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CONTENTS

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SANKHYA VIGNAN

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EDITORIAL

"YOU CAN NOT CROSS THE SEA MERELY BY STANDING AND STARING AT THE WATER."

-TAGORE

We are extremely happy to present this issue (NSV 12, No. 2, Dec. 2016) just in time. We thank our contributors, evaluators, readers and well wishers for their consistent support which has made it possible.

This issue contains 1 article, 3 research articles, 1 review article, Biography, Book review and other things as usual.

Under the caption **"Management and Statistics"** there is an **article** by **A. C. Brahmbhatt** on **qualitative analysis** which is much more relevant for managerial applications.

There is a **research article** discussing in nutshell about **Supply Chain Management** which is given by **D. S. Dave, Michel Dotson and James Stoddard.**

One **research article** is on **M. A. and M.R. Control Charts** using **three delta limits** instead of three sigma limits. This work is carried out by **Kalpesh S. Tailor.**

Another **research article** describes very lucidly a study on **demographic transition and stock market growth for India.** This work is presented by **Hemal Pandya and Delnaz Jokhi.**

There is a **review article** discussing briefly guidelines useful for research workers for **exploratory factor analysis.** This work is executed by **Stuti Dholakia and Chetna Bhavsar.**

One biographical sketch on famous statistician **Sir Francis Galton** is presented by **H. D. Budhbhatti.**

There is a **book review** on an interesting book in empirical econometrics. Review work is carried out by **H. M. Dixit.**

We have **Readers Forum** expressing the suggestions and critics given by some readers. This has been presented by **A. M. Patel.**

We have separately given a brief note for **Peer Review System** and **Guidelines for** our **Contributors** which may be useful.

We are highly indebted to our following **Referees** who have carried out an excellent job for evaluating the articles submitted for publication for this issue. **(The names are given one by one in order of their appearance in the journal.)**

(1)	**Jayesh R. Purohit**	**(2)**	**A. C. Brahmbhatt**
(3)	**Manish B. Thakar**	**(4)**	**R. G. Bhatt**
(5)	**Hemal B. Pandya**	**(6)**	**A. M. Patel**
(7)	**Shailesh Teredesai**		

Digital copy of this issue will be sent to all our readers whose email ID are with us. **Printed copy** of the journal will follow soon.

We express our best wishes for the forthcoming **NEW YEAR 2017** by all means to you in terms of prospects and progress.

Wishing you pink health and season's greetings.

Ahmedabad

Date : 31-12-2016

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FROM EDITOR'S DESK

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GUIDELINES FOR AUTHORS:

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5. The main paper (Manuscripts) should not exceed more than 3,000 to 4,000 words(including graphs&charts).
6. Article should be typed in 12 point - Times New Roman Fonts English with a one and half space and single column with 1 Margin on a Standard A4 size Paper. The Page numbers should be at the center of every page. All headings & sub headings must be in bold letters.
7. Table should be numbered consecutively,the title of the table should be placed above the table. The source should be indicated at the bottom.
8. All the tables, charts, graphs, diagrams should be in black and not in colors.
9. Footnotes, italics, and quotation marks should be kept to the minimum.
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QUALITATIVE RESEARCH

A. C. Brahmbhatt*

The researchers in planning their study need to think as to which research philosophy would he adopt. There are two major approaches –the Postpositivist philosophy and the Social Constructionivist philosophy.. The Postpositivist philosophy refers to Quantitative research and the latter one refers to the Qualitative research . The Social Constructivist philosophy is based on several assumptions that human beings engage with their world and make sense of it in the context of their historical and social perspectives. Under this philosophy the qualitative researchers attempt to explore and understand the meaning individuals and groups ascribe to a social or human problem.As the Quantitative research focuses mostly on two –Survey research and Experimental research , the Qualitative research focuses mostly on the following approaches:

1. Ethnography

In the ethnographic approach the researcher studies an intact cultural group or community in a natural setting over a prolonged period of time by collecting data using participant-observation mode **.** PortiCo Research agency in US did ethnographic study for their client –Lipton to find the peoples' attitude towards tea. As a result of the study they found out the shift in their attitude towards the Iced tea and they suggested lots of creative developments in the area of Iced tea.

2. **Grounded Theory**

In this approach the goal is to develop a theory that explains or better understands the phenomenon , a theory is grounded in the data that was collected. The relative

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success of the researcher depends on his/her ability to ask deep level questions about the data, ferreting out meaning on multiple levels**.**

3. Phenomenological Research

The researcher extracts the essence of human experiences about a phenomenon as described by participants to understand the meaning that people attach to their experiences ; e.g. How the senior citizens relate to music in their lives.

4. **Narrative Research**

For example one or more entrepreneur narrate the stories about their lives. From it researcher can analyze and decode the hidden motives and attitudes . It could be helpful to know the entrepreneurial abilities required to succeed.

5. **Case Study**

Researcher explores in depth an event, action, stores, consumers, firms , process etc. For example the researcher can undertake the case study of 5 best stores and 5 worst stores and find out the factors affecting store patronage.

Qualitative Research differs from Quantitative Research in terms of its conceptual framework , adopts an inductive process, data mostly collected through observation and collected in words or text and analyzed by themes (and not by statistical tools and techniques),small , strategic samples –not necessarily representative and ultimately the propositions developed that synthesize themes and lead to rich descriptions, models and theories as against hypothesis testing approach of quantitative research.

6. Acknowledgements

I thank the referee for his review of my artcle.

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MANAGEMENT AND STATISTICS
RESEARCH ARTICLE

MATERIAL, INFORMATION, FINANCIAL FLOWS IN SUPPLY CHAIN MANAGEMENT

D. S. Dave(1), Michel J. Dotson(2) and James E. Stoddard(3)

ABSTRACT

Supply chain management describes the coordination of all activities starting with raw materials and ending with a satisfied customer. A supply chain may include suppliers, manufacturers, distributors, wholesalers and retailers working together to deliver products and services to end customers. The objective of supply chain management is to enhance organizational performance and to improve customer satisfaction by efficiently delivering products to the customer. Further, a supply chain provides an opportunity for each participating organization in the supply chain channel to earn appropriate profit. The objective of this study is to discuss the basic supply chain model as three supply chain flows: information flow, material flow, and financial flow.

1. INTRODUCTION

Supply chain management (SCM) describes the coordination of all activities starting with raw materials and ending with a satisfied customer. A supply chain may include suppliers, manufacturers, distributors, wholesalers and retailers

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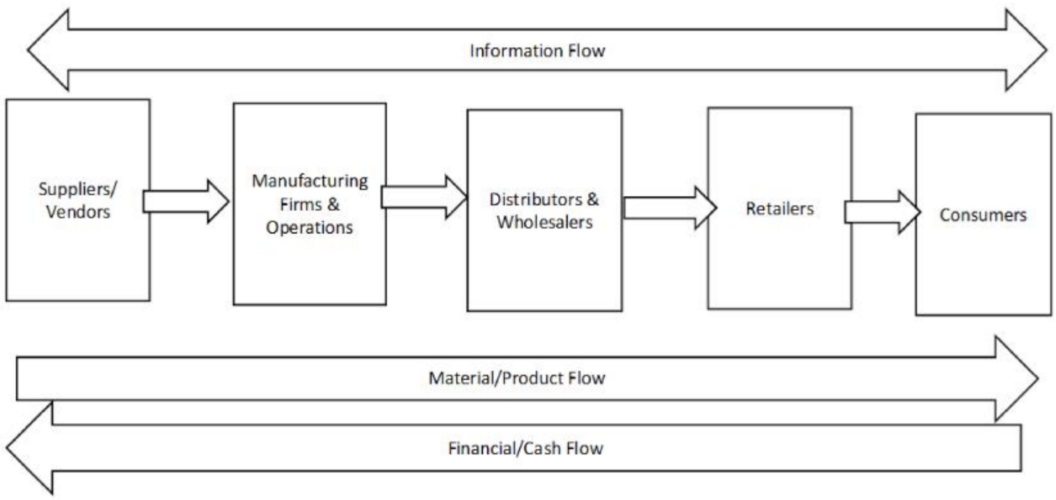
working together to deliver products and services to end customers. Vitasek (2013) and Oliver and Webber (1982) provided the definition of supply chain management as encompassing the planning and management of all activities involved in sourcing and procurement, conversion, and logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers (see also Beamon, 1998; Sumchi-Levi et al., 2008; Blackstone, 2013). Supply chain management offers the opportunity to capture the synergy of intra- and intercompany integration and management and deals with total business excellence and relationships with other members of the supply chain (Lambert and Cooper, 2000). Figure 1 presents a basic supply chain management model.

