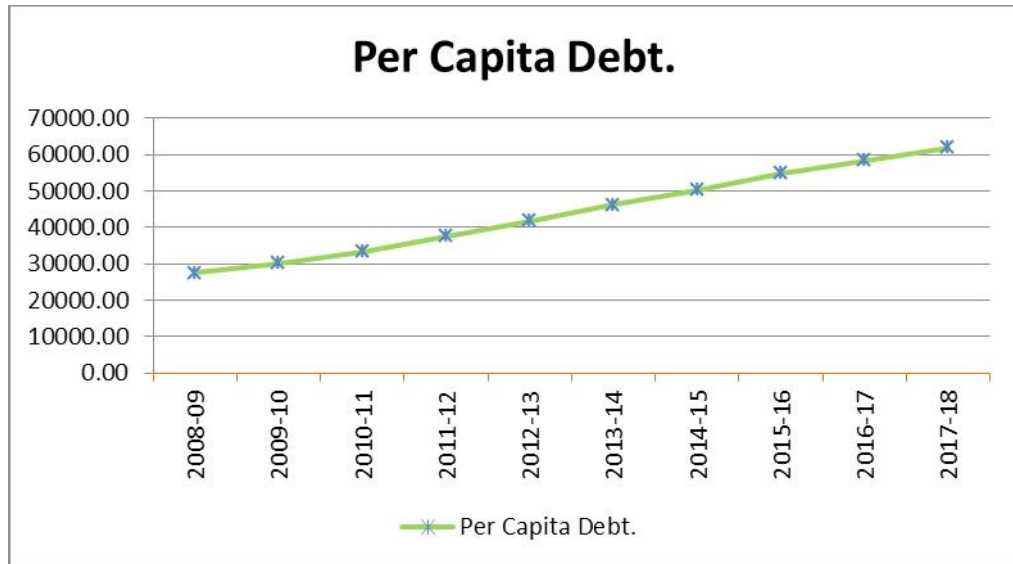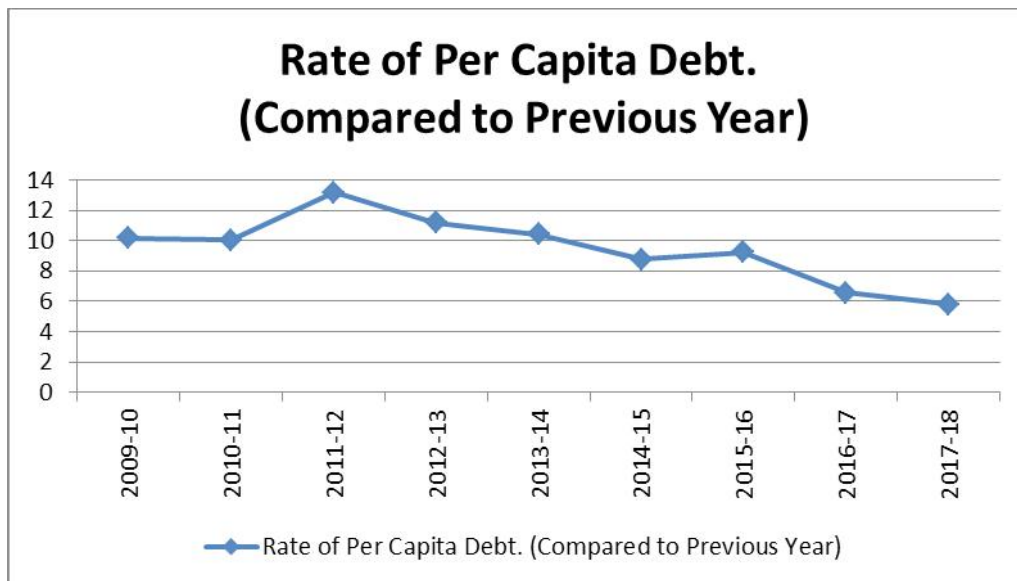
<div align="center">**Table 4.3**</div>

Year	GDP	Index (GDP)	% Total Debt. Of GDP	% Internal Debt. of DGP	% External Debt. Of GDP
2008-09	5630063	100	56.11	53.93	2.19
2009-10	6477827	115	54.49	52.42	2.07
2010-11	7784115	120	50.6	48.58	2.03
2011-12	9009722	116	50.14	48.25	1.89
2012-13	9944013	110	50.99	49.21	1.78
2013-14	11233522	113	50.47	48.83	1.64
2014-15	12445128	111	50.16	48.57	1.59
2015-16	13682035	110	50.45	48.91	1.54
2016-17	15183709	111	49.01	47.52	1.48
2017-18	16627585	110	47.89	46.44	1.45