Figure 1: Basic Supply Chain Management Model



The objective of supply chain management is to enhance organizational performance as well as improve customer satisfaction by efficiently delivering products or services to customers while each participating organization in the channel earns appropriate profits (Sahin and Robinson, 2002). Additionally, the objectives of supply chain management include maximization of responsiveness and flexibility to customers; minimization of cost, cycle time reduction, and maximizing access to inventory as well as capacity utilization and return on assets.

2. SUPPLY CHAIN MANAGEMENT FLOWS

Several authors have noted the importance of SCM in managing various flows, including the flow of goods and services, the flow of information, and the flow of finances. The attempt of supply chain should be to execute or implement a coordinated two-way flow of goods and services, information and finance. According to Stadtler (2005), supply chain management is the task of integrating organizational units along a supply chain and coordinating materials, information, and financial flows in order to fulfil customer demands with the aim of improving competitiveness of the supply chain as a whole. Rai et al. (2006) suggested that integrated information technology infrastructure enable firms to develop higher-order capability of supply chain process integration. This capability enables firms to split information flows from physical flows, and to share information with their supply chain partners in order to create information-based approaches for superior demand planning, for staging and movement of physical products, and for streamlining voluminous and complex financial work processes.

The following sections discuss in more detail the meaning behind the three important SCM flows: material flows, information flows and financial flows.

2.1 MATERIAL FLOWS

Material flow is the actual movement of goods or the delivery of services across the supply chain. All supply chain partners attempt to optimize the material flow to ensure that customers receive goods on time at a competitive price. One of the ways to accomplish this objective is to optimize inventory, logistics, and production costs. Additionally, supply chain partners must work together to streamline the material flow to reduce waste. For example, successfully moving the material in the supply chain and effective procurement practices can lower the cost and increase revenues. Moving material from upstream to downstream in the supply chain without interruption is absolutely necessary for an effective and sustainable supply chain. There is a significant physical flow between supply chain members including raw materials, work-in- process inventories, finished products, and returned items. Managing these flows effectively and efficiently requires a systems approach to successfully identify, analyze, and coordinate the interactions among the entities (Sahin and Robinson, 2002).

2.2 INFORMATION FLOWS

Cooper, Lambert, and Pagh (1997) suggest that supply chain management includes the two directional flow of products and information. Supply chain relationships lead to increased information flows, reduced uncertainty, and a more profitable supply chain (Fiala, 2005).Indeed, Rodriguez-Diaz and Espino-Rodriguez (2006) state the benefits of the development of relational capabilities include: a) An *information process* which refers to a superior ability to obtain any type of necessary information, select it, disseminate it through the network and to integrate different processes through firms, and b) A *knowledge process* which refers to the superior ability to obtain any type of information necessary to the present and future functioning of the network, integrating it and making it effective in maximizing the competitiveness of companies in the network.

Thus, supply chain affiliations can lead to relational learning which can occur between companies with a high degree of cooperation via both formal and informal information transfer.

Dyer and Singh (1998) have suggested that the sharing of knowledge and resources by firms are more likely to generate relational rents. Patnayakuni et al. (2006) conclude that tangible and intangible resources invested in supply chain partnerships enable information flow integration between a focal firm and its partners for supply chain coordination. Zhou and Benton (2007) suggest that effective information sharing and effective supply chain practice are necessary to achieve improvement in supply chain performance. Further, Kaipia (2009) contends that "planning nervousness" can be diminished by stabilizing planning and by synchronizing information sharing with upstream and downstream members of the supply chain to ensure that decisions are based upon the most current available data. Kaipia argues that rapidly responding supply chains require more integrated planning and, hence, more frequent information sharing.

Ruel et al (2013) traced the stages of information flow in a supply chain through the development of an innovation. Their results illustrate the difficulty of managing information flows during the implementation of its supply chain by a new organization. Costantino et al., (2015) demonstrate that a slow information sharing approach is successful in restricting the bullwhip effect and inventory variance throughout the supply chain.

2.3 FINANCIAL FLOWS

According to Hofmann (2005), supply chain finance is an approach for two or more organizations in a supply chain, including external service providers, to jointly create value through means of planning, steering and controlling the flow of financial resources on an interorganizational level. Financial resources are used by the supply chain for procurement, production and sales activities, as well as for decisions regarding the choice of SCM partners, i.e., financial stability (Udin, Kahn &Zairi, 2006). Leng and Zailani (2012) envisioned the concept of supply chain financial flow by considering how it reflects the firm's financial position as a method to evaluate customers and suppliers, etc. Fairchild's (2005) observations of the financial supply chain are that efficiencies can be developed via financial products (e.g., intelligent matching solutions) to oversee receivables, working capital needs, and the overall financial position of the organization. Finally, Pfohl and Gomm (2009) analyzed the role of financial flows in the supply chain and its impact on optimizing in terms of capital cost.

Wuttke, Blome and Henke (2013) identified the typical methods of financial supply chain management as buyer credit (term financing to finance suppliers such as advance payments or deposits), inventory/work-in-process financing (the buyer provides loans to suppliers to finance work-in-process), reverse factoring (supplier borrows from the bank for receivables at the buyer's lower interest rate), supply chain finance (automated reverse factoring for all the buyers suppliers), electronic platforms (third party systems electronically connecting supply chain members with financial institutions to automate payment), letters of credit (a guarantee to reduce supply chain member risk), open account credit (buyers receive credit from suppliers, and bank loans (short to medium term financing for working capital).

3. CONCLUSION

The preceding discussion suggests that, among the community of supply chain professionals, there are slight variations regarding the notion of supply chain management. However, many acknowledge that managing material flows, information flows and financial flows are particularly important to reduce costs across the supply chain while simultaneously achieving maximum customer service. The knowledge of supply chain management flows and understanding their interconnectivity within an organization as well as their interaction in the chain of supply can enhance manager's ability in various decision making processes. This knowledge is particularly imperative when an organization is operating in a global supply chain environment.

4. ACKNOWLEDGEMENTS

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RESEARCH ARTICLE

MOVING AVERAGE AND MOVING RANGE CHARTS UNDER THE ASSUMPTION OF MODERATENESS AND ITS 3δ CONTROL LIMITS

Kalpesh S. Tailor[(1)]

ABSTRACT

Moderate distribution is a very good alternative of normal distribution proposed by V.D. Naik and J.M. Desai (2015), which has mean deviation as scale parameter rather than the standard deviation. Mean deviation (δ) is a very good alternative of standard deviation (σ) as mean deviation is considered to be the most intuitively and rationally defined measure of dispersion. This fact can be very useful in the field of quality control to construct the control limits of the control charts. On the basis of this fact V.D. Naik and K.S. Tailor (2015) have proposed 3δ control limits. In 3δ control limits, the upper and lower control limits are set at 3δ distance from the central line where δ is the mean deviation of sampling distribution of the statistic being used for constructing the control chart. In this paper, it has been assumed that the underlying distribution of the variable of interest follows moderate distribution proposed by V.D. Naik and J.M. Desai (2015) and 3δ control limits of moving average and moving range charts are derived. Also an empirical study is carried out to illustrate these charts.

Key words: Mean deviation, Moderate distribution, M.A. and M.R. charts, 3δ limits

1. INTRODUCTION

A fundamental assumption in the development of control charts for variables is that the underlying distribution of the concerned quality characteristic is normal.

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The normal distribution is one of the most important distributions in the statistical inference in which mean (μ) and standard deviation (σ) are the parameters. V.D. Naik and J.M. Desai (2015) have suggested an alternative of normal distribution, which is called moderate distribution. In moderate distribution mean (μ) and mean deviation (δ) are the pivotal parameters and, they have properties similar to normal distribution.

V.D. Naik and K.S. Tailor (2015) have proposed the concept of 3δ control limits on the basis of moderate distribution. Under this rule, the upper and lower control limits are set at 3δ distance

from the central line where δ is the mean deviation of sampling distribution of the statistic being

used for constructing the control chart. Thus in the proposed control charts, under the moderateness assumption, the control limits for any statistic T should be determined as follows.