<div align="center">**Graph-4.6(a)**</div>
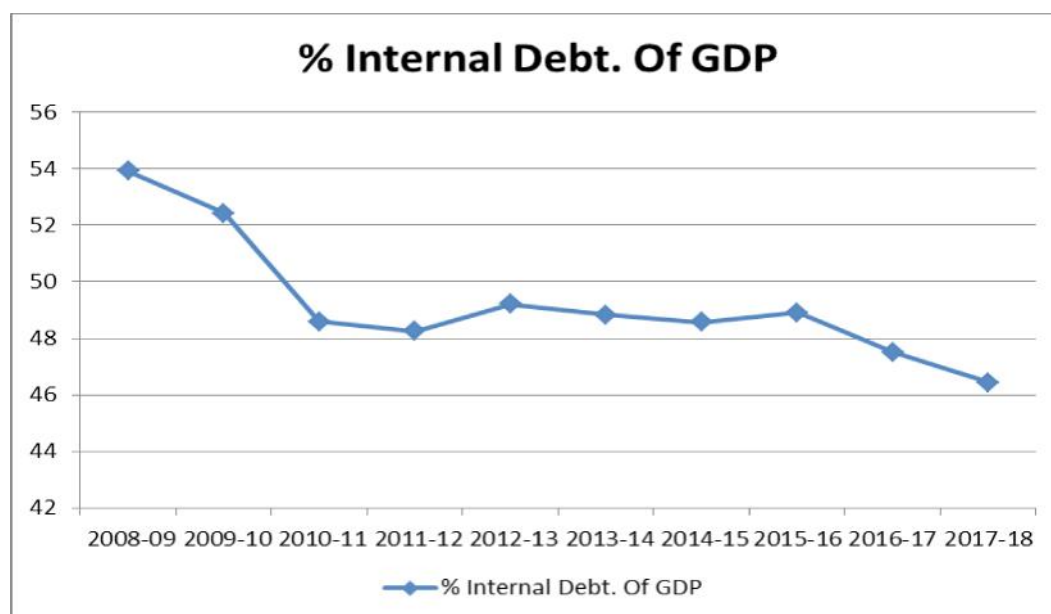
Graph-4.6(b)
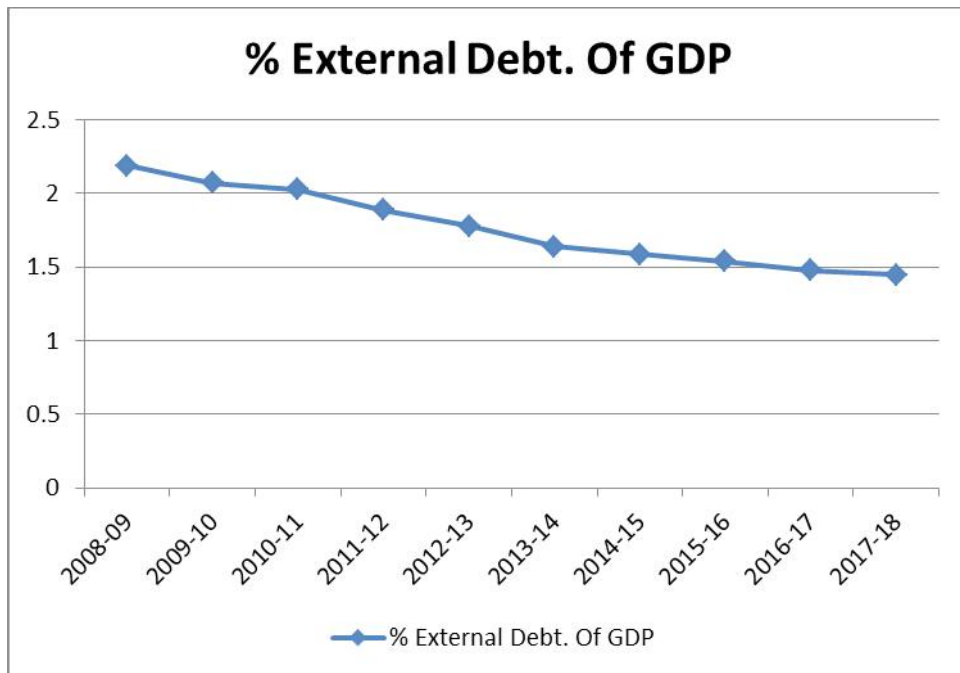
5. INTERPRETATION

Liability is a crucial component of economy for any country. It is the biggest hurdle in economic growth if it is not balanced with the profitability. Therefore it is worth to study the behaviour pattern of the liabilities over the years. Also it is essential to study its components such as internal liabilities and external liabilities along with its impact on GDP of a nation and per-capita debt as well. For our Study a period of ten years, ranging from 2008-09 to 2017-18 is considered for analysis.