Central line (CL) = Expected value of T = μ

Lower Control Limit (LCL) = Mean of T - $3\delta_T$ = $\mu - 3\delta_T$

Upper Control Limit (UCL) = Mean of T + $3\delta_T$ = $\mu + 3\delta_T$

Where μ is mean of T and δ_T is the mean deviation of statistic T.

It is found that since δ provides exact average distance from mean and σ provides only an approximate average distance, 3δ limits can be considered to be more rational as compared to 3limits.

Hence, in this paper it is assumed that the underlying distribution of the concerned variable follows moderate distribution and 3δ control limits for moving average and moving range charts are derived. An empirical study is also carried out to illustrate the use of these charts.

2. MOVING AVERAGE (M.A) AND MOVING RANGE (M.R) CHARTS

Moving average and moving range charts are a set of control charts for variable data (data that is both quantitative and continuous in measurement, such as a measured dimension or time). The M.A. chart monitors the process location over time, based on the average of the current subgroup and one or more prior subgroups. The M.R. chart monitors the process variation over time. The plotted points for a M.A. and M.R. charts, called a cell include the current subgroup and one or more prior subgroups. Each subgroup within a "cell" may contain one or more observation, but must be all is of the same size. It has been observed by S. W. Roberts (1959) while investigating ARL of M.A. chart that the performance of moving average chart is much better than conventional control chart; excepting that they are less quick in detecting large changes. A remedy of this deficiency is to use ordinary, $\overline{X}$-chart along with a moving average chart.

3.3 ¢JCONTROL LIMITS FOR MOVING AVERAGE (M.A) AND MOVING RANGE (M.R) CHARTS

Suppose a measurable quality characteristic of the product is denoted by X. Suppose that m samples, each of size n, are drawn at more or less regular interval of time from the production processes. These samples are known as subgroups, and for each of these subgroups the values of moving mean $\overline{X}_w$ and moving range R_w are obtained, where w is the moving (cell) size. Let the distribution of the variable X be moderate with mean μ and mean deviation δ, then, as proved by V.D. Naik and J.M. Desai (2015), the distribution of $\overline{X}$ is also moderate with mean μ and mean deviation $\frac{¢}{\sqrt{n}}$. Further, if the distribution of X is not moderate, and the number of units in each subgroup is 4 or more, then on the basis of central limit theorem for moderate distribution, it can be said that $\overline{X}$ follows moderate distribution.

3.1 3¢-CONTROL LIMITS FOR MOVING RANGE (M.R) CHART

The random variable, which is called relative range, has the following properties when it follows moderate distribution.

Relative range $\Omega = \sqrt{\frac{2}{\text{®}}}\frac{R}{\text{¢}'}$ (1)

Where δ' = predetermined process mean deviation. Further,

$$E(\Omega) = E\left(\sqrt{\frac{\text{®}}{2}}\frac{R}{\text{¢}'}\right) = d_2 \qquad (2)$$

Hence, E(R) = $\sqrt{\frac{\text{®}}{2}}d_2\text{¢}'$ (3)

Thus, when δ' is not perdetermined,

$$\text{¢}' = \sqrt{\frac{2}{\text{®}}}\frac{E(R)}{d_2} = \sqrt{\frac{2}{\text{®}}}\frac{R}{d_2} \qquad (4)$$

Similarly, if ¢_Ω and ¢_R are mean deviation of Ω and R respectively then it can be seen that

$$\text{¢}_\Omega = \frac{\text{¢}_R}{\text{¢}'} = d_3, \text{ hence } \text{¢}_R = \sqrt{\frac{2}{\text{®}}}\frac{d_3 R}{d_2} \qquad (5)$$

Thus, the 3δ- control limits of moving range chart can be determined as follows.

Central line (C.L) = $E(R_W)$

= $\overline{R_W}$ (6)

Lower control limit (L.C.L)

= $E(R_w)$ - 3¢_{R_W}

$$= \overline{R_W} - -3\sqrt{\frac{2}{®}}\,\frac{d_3\overline{R_w}}{d_2}$$

$$= \left(1-3\sqrt{\frac{2}{®}}\,\frac{d_3\overline{R_w}}{d_2}\right)\overline{R_w}$$

$$= D_3^{'}\overline{R_w} \qquad (7)$$

Where $D_3^{'} = 1-3\sqrt{\frac{2}{®}}\,\frac{d_3}{d_2}$

Upper control limit (U.C.L) = $E(R_w) + 3¢_{R_w}$

$$= \overline{R_w} + 3\sqrt{\frac{2}{®}}\,\frac{d_3\overline{R_w}}{d_2}$$

$$= \left(1+3\sqrt{\frac{2}{®}}\,\frac{d_3}{d_2}\right)\overline{R_w}$$

$$= D_4^{'}\overline{R_w} \qquad (8)$$

Where $D_4^{'} = 1+3\sqrt{\frac{2}{®}}\,\frac{d_3}{d_2}$

The constants $D_3^{'}$ and $D_4^{'}$ are computed for n = 2 to 25 and they are presented in table 1.

3.2 3¢-CONTROL LIMITS FOR MOVING AVERAGE (M.A) CHART

Suppose $\overline{X_w}$ is the moving mean and R_w is the moving range calculated from the given data where w is the moving (cell) size. Since $\overline{X_w}$ follows moderate distribution, its mean error is $\frac{¢_x}{\sqrt{n}}$, where δ_x is the mean deviation of the variable

X. When δ_x is not perdetermined, it is estimated by $\text{¢}_x = \sqrt{\frac{2}{\text{®}}}\,\frac{\overline{R_w}}{d_2}$ (from (4))

Hence, the 3-δ control limits of moving average chart can be determined as follows.

Central line (C.L) $= E(\overline{X_w})$

$$= \overline{X_w} \qquad (9)$$

Lower control limit(L.C.L) $= E(\overline{X_w}) - 3\text{¢}_{X_w}$

$$= \overline{X_w} - 3\frac{\text{¢}_x}{\sqrt{n}}$$

$$= \overline{X_w} - 3\frac{1}{\sqrt{n}}\sqrt{\frac{2}{\text{®}}}\,\frac{\overline{R_w}}{d_2}$$

$$= \overline{X_w} - A_2^{'}\overline{R_w} \qquad (10)$$

Upper control limit(U.C.L) $= E\left(\overline{X_w}\right) + 3\text{¢}_{x_w}$

$$= \overline{X_w} + 3\frac{\text{¢}_x}{\sqrt{n}}$$

$$= \overline{X_w} + 3\frac{1}{\sqrt{n}}\sqrt{\frac{2}{\text{®}}}\,\frac{\overline{R_w}}{d_2}$$

$$= \overline{X_w} + A_2^{'}\overline{R_w} \qquad (11)$$

Where $A_2^{'} = \frac{3}{d_2\sqrt{n}}\sqrt{\frac{2}{\text{®}}}$ and its values are given in the table 1.

Table 1

n	$D_3^{'}$	$D_4^{'}$	$A_2^{'}$
2	0	2.8097	1.4997
3	0	2.2553	0.8160
4	0	2.0228	0.5815
5	0.1111	1.8889	0.4603
6	0.1992	1.8008	0.3853
7	0.2628	1.7372	0.3343
8	0.3108	1.6892	0.2975
9	0.3489	1.6511	0.2688
10	0.3803	1.6197	0.2457
11	0.4064	1.5936	0.2151
12	0.4286	1.5714	0.2122
13	0.4476	1.5524	0.1986
14	0.4641	1.5359	0.1874
15	0.4790	1.5210	0.1779
16	0.4919	1.5081	0.1691
17	0.5038	1.4962	0.1619
18	0.5142	1.4859	0.1547
19	0.5238	1.4763	0.1492
20	0.5330	1.4670	0.1436
21	0.5414	1.4586	0.1380
22	0.5489	1.4511	0.1332
23	0.5559	1.4442	0.1292
24	0.5626	1.4374	0.1253
25	0.5690	1.4310	0.1220

4. AN EMPIRICAL STUDY FOR MOVING AVERAGE (M.A) AND MOVING RANGE (M.R) CHART

For constructing the control charts on quality characteristics in manufacturing process many schemes rather than conventional control charts have been used. For example, a chemical plant may maintain charts on which are plotted the results of daily analyses made to determine the percentage of certain chemicals constituents in its incoming materials, product in process, and finished product.