Looking at the Internal Liabilities, it can be seen from Table-4.1 and Graph-4.1 that the debt has increased consistently throughout the selected period of ten years i.e. 2008-09 to 2017-18 and the rate of increase has remained between 7% and 15% in comparison to the previous year. The trend for Internal debt is found to be almost linear. Also it can be observed that 2011-12 onwards the rate of increase has slow-downed consistently. It may be noted that there is no drastic change observed in the internal debt after the demonitisation.

Looking at the External dues, it can be seen from the Table-4.1 and Graph-4.2 that the debt has increased consistently throughout the selected period of ten years i.e. 2008-09 to 2017-18 and the rate of increase has remained between 4% and 9% in comparison to the previous year. The trend of Internal debt is found almost linear. Also it can be observed that from 2014-15 onwards the rate of increase in external debts has remained stable by about 7% as compared to previous years. However it was nearly 4% only in 2012-13 and 2013-14. It should be noted that there is no significant reduction observed in internal debt after demonitisation. And impact of GST is yet to be measured in coming years.

It can also be seen that the internal debt has remained almost 97% of the total debt throughout the selected period and the external dues has remained about 3% of the total debt throughout the study period.

Looking to the overall picture of Total Outstanding, from Graph 4.3 it can be seen that the debt has increased consistently throughout the periods 2008-09 to 2017-18. However the rate of increase has decreased throughout the period except the year 2011-12.

After all it should be the ultimate goal of the government to see that every citizen should have minimum burden of debt or should be free from the debt for the quality of life for the people and development of the nation. Therefore it is also important to observe the per-capita debt. These figures are given in the Table-4.2 and represented by the Graph-4.4. It is very clear from the graph that the per-capita debt has consistently increased throughout the period and it has become more than double during this period of ten years. However from the Graph-4.5 it can be seen that rate of change in per-capita debt compared to previous year has decreased throughout the selected period except the year 2011-12.

GDP is a tool of measuring economic growth of any nation. It is quite natural that liabilities directly affect the economic growth of any nation. Here an attempt is made to visualize the impact of liabilities on GDP.

It can be seen from the table 4.3 that GDP of our nation has increased by three folds during the last ten year period. But the growth rate of GDP was at the peak during the years 2009-10 to 2011-12. Then the rate of growth has slow downed consistently till the last year of the considered period. From the table 4.3 it can be seen that the Total debt is almost 50% of the GDP which is a huge part affecting the economy. Among this, almost 48% is internal debt and remaining about 2% is for external dues. Consolation is - the share of liability in GDP has a decreasing rate of increase during the selected period. This can be seen from

the graph-4.6(a) and graph-4.6(b).

6. FINDINGS AND SUGGESTIONS

Overall study shows that the liability has increased throughout the selected period with almost constant rate. However the rate of increase has decreased by a nominal amount during the whole period except for the couple of years in the beginning of the series. This picture is almost similar for both the internal debt as well as the external liabilities. It is also observed that the liabilities remain to almost 50% of GDP.

It is an extremely a serious matter that half of the GDP is spent as a liability. Therefore Government and Economists should frame out the effective policies that can help in reducing the liabilities. Also internal liabilities should be reduced by significant amount as it is almost 98% of the total liabilities.

7. ACKNOWLEDGEMENT

I am thankful to the referee for his valuable suggestions in revising the earlier draft of this research paper.

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PROFESSOR AMARTYA SEN[*]

**H. D. BUDHBHATTI

In this article it is my humble attempt to present (in brief) the biography of an eminent economist, academician, thinker and also a philosopher - PROFESSOR AMARTYASEN. He has been a very outstanding distinguished personality and also PRIDE OF INDIA for his notable academic achievements.

Early life and education

Sen was born in a Bengali Kayastha family in Santiniketan in West Bengal, India, on the campus on Rabindranath Tagore's Viswa-Bharati University, to Ashutosh Sen and Amita Sen. Sen's family was from Wari and Manikganj, Dhaka, both in present-day Bangladesh. His father Ashutosh Sen was a professor of chemistry at Dhaka University who moved with his family to West Bengal in 1945 and worked at various government institutions, including the West Bengal Public Service Commission (of which he was the chairman), and the Union Public Service Commission.

Sen began his high-school education at St Gregory's School in Dhaka in 1940. From fall 1941, Sen studied at Patha Bhavana, Santiniketan. In 1951, he went to Presidency College, Kolkata, where he earned a B.A. in Economics with First Class, with a minor in Mathematics, as a graduating student of the University of Calcutta. While at Presidency, Sen was diagnosed with oral cancer, and given

a 15% chance of living five years. With radiation treatment, he survived, and in 1953 he moved to Trinity College, Cambridge, where he earned a second B.A. in Pure Economics in 1955 with a First Class, topping the list as well. He was elected President of the Cambridge Majlis. While Sen was officially a Ph.D student at Cambridge (though he had finished his research in 1955-6), he was offered the position of Professor and Head of the Economics Department of the newly created Jadavpur University in Calcutta, and he became the youngest chairman to head the Department of Economics. He served in that position, starting the new Economics Department, during 1956 to 1958.

Meanwhile, Sen was elected to a Prize Fellowship at Trinity College, which gave him four years of freedom to do anything he liked; he made the radical decision to study philosophy.

In Cambridge, there were major debates between supporters of Keynesian economics on the one hand, and the "neo-classical" economists who were skeptical of Keynes, on the other. However, because of a lack of enthusiasm for social choice theory in both Trinity and Cambridge, Sen had to choose a different subject for his Ph.D. thesis, which was on **"The Choice of Techniques"** in 1959, though the work had been completed much earlier (except for some valuable advice from his adjunct supervisor in India.

RESEARCH WORK

Sen's work on **'Choice of Techniques'** complemented that of Maurice Dobb. In a Developing country, the Dobb-Sen strategy relied on maximising investible surpluses, maintaining constant real wages and using the entire increase in labour productivity, due to technological change, to raise the rate of accumulation. In other words, workers were expected to demand no improvement in their standard of living despite having become more productive. Sen's papers in the late 1960s and early 1970s helped develop the theory of social choice, which first came to prominence in the work by the **American Economist Kenneth Arrow**. Arrow, while working at the RAND Corporation, had most famously shown that when voters have three or more distinct alternatives (options), any ranked order voting system will in at least some situations inevitably conflict with what many assume

to be basic democratic norms. Sen's contribution to the literature was to show under what conditions **Arrow's impossibility theorem** applied, as well as to extend and enrich the theory of social choice, informed by his interests in **history of economic thought and philosophy.**

In 1981, Sen published *Poverty and Famines: An Essay on Entitlement and Deprivation* (1981), a book in which he argued that famine occurs not only from a lack of food, but from inequalities built into mechanisms for distributing food. Sen also argued that the Bengal famine was caused by an urban economic boom that raised food prices, thereby causing millions of rural workers to starve to death when their wages did not keep up.

In *Poverty and Famines*, Sen revealed that in many cases of famine, food supplies were not significantly reduced. In Bengal, for example, food production, while down on the previous year, was higher than in previous non-famine years. Sen points to a number of social and economic factors, such as declining wages, unemployment, rising food prices, and poor food-distribution, which led to starvation. His capabilities approach focuses on positive freedom, a person's actual ability to be or do something, rather than on negative freedom approaches, which are common in economics and simply focuses on non-interference.

In addition to his important work on the causes of famines, Sen's work in the field of development economics has had considerable influence in the formulation of the **"Human Development Report"**, published by the **United Nations Development Programme.** This annual publication that ranks countries on a variety of economic and social indicators owes much to the contributions by Sen among other social choice theorists in the area of economic measurement of poverty and inequality.

Sen's revolutionary contribution to development economics and social indicators is the concept of **"capability"** developed in his article **"Equality of What"**.

He wrote a controversial article in *The New York Review of Books* entitled "More Than 100 Million Women Are Missing" (see Missing women of Asia), analyzing the mortality impact of unequal rights between the genders in the developing world, particularly Asia.

In 1999, Sen further advanced and redefined the capability approach in his

book *Development as Freedom*. Sen argues that development should be viewed as an effort to advance the real freedoms that individuals enjoy, rather than simply focusing on metrics such as GDP or income-per-capita.