Table 2

Date	Daily Value	3-day moving average	3-day moving range	Date	Daily Value	3-day moving average	3-day moving range
Sept. 1	0.24	-	-	26	0.17	0.163	0.10
2	0.13	-	-	27	0.18	0.153	0.07
3	0.11	0.160	0.13	28	0.13	0.160	0.05
4	0.19	0.143	0.08	29	0.28	0.197	0.15
5	0.16	0.153	0.08	30	0.16	0.190	0.15
6	0.17	0.173	0.03	**Oct.** 1	0.14	0.193	0.14
7	0.13	0.153	0.04	2	0.16	0.153	0.02
8	0.17	0.157	0.04	3	0.14	0.147	0.02
9	0.10	0.133	0.07	4	0.10	0.133	0.06
10	0.14	0.137	0.07	5	0.13	0.123	0.04
11	0.16	0.133	0.06	6	0.20	0.143	0.10
12	0.14	0.147	0.02	7	0.14	0.157	0.07
13	0.17	0.157	0.03	8	0.10	0.147	0.10
14	0.15	0.153	0.03	9	0.18	0.140	0.08
15	0.20	0.173	0.05	10	0.11	0.130	0.08
16	0.26	0.203	0.11	11	0.08	0.123	0.10
17	0.16	0.207	0.10	12	0.12	0.103	0.04
18	0.00	0.140	0.26	13	0.13	0.110	0.05
19	0.18	0.113	0.18	14	0.12	0.123	0.01
20	0.18	0.120	0.18	15	0.17	0.140	0.05
21	0.20	0.187	0.02	16	0.10	0.130	0.07
22	0.11	0.163	0.09	17	0.09	0.120	0.08
23	0.30	0.203	0.19				
24	0.21	0.207	0.19				
25	0.11	0.207	0.19				

A common variation of this is to plot moving averages rather than daily values. The moving average is particularly appropriate in continuous process chemical manufacture when applied to quality characteristics of raw materials and product in process. The smoothing effect of the moving average often has an impact on the figures similar to the effect of the product of the blending and mixing that take place in the remainder of the production process.

To illustrate M.A. and M.R. charts, a data set is taken from E .L. Grant and R. S. Leavenworth (2000). The data together with moving averages () and moving ranges () are shown in table 2. The figures given are the daily analysis of percentages of unreacted lime (Cao) at an intermediate stage in a continuous manufacturing process. The 3-day moving averages and 3-day moving ranges are calculated. The average given for Sept. 3 is the average of the percentages on the second, third and fourth, and that for Sept. 4 is the average of the second, third and fourth and so fourth.

The 3 control limits for moving average and moving range charts are computed for the data set given in table 1 and presented in table 3.

Table 3

Chart	LCL	CL	UCL
Moving Average chart	0.0886	0.1533	0.2180
Moving Range chart	0	0.0793	0.1788

Now the moving average and moving range charts under the assumptions are plotted as follows.

Figure 1(a) Moving average chart

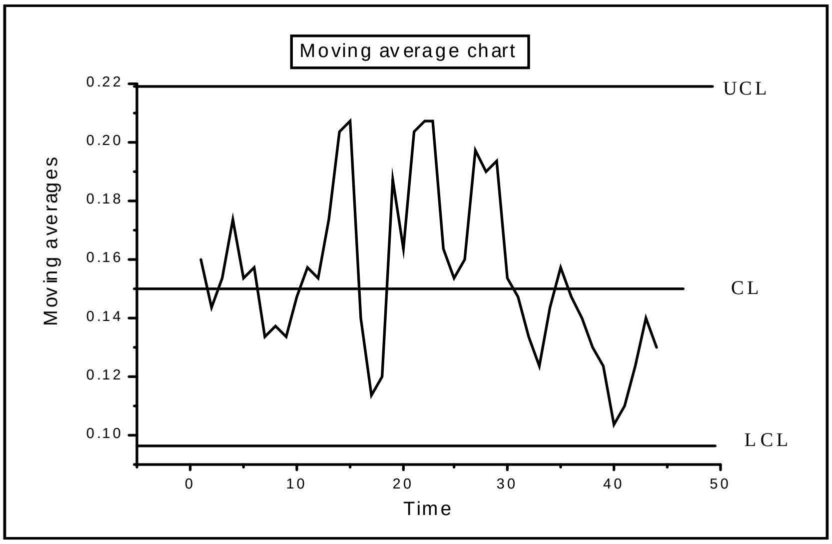

Figure 1(b) Moving range chart

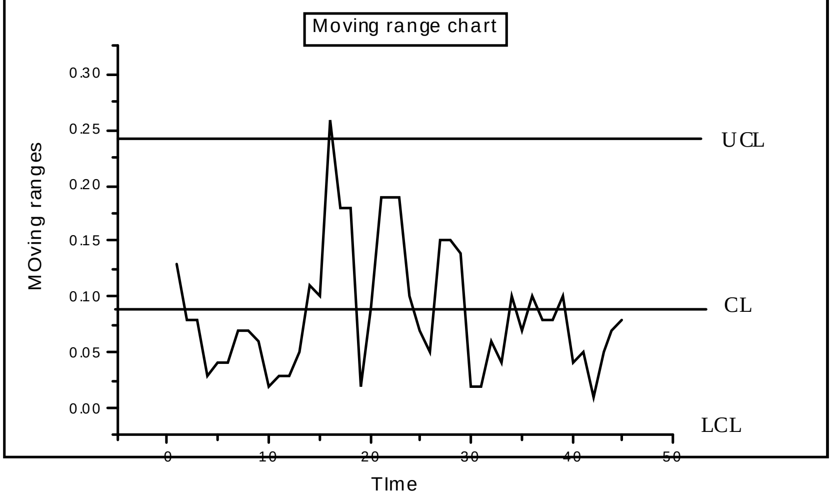

Figure 1(a) shows the moving average chart under the assumption of moderateness. From the chart it can be seen that all sample points fall within the two control limits. So the production process is under the statistical control with respect to moving average.

Figure 1(b) shows the moving range chart under the assumption of moderateness. From the chart it can be seen that few sample points fall outside the upper control limit. So the production process is out of the statistical control with respect to moving range.

It is clear that whenever a shift in universe average occurs within a subgroup rather than between subgroup, the R chart tends to show lack of control. Thus a sudden shift in the mean may show up first on the R-chart. Changes of short duration that do not persist through one entire subgroup may be shown only on the R-chart and not on $\bar{X}$ - chart. In figure 1, the indications of lack of control are on moving average chart.

5. SUMMARY AND CONCLUSION

In this paper, moving average and moving range charts are described under the assumption of moderateness rather than normality. Both the schemes are special case and perform better than the conventional control charts as they detect small shifts more quickly than the usual control charts.

The interpretation of out of control situation on moving average and moving range charts is the same as on conventional and R-charts. Since successive points on moving average and moving range charts are not independent of one another, the interpretation of several points in a row outside control limits is obviously not the same. Similarly, runs above or runs below the central line do not have the same significance on moving average and moving range charts as on conventional and R-charts.

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7. APPENDIX

Moderate Distribution

Suppose the p.d.f. of a distribution of a random variable X is defined as,

$$f(x) = \frac{1}{®¢} e^{-\frac{1}{®}\left(\frac{X-«}{¢}\right)^2} ; \quad -\infty < X < \infty, ¢ > 0$$

Then, the random variable X may be said to be following **moderate distribution** with parameters μ and δ and may be denoted as X M (μ, δ).It can be proved that,

(i) $\int_{-\infty}^{\infty} f(x) = 1$

(ii) Mean = E(x) = μ

(iii) Mean deviation = E [|X-π|] = δ

(iv) Standard deviation = $\sqrt{\frac{\text{®}}{2}}\ \delta$

(v) M.G.F = $M_x^{(t)}$ = $e^{\text{®}t+\frac{\text{®}}{4}\text{¢}^2 t^2}$

(vi) f (μ - x) = f (μ + x)

It may be noted that the relationship between σ and δ is same as that in the normal distribution.

Thus, the distribution of a random variable X having p.d.f. as defined above has location parameter as mean μ and scale parameter as mean deviation δ.