PROFESSIONAL CAREER

Sen began his career both as a teacher and a research scholar in the Department of Economics, **Jadavpur University as a Professor of Economics** in 1956. He spent two years in that position. From 1957 to 1963, Sen served as a **Fellow of Trinity College,** Cambridge. Between 1960 and 1961, Sen was a visiting Professor at Massachusetts Institute of Technology in the United States, where he got to know Paul Samuelson, Robert Solow, Franco Modigliani, and Norbert Wiener. He was also a visiting Professor at UC-Berkeley (1964-1965) and Cornell (1978-1984). He taught as Professor of Economics between 1963 and 1971 at the **Delhi School of Economics** (where he completed his *magnum opus* Collective Choice and Social Welfare in 1969).[24] During this time he was also a frequent visitor to various other premiere Indian economic schools and centres of excellence like **Jawaharlal Nehru University, Indian Statistical Institute, Centre for Development Studies, Gokhale Institute of Politics and Economics and Centre for Studies in Social Sciences.** Sen was a companion of distinguished economists like Manmohan Singh (Ex-Prime Minister of India and a veteran economist responsible for liberalizing the Indian economy), **K. N. Raj** (Advisor to various Prime Ministers and a veteran economist who was the founder of Centre for Development Studies, Trivandrum, which is one of India's premier think tanks and schools) and **Jagdish Bhagwati** (who is known to be one of the greatest Indian economists in the field of International Trade and currently teaches at Columbia University). This is a period considered to be a Golden Period in the history of DSE. In 1971, he joined the **London School of Economics as a Professor of Economics** where he taught until 1977. From 1977 to 1988, he taught at the **University of Oxford,** where he was first **a Professor of Economics and Fellow of Nuffield College,** and then the Drummond Professor of Political Economy and a Fellow of All Souls College from 1980. In 1987, he joined **Harvard as the Thomas W. Lamont University Professor of Economics.** In

1998 he was appointed as Master of Trinity College, Cambridge, becoming the first **Asian head of an Oxbridge college.** In January 2004, Sen returned to Harvard. He also established the Eva Colorni Trust at the former **London Guildhall University** in the name of his deceased wife.

In May 2007, he was appointed as **chairman of Nalanda Mentor Group** to examine the framework of international cooperation, and proposed structure of partnership, which would govern the establishment of **Nalanda International University Project** as an international centre of education seeking to revive the ancient center of higher learning which was present in India from the 5th century to 1197.

On 19 July 2012, Sen was named the first chancellor of the proposed Nalanda University (NU). Teaching began in August 2014. On 20 February 2015, Amartya Sen withdrew his candidature for a second term.

Membership and associations

He has served as president of the **Econometric Society (1984), the International Economic Association (1986–1989), the Indian Economic Association (1989) and the American Economic Association (1994).** He has also served as President of the Development Studies Association and the **Human Development and Capability Association.** He serves as the honorary director of the Academic **Advisory Committee of the Center for Human and Economic Development Studies at Peking University in China.**

Sen has been called **"the Conscience of the profession"** and **"the Mother Teresa of Economics"** for his work on **famine, human development theory, welfare economics, the underlying mechanisms of poverty, gender inequality, and political liberalism**

Sen has served as **Honorary Chairman of Oxfam - the UK** based international development charity, and is now its Honorary Advisor. Sen is also a member of the **Berggruen Institute's** 21st Century Council.

AWARDS AND HONOURS

Sen has received over 90 honorary degrees from universities around the world.

- Adam Smith Prize, 1954
- Foreign Honorary Member of the American Academy of Arts and Sci-

ences,1981

- Honorary fellowship by the Institute of Social Studies, 1984
- **Nobel Memorial Prize** in Economic Sciences, 1998
- **Bharat Ratna,** the highest civilian award in India, 1999
- Honorary citizenship of Bangladesh, 1999
- Order of Companion of Honour, UK, 2000
- Leontief Prize, 2000
- Eisenhower Medal for Leadership and Service, 2000
- 351st Commencement Speaker of Harvard University, 2001
- International Humanist Award from the International Humanist and Ethical Union, 2002
- Lifetime Achievement Award by the Indian Chamber of Commerce, 2004
- Life Time Achievement award by Bangkok-based United Nations Economic and Social Commission for Asia and the Pacific(UNESCAP)
- Honorary degree, University of Pavia, 2005
- National Humanities Medal, 2011
- Order of the Aztec Eagle, 2012
- Chevalier of the French Legion of Honour, 2013
- 25 Greatest Global Living Legends In India by NDTV, 2013
- Top 100 thinkers who have defined our century by The New Republic, 2014
- Charleston-EFG John Maynard Keynes Prize, 2015
- Johan Skytte Prize in Political Science, 2017

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Books

Prof. Sen has written several books, research ppaers and articles. Only a few of them are presetned here.