Just as the area of normal curve is measured in terms of σ from mean μ, the area of moderate distribution should be measured in terms of δ from mean μ. They have prepared moderate table pertaining to the area under standard moderate curve. From this table, it can be seen that

(a) P (μ - δ < X < μ + δ) = 0.57506 i.e. Mean ± 1 M.D covers 57.51% of area

(b) P (μ - 2δ < X < μ+2δ) = 0.88946 i.e. Mean ± 2M.D covers 88.95% of area.

(c) P (μ - 3δ < X < μ+3δ) = 0.98332 i.e. Mean ± 3M.D covers 98.33% of area.

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RESEARCH ARTICLE

EVALUATING THE IMPACT OF DEMOGRAPHIC TRANSITION AND ECONOMIC GROWTH ON STOCK MARKETS OF INDIA IN THE 21ST CENTURY

Hemal Pandya[1], Delnaz Jokhi[2]

ABSTRACT

Demographic Transition is the nearly ubiquitous transformation that the countries go through. This transition is from a state of high fertility and high mortality to one of low fertility and low mortality. Our developing country India is going through a transitional period of rapid population growth. India is the second most populous country of the world, 1210.6 million according to 2011census and its population is growing incessantly. Of the total population, the economically productive age group of 15-59 years constitute of 60.3 percentage of the whole population.[1]Also the median age of the population is 25.36 years; the middle aged economically contributing population consists of 11.24 percentage of the population.[2]And the 60+ age people constitute only 8.6 percentage of the population.[3] Thus we can say that India is experiencing its “first demographic dividend”. Also in today’s times India is one of the fastest growing economies of the world. The middle aged people have high incomes and savings and so are willing to take risk in stock investments.

This paper is an attempt to study the impact of demographic transition and

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economic growth on the B.S.E. and N.S.E. stock markets of India. This research paper evaluates this impact by studying the relationship between price earnings ratio, GDPPC and demographic variables, using Multiple Regression Analysis for the time period of 2000 to 2015.

Key Words: Demographic Transition, Economic Growth, Stock Markets, Multiple Regression Analysis

1. INTRODUCTION

Demographic transition of population aging is an emerging issue throughout the developing world. There has been a great deal of theoretical and empirical research on the relationship between demographic transition and economic growth for developed economies since 1990s when the population aging emerged to influence the economy and society. Generally speaking, the literature indicates that the aging of the population generates negative economy-wide effects that would slowdown the economic growth. With reference to the relationship between demographic transition and economic growth, the empirical results are inconclusive as there is an evidence both supporting a positive and a negative relationship. As the issue of population aging began to unfold at the beginning of the 21st century for developing countries, hardly any research was undertaken which would study the inter-relationship between demographic transitions, economic growth and their impact on stock market indicators. This paper is an attempt to study the impact of demographic transition and economic growth on stock markets of India.

2. THEORETICAL FRAMEWORK

Demographic Transition refers to the nearly pervasive change countries go through from a regime of high fertility and high mortality to one of low fertility and low mortality. Since in this phenomenon death rates declining first, followed by the birth rates later, countries like India often experience a transitional period of rapid population growth. Initial decreases in child mortality result in a baby boom. Subsequent declines in fertility put an end to the boom and create a distinct cohort at the bottom of the age distribution of the population. As this boom cohort passes through time, it influences the economy and stock markets in the long run. When the cohort reaches the working ages, a stimulus to economic growth may be provided. Output may increase simply as a function of the additional number of workers in the economy and the lower wages that they may obtain. Households may also have more disposable income to save more; and in the expectation of higher returns, they are ready to bear higher risk levels related to their investments. Also the reduction in the number of child dependents, leads to an increase in need for various types of investment avenues to curb their extra investment capacity, including rising capital stock which further influences the country's economic output. This population-related increase in economic growth is referred to as the **First Demographic Dividend** and this leads to good investments and returns in the stock markets also. This argument thus forms the base of our research.

India's demographic transition is reflected in its changing age composition, specifically in the share of the working-age population, which we refer to as the **Economically Productive Population**. This economically productive population consists of the young population having age 15-24 and adult population age 18 and above. Out of this economically productive population it is seen that the middle aged people i.e. the age of 40 to 49 years are willing to take higher risks in their investments in the expectation of higher future returns and thereby they invest in various levels of risk bearing stocks. These Middle Aged Economically Productive population denoted as **MEPP** have the potential to enhance our country's growth prospects. The greater the share of the population in the working –age group; the more will be the savings and investments in the economy.

3. RATIONALE OF STUDY

It is a known fact that the country's development takes place only if its citizens contribute positively to it. The demographic variables, especially the birth and death rates, the fertility rates and the age-structure of the population have a great impact on the type of population structure a country has. Also citizens of different age structures behave differently. The young ones and older people are more consumers and fewer contributors to the economy, whereas the youth and the economically productive population are the chief contributors to a countries economic growth and less consumers in relation to their contribution to the Output.

India is the second largest populated country of the world but, its population age-structure over the years has changed drastically and has become very rich especially in the 21st century in terms of its potential productive population. Because of the bulging economically productive population, it is experiencing the "first demographic dividend". Also in this 21st century it's one of the fastest growing economies of the world. These favourable conditions boost the stock markets performance too. Thus, it is the middle aged citizens of a country who have more income and savings and hence have the willingness to take risks in the stock markets

The Impact of this demographic transition in the age-distribution of India and the economic growth on the stock markets of India needs to be revealed. This paper is an attempt to study the impact of demographic transition and economic growth on the B.S.E. and N.S.E. stock markets of India. *This research paper evaluates this impact by studying the relationship between price earnings ratio, GDPPC and demographic variables, using Multiple Regression Analysis for the time period of 2000 to 2015.*

This research paper thus, tries to reveal the contribution of the demographic dividend and economic growth on stock market indicators. This research is based on the theoretical set up that, there exists a relationship between demographic transition, economic growth and stock markets. Throughout the world very few studies have touched upon such a research considering the concept of stocks markets with demographics and economic growth. More over a research in the

Indian context and that to in the 21st century is indeed one of its kinds.

4. LITERATURE REVIEW

- **Bosworth & Ralph C. (2004):** This paper is a literature review study based paper. It discusses the literature on the macroeconomic and asset market effects of population aging, focusing on four related issues: (i) The impact of population age structure on aggregate household saving; (ii) The effect of population aging on investment demand; (iii) Evidence on the influence of population age structure on financial market asset prices and returns; and (iv) Effects of globalization on our interpretation of the impact of demographic change. At the end of their research they have given good suggestions for betterment of such related research and also stated avenues for future research.
- **Roy, Punhani, & Shi (2012)** have studied the links between stock and bond process related variables, economic and demographic variables. They have used regression analysis and documented robust relations between price earnings ratios of stocks and demographics, though only in the U.S. Their results of regression for the German Dax's P/E Ratios show a moderate impact of demographic variables and economic variable GDP per capita on the stock market indicator. However, they found robust associations between long term government bond yields and demographic variables of developed countries of U.S., U.K., Germany, Japan and France.
- **Arnott & Chaves (2012)** have studied the effect of demographic changes on three measures of great importance for countries all over the world: real per capita PPP-adjusted GDP growth, stock market excess returns, and bond market excess returns. They have used the concepts of polynomial curve fitting on the regression coefficients of demographic and higher GDP growth was associated with young adult's age 20-30 years. With reference to stocks he interpreted that when a country had a good portion of its population between 35-59 years or even if the age group of 45-64 years grew at a fast

rate as compared to the young adults or senior who are 70+, the stocks performed very well. In his research he found a strong relationship between demographic variables, stock and bond returns and the GDP growth. For this study he used the polynomial curve fitting concept.

- **Chaves (2012)** in his article Chaves studies the influence of demographic transition on the economy and financial markets of 30 countries like U.S., Japan, Denmark, Spain, Ireland and China. He has taken into consideration the difference between the share of workers in the population and the share of retirees. Further the influence of the change in this difference on the GDP per capita growth is studies. He has also studied the impact of the difference in the share of population between the potential buyers and sellers on the stock and bond excess returns. In the article he reveals that developing countries are experiencing a great change in their demographic structure and this will impact the economic growth and capital markets in not a very encouraging manner, considering the past trends.

5. RESEARCH METHODOLOGY

*** RESEARCH OBJECTIVES**

1. To justify the Demographic Transition of the Indian Economy
2. To evaluate the impact of demographic transition and economic growth on the stock markets of India

*** Research Design**

- This research is based upon Descriptive and Causal Research Designs.
- The Population under study is – The population of India.