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- *Sen, Amartya (1997) [1976]. On Economic Inequality (expanded ed.). Oxford New York: Clarendon Press Oxford University Press. ISBN 9780198281931. 1980–1989*
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SV NEWS LETTER

<div align="right">

D. K. Ghosh*

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Prof. K. Muralidharan: Profile

Dr. K. Muralidharan is currently working as Professor of Statistics, Faculty of Science, The Maharajah Sayajirao University of Baroda, Vadodara. He was former Head of department of Statistics and Director of Population Research Centre, MSU Baroda. Along with his teaching at MSU, he is also working as an adjunct faculty to IIT Gandhinagar Since 2012.

He has obtained his MSc degree with a gold medal in Statistics from Calicut University, Kerala (1987); MPhil in Statistics (1989) and Ph.D. in Statistics (1996) from Sardar Patel University and has completed Post Doctoral Fellowship from Institute of Statistical Science at Academia Sinica, Taiwan (2003). He is an internationally certified Six Sigma Master Black belt from Indian Statistical Institute, Bangalore (2008).

He has about twenty seven years of teaching and research experience and has guided about six research students for doctorate degree. He has more than hundred ten research publications in international and national journals. His research interests are in the field of Statistical inference, Applied Stochastic point processes, Reliability and Life testing, industrial statistics, Quality and Six Sigma. He is the Coordinating Editor of Journal of Probability and Statistical Science published from Taiwan, Associate Editor of Journal of Indian society for Probability and Statistics published from India, Associate Editor of International Journal of Mathematics, Statistics and Operations Research published from Singapore and Associate Editor of Investigations in Mathematical Science published from India. **He is also an**

* FRSS, Dept. of Statistics, Saurashtra University, RAJKOT, Gujarat
  email : dilipghoshsep@gmail.com

Editorial Board member of Sankhya Vigyan, published by GSA.

He has won number of awards and fellowships including the Commonwealth Academic Fellowship sponsored by British Council, UK (2011). Recently, he was awarded the "Best Science Teacher award in Mathematical Sciences" by Gujarat Science Academy, Ahmedabad (2017). **He was also awarded the "Young emerging future leader of Quality and Reliability" by Society for Reliability Engineering, Quality and Operations Management (SREQOM), New Delhi (2012).** He is a Principal member of the Bureau of Indian Standards (BIS) New Delhi since 2010. He has been the Secretary of Indian Society for Probability and Statistics for the terms 2013-2014 and 2015-2016.

Besides publishing the best seller book entitled **"Six Sigma for Organizational Excellence: A Statistical approach** (ISBN 978-81-322-2324-5, e-ISBN 978-81-322-2325-2) with Springer, he has co-authored another book entitled "An Introduction to Parametric inference" (ISBN-978-81-8487-416-7) with **Prof. B. K. Kale,** and the book is published by Narosa, New Delhi. His first book on **"Statistical Methods for Quality, Reliability and Maintainability"** (ISBN-978-81-203-4543-0) published by PHI learning private Ltd, is a blend of three disciplines, namely: management, science and engineering and can be used as a text cum reference book for engineers and practitioners in manufacturing and maintenance area.

Prof. K. Muralidharan has completed five major research projects funded by UGC (2), DST, MoHFW, and NHRC New Delhi. Apart from this he has guided many student projects and consultancy projects on statistical methods and Six Sigma. So far he has presented papers in more than hundred national and international conferences and has organized a dozen conferences and seminars.

He has chaired number of conference/seminar/workshops sessions and was resource person to many UGC refresher course programs at various universities across India. He had visited number of universities in India, Taiwan, UK, Russia and UAE.

CONFERENCES AND SEMINARS :

1.   A Two-Day Hands-On Research Workshop on Machine Learning Using R and LaTex by Dr. P.S. Rana at LIMCOS, Loyola College, Chennai from 8Th June to 9th June 2018.

2.   21st Annual Conference of the Society of Statistics, computer and application (SSCA) scheduled to be held at SV Agricultural College (ANGRAU), Tirupati during 29 - 31 January 2019.
     Contact Person: Dipak Roy Choudhury   dipakp1951@gmail.com and manivannan kaliappan, manivannanid@gmail.com

3.   International conference on "Emerging Methodologies in Theoretical & Applied Statistics (EMTAS)" in conjunction with IASP annual conference during 18-20 September, 2018 to be held at Dep. Of Statistics, Banaras Hindu University,Varanas
     Contact Person :Brijesh P. Singh, Associate Professor, Department of Statistics, Institute of Science, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India Email: brijesh@bhu.ac.in

4.   **National seminar** on "*Recent Trends in Statistical Theory and Applications-2018 (NSSTA-2018)*" during 28 to 30 June 2018 at the Department of Statistics, University of Kerala, P.O. Kariavattom, Trivandrum, as a part of the *National Statistics Day Celebrations of 2018*.
     Contact person: Dr C. Satheesh Kumar, Convener: NSSTA-2018, **nssta2018@gmail.com or contact Organizing Secretary, +919495366416**

5.   MTMI Bangkok International conference on December 22-23, 2018.
     Contact Person: Dinesh K. Sharma, Ph.D., Program Chair & Editor-In-Chief, Journal of Global Information Technology, Professor, Quantitative Methods & Computer Applications, Dept. of Business, Management & Accounting, University of Maryland Eastern Shore,
     Princess Anne, MD 21853, USA.

6.   Date Extended Invitation to participate in 8th International Conference at Apeejay, Dwarka Campus on July 20, 2018.
     Contact person: Dr. Monika Arora, marora.asm@gmail.com

7.   **Tenth International Triennial Calcutta Symposium on Probability and Statistics (Celebrating the Birth Centenary of Prof. H. K. Nandi)** between **December 27-30, 2018** at the Department of Statistics, Calcutta University, Kolkata, India.

8.   **9th International Purdue Symposium on Statistics and Celebration of the**

50th Anniversary of the Department of Statistics, June 5, 2018 - June 8, 2018, Lafayette, USA.
Contact person: **iss2018@stat.purdue.edu**

9. 4th conference of International society for Non Parametric Statistics, June 11 – 15, 2018, Salerno.
    Contact Person: *Michele La Rocca, Brunero Liseo and Luigi Salmaso* IT

10. 12th International Vilnius Conference on Probability Theory and Mathematical Statistics and 2018 IMS Annual Meeting on Probability and Statistics, Vilnius (Lithuania), July 2, 2018 — July 6, 2018. A
    Contact Person: Conference & Event Management, UAB "Kalanis"
    Pylimo str. 41A, LT-01136 ("Linden"), Vilnius, Lithuania, Mobile: +370 682 28647, www.seventips.lt, E – mail: registration@seventips.lt

11. **10th International conference in Teaching statistics, Kyoto, Japan, 8 – 13 July, 2018.**
    Contact person: Katie Makar, Rob Gould or Sibel Kazak at IPC@icots.info

12. First Conference of the Actuarial Society of Iran, from 18 to 19 August 2018, held in cooperation with the Faculty of Mathematical Sciences of Shahid Beheshti University. Iran
    Contact person: Email Address: info@iac1.ir, Address: Tehran, Shahid Beheshti University
    Phone Call: +98 21 2241 9430

13. 2018 Joint International Society for Clinical Biostatistics and Australian Statistical Conference, which will take place in **Melbourne** from the **26-30 of August 2018**.
    Contact person: Program Manager, iscbasc2018@arinex.com.au

14. The Royal Statistical society Conference for all Statistician and Data Scientists, 3 – 6 September,2018, CARDIFF, WALES, UK.
    Contact Person: news@rss-mail.co.uk

15. The 2018 Michigan State Symposium on mathematical statistics and applications will be held at MSU from Sep 14-16, 2018, Michigan Sate University, USA.
    Contact person: Institute of Mathematical Statistics.

16. Conference on Experimental design and analysis, SCPE 2018, December 13 – 15, 2018, National Tsing Hua University, Hsinchu, Taiwan.
    Contact Person: Email:ceda2018@stat.sinica.edu.tw, Dr. Frederick Kin Hing Phoa & Ms. Zi-Xiu Lai

BOOK REVIEW

Title   : Theory of Econometrics
Author   : A.Koutsoyiannis
Pages   : 677
Publisher   : PALGRAVE, New York
            (First Edition 1973, Second Edition 1977, Last Reprint 2017)

> *The emphais of the economic implications of the various measurement techniques is my prime objective and goal. As a result, the economists will become increasingly aware of the ease with which the powerful tool of econometrics can be applied meaningfully to specific economic problems, without any botheration of the heavy mathematical reauirements.*
>
> -Author

This book on Econometrics theory is an exallent textbook used in various universities and academic institutions whorldwide. It is printed for about 10 times which shows its importance and popularity.

The content of the text is presented in **three parts**. **First Part** deals with correlation. theory and simple linear regression model. There are 8 chapters describing the almost basic requirements for the entire study.

Second Part describes econometric problems by means of the studies on autocorrelation, multicollinearity, errors in variables, dummy variables, lagged variables and DL Models. This is presented in 5 chapters.