*** Data Sources**

Secondary data was collected from various sources like: The Census Department of India, World Bank, Socio-Economic Reports of the Government of India, RBI Bulletin, N.S.E. and B.S.E. official websites. The stock market data was available from the year 2000 so the period under study is 2000-2015.

6. DATA ANALYSIS

India is going through a crucial demographic transition which is clearly evident from Table 1. Post liberalisation and especially with the advent of the 21st century the Fertility rates have declined from 3.2 children per family in 2001 to 2.5 children per family in 2011. The Crude Birth Rate is declining at a faster rate as compared to the Crude Death rates; thus India is going through the 3rd phase of Demographic transition.

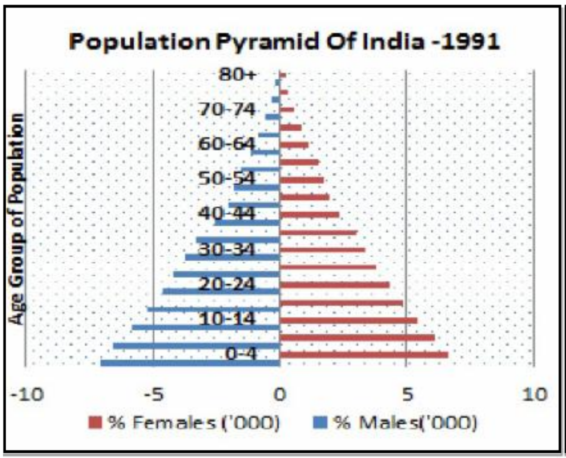
Table 1- Comparative view of various Rates during the Census years

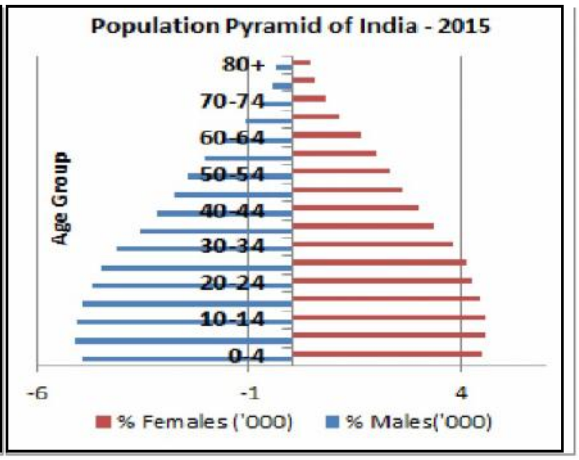
Census Year	1991	2001	2011
Total Fertility Rate	3.959	3.243	2.563
Crude Death Rate	10.581	8.553	7.52
Crude Birth Rate	30.912	26.004	21.116
G.D.P. per capita growth annual %	0.9804	3.0238	5.2311
Median Age	21.1	22.71	25.36
Age 40-49 years population share (in %)	8.9611	10.623	11.240

Source: (World Bank - World Development Indicators, 2015) and (United Nations -World Population Prospects)

Though, India is the second most populous country of the world, it is 1210.6 million according to 2011 Census and its population is swelling unceasingly. Further, out of the total population, economically productive population also known as the working age population group of 15-59 years constitute of 729.9 million people that is 60.3 percentage of the whole population and also the 60+ age people constitute only 8.6 percentage of the total population.[4] Thus we can say that India is experiencing its "First Demographic Dividend". Table 1 below clearly reveals these significant favourable changes in the demographics and the economy of India, in the Post liberalisation era. Also the Chart Below clearly reveals the transition the population age structure has gone through from 1991 to 2015.

Chart 1. Population Pyramids revealing the Demographic Transition of India





The above chart clearly reveals that in 1991 during the year of liberalisation of the economy the population pyramid looked like a near perfect triangle, however over the years the triangular structure of the population has got a big bulge around the age group of 20-24 years. This change in the age structure composition and a higher percentage of people in the Economically Productive Population age group provides a big push to the economy and these in turn have an impact on the stock markets performances. With this theoretical support we have devised the following Models, to analyse the impact of Demographic Transition and Economic Growth on Stock Markets of India. Multiple Regression Analysis was carried out in order to examine the nature of relationship between the demographic, economic and stock market indicators.

Variable Descriptions and Model Specification:

Table 2- Variable Descriptions

Name	**Description**
Dependent Variable	
PERatio	Price-Earning (P/E) Ratio of B.S.E. and N.S.E.
Independent Variable	
MEPP	Ln(Middle aged Economically Productive Population) where, MEPP is the Ratio of Middle aged 40-49 yrs. to Total Population
MedAge	Median Age Of The Population
GDPPC	G.D.P. per capita annual percentage growth

The Data were analysed using Multiple Regression models to study the relationships between demographic variables, economic growth and stock markets of India. On the basis of the variables defined above, the Multiple Regression Models applied for the analysis are:

Model 1 B.S.E. –

Model for stock market data of B.S.E.

$$PERatioBSE = \alpha_0 + \alpha_1 MEPP + \alpha_2 MedAge + \alpha_3 GDPPC + \varepsilon$$

Model 2 N.S.E. –

Model for stock market data of N.S.E.

$$PERatioNSE = \beta_0 + \beta_1 MEPP + \beta_2 MedAge + \beta_3 GDPPC + \varepsilon$$

8. EMPIRICAL RESULTS

The results of Multiple Regression Analysis for both the above models are summarized in Table-3 below:

Table 3- The comparative view of the relations and significance between the variables

	Model 1 B.S.E.		Model 2 N.S.E.	
Independent Variables	**Coefficient**	**p value**	**Coefficient**	**p value**
Constant	1048.873	0.007	427.322	0.066
MEPP	-217.703	0.009	-91.589	0.065
MedAge	56.107	0.009	24.642	0.056
GDPPC	-0.716	0.164	-0.402	0.224
R square	0.549		0.408	
F	4.878		2.76	
Overall Model Sig- p value	0.019		0.088	

Dependent Variable PERatio = Price-Earnings (P/E) Ratio of B.S.E. and N.S.E. respectively

From the above table we extract the following estimated models:

Model 1 B.S.E.

Estimated Model for stock market data of B.S.E.

PERatioBSE = 1048.873 -217.703MEPP + 56.107MedAge -0.716GDPPC

In this model the highest contributing variable is MEPP followed by MedAge and GDPPC respectively. MedAge has a positive relation, whereas MEPP and GDPPC have a negative relation with PERatioBSE. This clearly indicates that the middle aged economically productive population is the highest contributing variable to the P/E ratio of BSE, but unfortunately it has a negative impact on the growth stock market returns as indicated by the P/E Ratio. Though the overall middle aged population has positive effect on P/E ratio but when it is curtailed to only the economically productive section of this population, the effect becomes drastically negative. This means that India is not able to curb the fullest investment capacity of its economically productive population and hence it leads to an inverse relation between economic growth (as indicated by GDPPC) and the stock market indicator (P/E Ratio) too. The p values of the estimated coefficients of MedAge and MEPP are significant whereas, that of GDPPC is insignificant. This indicates that the effect of demographic variables on the stock market is much more significant rather than that of the economic growth. This is because the economic growth of the country cannot be achieved without increasing the productivity and thereby the investment capacity of its economically productive population. The overall models p value of the F statistic is significant. The value of the coefficient of determination reveals that 54.9% of the total variation in PERatioBSE is explained jointly by the independent variables: MEPP, MedAge and GDPPC by 54.9%. Thus it can be interpreted that the demographic and economic indicators do have a moderate impact on the stock market indicator of Bombay Stock Exchange.

Model 2 N.S.E.

Model for stock market data of N.S.E.

PERatioNSE = 427.322 -91.589MEPP + 24.642MedAge - 0.402 GDPPC

One can easily note that almost similar results have been obtained in case of NSE, again revealing MEPP as the highest contributing variable with an inverse relation to the PERatioNSE. Here also MedAge is a positively contributing variable to the growth of the stock market but MEPP i.e. the economically productive segment of the total middle aged population indicates an inverse relationship. Again similar to the previous results GDPPC shows an inverse relation with the P/E ratio for NSE. The p values of all the estimated coefficients: MedAge, MEPP and GDPPC respectively are insignificant indicating all the three independent variables having an insignificant effect on the growth of the stock market for NSE. This reveals that the stock market relies more upon some other variables such as Investor sentiments, corporate growth, industrial growth, Technology development, etc. rather than the demographic and economic growth variables. The overall models p value of the F statistic is also insignificant. The value of the coefficient of determination reveals that only 40.8% of the total variation in PERatioNSE is explained by these independent variables. Thus we can interpret that the demographic and economic indicators do have a moderate effect on the P/E Ratio of NSE. Further, this model is weaker as compared to the estimated model for BSE again justifying the necessity of inclusion of other independent variables in order to explain the variations in the dependent variable: P/E Ratio in a stronger manner.