Thirs Part discusses the models of simultaneous relationships in 8 chapters. Here the probmes of identification, ML Methods, 3 stages least squares methods etc. are discussed. The last chapters discuss briefly about choice of econometric methods and Monte Carlo Studies.

Special excercises and questions are given in Appendix III with sufficient details chapterwise.

There are some specific features of this book.

(1) Though rigorous modelling techniques are presented, author has taken sufficient care about not bothering the readers by means of very heavy mathematical treatments.

(2) At many places, where the recent results for research work is presented, exact location for the research work is given.

(3) Chapter 17 is an excellent one in which mixed estimation methods are given using the method of principal components.

(4) There are numerous illustrations in each chapter to demonstrate the uses of theoretical developments.

(5) Special treatments for ML methods are given by means of LIML and FIML methods.

(6) Treatment for simultaneous equations and Identification problems is excellent.

(7) The whole text has a very lucid exposition at each place eventhough very difficult and complex methods are presented.

This authentic text is definitely useful for students, teachers and research workers in the fields of natural and behavioural sciences as well as for managerial studies and business applications where the econometric modelling techniques are inevitable.

Dated 11-06-2016
Dr. H. M. Dixit
Head, Dept. of Statistics
Arts and Commerce College
PILWAI (N.G.)

Note : Members of editorial board are in no way concerned with the views, opinions or ideas expressed in this issue. Authenticity responsibility lies solely with the persons presenting them.

READERS FORUM

A. M. PATEL*

(Readers are requested to feel free for sending their views and constructive suggestions for this section.)

* **K. Muralidharan (Vadodara)**

As I understand, SV is an old journal started wiht a modest beginning to bring forth Gujarat based statisticians, students and practisioners in one fold. Number of events have happend over a period of two decades or so. Many professors and faculty members have owned this journal as Editor, Editorial members and Associate editors etc.

The Journal had undergone many changes and modifications in this process. For last few years it is coming up with lots of new inputs and paper views at length. I have been fortunate to be a part of the Editorial board members of this journal for quite some time.

I have seen some good articles contributed and reviewed by senior facutly members along with the other informations.

I therefore appreciate all the current editors of the journal along with Prof. B. B. Jani as chief editor for their encouraging effors in giving a new lease of life to the journal.

Dr. Jani is really influencing the statistics community through the literary contents and informations included in this journal. I express my best wishes for S V Journal.

* **D. K. Ghosh (USA)**

Jani sir, Namaste. Since long we could not meet. At present, I am in USA and will come back in August. I send some informations about seminars, workshops and conferences to be held abroad. I am sure you would like to include them under News Items (SV Letter). Will see you soon as I return back. My best wishes for SV progress. Have a nice day.

* **R. N. Pancholi (USA)**

I get regularly this journal. It gives new ideas also. Please increase its frequency. My best wishes for the journal.

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* Rtd. Principal, H. K. Commerce College, Ahmedabad
  and Ex. Secretary, Gujarat Vidyasabha and Brahmachariwadi Trust, Ahmedabad.

AMARTYA SEN*

Professor AMARTYA SEN was born on 3rd November 1933 in Santiniketan at Calcutta. He was graduated at University of Culcutta and then he received his master's degree and Ph.D. from University of Cambridge.

He is an Indian Economist and philosopher, who has been teaching since 1972 and has worked in India, UK and USA.

He has made contributions to **Welfare economics, social choice theory, economic and social justice, economic theories of Famines and Indices of the measure of well beings of citizens of developing countries.**

He is currently the Thomas W. Lamont University professor at Harward University and faculty member at Harward Law School. He is also a fellow of Trinity College, Cambridge.

He will be ever remembered-immortal (like his name) for **HUMAN DEVELOPMENT INDEX (HDI)**. He has been an academician, a thinker, an economist, and a philosopher.

Prof. Sen has received more than 90 honorary degrees from Universities around the word. He has to his credit many publications, research articles, academic documents etc. He was awarded **NOBEL MEMORIAL PRIZE** in 1998. He was greatly honoured by awarding **BHARAT RATNA** for his significant contributions in Welfare Economics. Recently he was awarded the **John Skytte Prize** in Political Science for his academic achievements.

*(Brief Biographical sketch is given inside the journal)
This space is specially donated by Prof. Shailesh Teredesai (Ex. Head, Statistics Dept., S. M. Patel Insitute of Commerce, GLS, Ahmedabad-380 009.

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                    To,

From :
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C/o. Statistics Dept. Gujarat University, Ahmedabad-380 009. (INDIA)