9. CONCLUSION

This research was undertaken to study the impact of demographic transition and economic growth on stock markets of India. This research paper thus, attempts to reveal the contribution of the demographic dividend and economic growth on the growth of stock markets in India. The results indicate that it is necessary for the country to consider the impact of the changes in her demographic structure and economic growth while evaluating her stock markets. Further, there is a clear indication that India though it has a handsome amount of Demographic Dividend as its major asset on her hand, it is not able to use this dividend adequately in order to increase its economic growth and achieve better performance of her stock markets. There is a great underutilization of this Demographic Dividend in an unproductive manner. Much needs to be done in order to increase the productivity of this asset. India should actively act to utilize this asset to improve this productivity, thereby accelerating the savings and investment capacity of this economically productive segment of the population in the stock markets.

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ANNEXURE

Some Justifications Regarding the Choice of the Variables under this Study

1. For the semi log models of B.S.E. and N.S.E. Annual data for 16 years from 2000 to 2015 was applied. For this purpose, we have used the daily P.E. Ratio data from the official websites of BSE and NSE from 1st July to 30th June, for each year. Our Demographic data from U.N. data source is for the same period, so in order to have parity in the time period of all the variables, we have computed the Arithmetic Mean of daily P/E Ratios computed in order to get the annual figures for the years 2000 to 2015, so it is 16 years data calculation.

2. The Median Age is taken as an explanatory variable since the Asset Accumulation and Decumulation patterns are very different today than in the past. Hence there is a need to redefine the age ranges. According to the Life Cycle Hypothesis, the population distribution is in its second stage of the Life Cycle at the Median Age and this middle age population earn more income than their consumption and hence they are the potential stock market investors.

3. As far as all independent variables being independent is concerned, there is a significant correlation only between median age and MEPP, since they are based upon the same population figures. But both these variables are necessary in order to explain the demographic structure and its impact thereby on the stock market.

4. With reference to our query of R Sq.: Since the P.E. Ratios are affected by several other external factors, the variables used in our model explain only 54.9% and 40.8 %, of the variations for B.S.E. and N.S.E. Stock market variables respectively. Since the study aims at analysing the impact of only Demographic (population related variables) and economic growth on Stock markets, only MEPP and Median Age are considered in this study.The differences in risk preferences, stock market access, stock market development, education and other socio-economic characteristics of investors are the plausible factors that may increase the strength of results and specifications across the markets.

REVIEW ARTICLE

REVIEW OF EXPLORATORY FACTOR ANALYSIS : SOME GUIDELINES FOR EMPIRICAL RESEARCHERS

Stuti G. Dholakia[1], Chetna D. Bhavsar[2]

ABSTRACT

Factor analysis is a multivariate statistical approach commonly used for data reduction and identifies the hidden structure. Most of the researchers apply direct software techniques for Exploratory Factor Analysis (EFA). However it is very essential to understand the underlying theory, constraints and parameters to enable appropriate and correct decisions. This paper attempts to examine various possibilities of selection techniques involved in EFA in light of practical research. The goal of this paper is to collect, in one article, information that will allow researchers and practitioners to understand the various steps involved in factor analysis and then allows researcher to make decisions about "best practices" in exploratory factor analysis.

Key words: Exploratory factor analysis, Extraction methods, Rotation methods, Factor scores.

1. INTRODUCTION

Factor analysis refers to a variety of statistical techniques whose common objective is to represent a set of variables in terms of a smaller number of hypothetical variables. So from the structure of observed (or measured) variables,

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factor analysis makes inferences about the casual structure among the factors. It is used in the determination of a small number of factors based on a particular number of inter-related quantitative variables.

Factor analysis measures not directly observable variables but it measures several of its underlying dimensions. The identification of such underlying dimensions (factors) simplifies the understanding and description of complex constructs. Generally, the number of factors is much smaller than the number of measures. From this angle, factor analysis is viewed as a data-reduction technique.

2. PURPOSE OF THE STUDY

Factor analysis is widely used in the field of management, psychology, economics and agricultural and chemical data. So if the decisions involved in factor analysis is wrongly taken then the final solution would not give reliable decisions. So researcher should be careful while taking decisions about all indeterminacies involved in factor analysis. This paper gives the researcher all the steps involved in EFA.

3. STEPS OF EXPLORATORY FACTOR ANALYSIS

[1] Entry of data and checking the applicability to factor analysis.

[2] Extracting number of factors and factor loadings using extraction method.

[3] Rotating to simplify the structure.

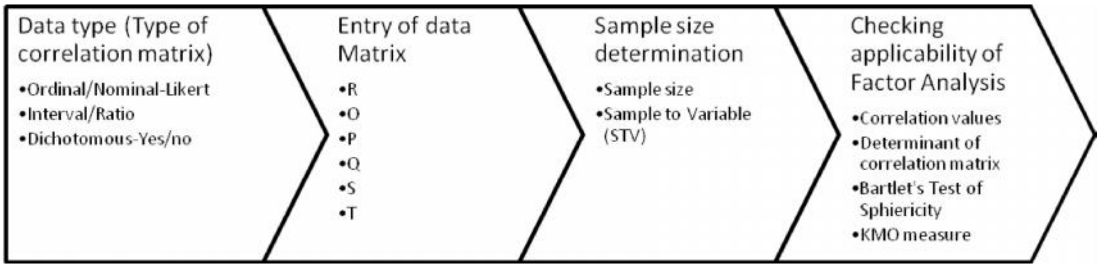
[4] Interpreting the hidden factor structure.

[5] Checking the structure for future (retention).

[6] Estimating factor scores.

[7] Future usage of outputs of factor analysis.

STEP 3.1 FOR KNOWN STRUCTURE OF OBSERVED VARIABLES (ENTRY)



3.1.1 DATA TYPE

Authors	**Suggestions/ findings**
Bernstein and Teng(1989)	Pearson correlations of them give rise to spurious multidimentionality and biased factor loadings.
Swygert et al. (2001)	Conduct a full information factor analysis.
Garrido et al.(2013)	Polychoric correlations are performed on data from ordinal values.

Most of the researchers are just not checking this criteria and using SPSS, STATA or SAS inbuilt software options which assumes the variables as interval or ratio type variables. So if this condition is violated, then researcher should rethink about type of correlation coefficient.

On the basis of this literature review, it suggests the use of Pearson correlation for interval or ratio type of data. (This is inbuilt option in different software's factor program menu.) Use polychoric or tetrachoric correlation coefficient for ordinal or dichotomous data. (This can be done with plugging to SPSS or SAS software.)

Other common recommendations are to (a) combine the items into mini-scales and then factor the mini-scales, and/or (b) conduct extension and/or higher-order factor analyses, (c) directly deal with the underlying multivariate distribution instead of calculating tetrachorics on the basis of bivariate tables.

Even newly developed but not frequently used free software called “FACTOR” (2006) uses the combination of Pearson or polychoric correlation coefficient according to the nature of correlations.

3.1.2 ENTRY OF THE DATA MATRIX

As the data type is known the first step is of entry mode. Some authors refer to several different types of factor analysis, such as R-Factor Analysis or Q-Factor Analysis. (Thompson (2004)) These simply refer to what is serving as the variables (the columns of the data set) and what is serving as the observations (the rows). This can be decided on the basis of the purpose or aim of the analysis.

Entry type of a matrix	**Data collected for (Columns data set)**	**Grouping of variables (Rows data set)**
R	Persons	Variables
O	Variables	Persons
P	Variables	Occasions
Q	Occasions	Variables
S	Occasions	Persons
T	Persons	Occasions

Mostly R type matrix is used for entry but this decision should be taken depending upon the purpose of factor analysis.

Even there can be errors while selecting a sample, selecting variables, measuring variables, considering distribution of variables. So while taking a sample care should be taken.

3.1.3 SAMPLE SIZE DETERMINATION

Authors	Suggestions/ findings
Comery andLee(1992)	100 as poor, 200 as fair, 300 as a good,500 as very good and 1000or more as an excellent sample size
Fabrigar et al.(1999)	Overly homogeneous samples should be avoided.
MacCallum, et al.(2001)	Communalities are high and if each factor is defined by several items, sample sizes can be relatively small. Weaker relationships of factor loadings need a larger sample size.
Stevens(2002)	5-20 participants per scale item.
Suhr(2006)	At least 100 cases and a STV ratio of no less than 5

Most of the researchers are deciding the sample sizes in prior only, but upon closer inspection of literature, it can be said that, determination of sample size sufficiency is dependent upon the stability of the solution; therefore, the adequacy of a sample cannot be fully determined until the analysis has been conducted. Only the final factor solution can provide enough evidence to suggest that a sample is sufficient. So after the final solution, researcher should check whether to increase the sample size or not. This checking step will give more replicable factor structure for future usage of factor analysis.

3.1.4 CHECKING USAGE OF FACTOR ANALYSIS

Multicollinearity can be detected by looking at the determinant of the *R*-matrix. The determinant of the *R*-matrix should be greater than 0.00001; if it is less than this value then look through the correlation matrix for variables that correlate very highly (r > 0.8) and consider eliminating one of the variables (or more depending on the extent of the problem) before proceeding. The choice of which of the two variables to eliminate will be fairly arbitrary. SPSS produces these residuals in the lower table of the reproduced matrix and we want relatively few of these values to be greater than 0.05.

Authors	**Suggestions/ findings**
Hair et al. (1995)	Factor loadings ±0.30=minimal, ±0.40=important, and ±.50=practically significant.
Pett et al.(2003)	If Determinant of correlation matrix is very small it indicates few linear combinations exist.
Hogarty et al. (2005)	Minimum level of N or Np ratio was not possible to achieve good factor recovery.

KAISER-MEYER-OLKIN (KMO) MEASURE OF SAMPLING ADEQUACY

H_0: The KMO values for individual variables are produced (in SPSS) on the diagonal of the Anti-Image Correlation Matrix. The values of the correlation should be above 0.5 for all variables. If there are values below 0.5 then removing the variable is recommended. (Beavers et al (2013))

KMO Value	**Degree of Common Variance**
0.90 to 1.00	Marvelous
0.80 to 0.89	Meritorious
0.70 to 0.79	Middling
0.60 to 0.69	Mediocre
0.50 to 0.59	Miserable
0.00 to 0.49	Do not use factor analysis

BARTLETT TEST OF SPHERICITY

H_0: The correlation matrix is an identity matrix. (So it is used to check whether the variables are uncorrelated).This hypothesis must be rejected, which provides the evidence of existence of linear combinations. So if the value of the test statistic for sphericity is large and the associated significance level is small, then the hypothesis is rejected and so it can be said that factor analysis can be used to understand the hidden relationships of variables. But, if the hypothesis is not rejected then the use of factor model should be reconsidered.

Most of the researchers are using KMO test but they are not checking multicoliniarity so this will affect the final decision.

STEP 3.2 FOR UNKNOWN STRUCTURE OF RELATIONSHIP BETWEEN VARIABLES AND FACTORS

3.2.1 CRITERION TO SELECT THE NUMBER OF FACTORS

a) KAISER'S CRITERIA/ EIGEN VALUE > 1 AND SCREE PLOT

Kaiser Criterion (1960) (K1) stated that factors should be retained if their eigenvalues are greater than or equal to one (Costello andOsborne, 2005). The reasoning behind the Kaiser Criterion is that a component having an eigenvalue greater than one accounts for more variance than would a single item, thus suggesting merit for combining those items into a factor or component. This can be used keeping in mind that it explains common (shared) variance of that factor.

Cattell's Scree Plot (1966) is a graphical representation of the factors and their corresponding eigenvalues. Because the first component accounts for the greatest amount of variance, it has the highest eigenvalue. The eigenvalues continually decrease resulting in a picture that is often called the "elbow" shape. The scree plot cutoff is quite subjective, requiring that the number of factors be limited to those occurring before the bend in the elbow (Fabrigar et al., 1999).

b) FIXED % OF EXPLAINED VARIANCE

On the basis of the aim of the study, keep as many factors as are required to explain 60%, 70%, 80-85%, or 95%. The majority suggests that 75 – 90% of the variance should be accounted for (Pett et al., 2003); however, some indicate as little as 50% of the variance explained is acceptable.

c) A PRIORI

From the past research, the researcher has some fixed number of factors to extract, then it can be considered as a prior considerations.

d) RANK OF A MATRIX

The communality can be estimated under the assumption of the rank of the correlation matrix. If the correlations are not independent or arbitrary values then Harman (1978, pg 71) gave guidelines for the number of linearly independent conditions of correlations. On the basis of that he developed the technique to estimate communalities. Also he gave the techniques to estimate communalities from reduced rank and approximate rank of a matrix.

e) HORN'S PARALLEL ANALYSIS (PA)

Horn (1965) proposes PA, a method based on the generation of random variables to determine the number of factors to retain. Some others suggest that this gives the most accurate results.

f) VELICER'S MAP TEST

Velicer (1976) proposes the MAP test (Minimum Average Partial), a method based on the application of PCA and in the subsequent analysis of partial correlation matrices. This rule employs the EFA concept of 'common' factors to determine how many components to extract. The method seeks to determine what components are common, and is proposed as a rule to find the best factor solution, rather than to find the cutoff point for the number of factor.

Authors	Suggestions/ findings
Humphreys and Montanelli (1975)	PA - appropriate method to identify the factors.
Zwick andvelicer (1986)	PA- most accurate. MAP- quite accurate under many conditions but MAP underestimate - low variables loading and low number of variables per component the number of factors.
Steavens(2002)	K1 - too many factors for > 40 variables with communalities around 0.4. - accurate with 10-30 variables with communalities around
Pett et al(2003)	K1 - used only in PCA.
Costello and Osborne(2005)	K1 - improper factor retention.
Weng and Cheng(2005)	PA performs well with Likert or binary data.
Ledesma et al.(2007)	ViSta-PARAN provides parametric and non-parametric PA for PCA and PAF, whose results are better than scree plot.

On closer inspection of literature, it can be said that because of the software inbuilt options K1 is widely used without knowing that K1 gives improper factor solutions. So, for a researcher it is suggested to take the decision regarding the number of factors to be retained should be taken only after using proper technique depending upon the type of variables.

g) RMSEA (ROOT MEAN SQUARE ERROR OF APPROXIMATION)

When using maximum likelihood factor analysis or generalized least squares factor analysis, chi square test is done, indicating the degree to which the extracted factors enable the reproduce the underlying correlation matrix. RMSEA is a measure of fit based on the chi-square value and the degrees of freedom. One rule of thumb is to take the number of factors with the lowest RMSEA or the smallest number of factors that has an adequate RMSEA. Some authors have suggested following rules of thumb.

RMSEA Value	**Fit**
Less than 0.05	Close fit
0.05-0.08	Fair fit
0.08-0.10	Moderate fit
Greater than 0.1	Unacceptable fit

h) OTHER CRITERIA

There are several rules for determining how many factors are appropriate for any data. Mardia, Kent, and Bibby (1979, pg. 258) point out that there is a limit to how many factors one can have and actually end up with a model that is simpler than the original row data.

In practice there is no single best rule to use and a combination of them is to be used if there is no a priori hypothesis about the number of factors to retain. There are also a variety of other methods out there that are very popular with some authors Minimum average partial correlation and modified parallel analysis are some of them. The other criterions that require multivariate normality are likelihood ratio test, AIC (Akaike's information criterion), and SBC (Schwartz's Bayesian criterion), comparative data (CD). (Preacher et al (2003)).

So the researcher should be very cautious regarding this very important decision of selecting number of factors to retain.

3.2.2 EXTRACTION METHODS

The method selected should be based on the nature of the underlying distribution of the data. For example, MLE is used when data are multivariate normal, while PAF makes no distributional assumptions (Fabrigere et al. (1999)). For other method clear guidelines are missing. Even a newly developed technique Minimum rank factor analysis (MRFA) is used in a free software called "FACTOR".

Extraction method	Criteria	Significance test/assumptions
Principal component analysis (PCA)	It finds uncorrelated linear combinations of the observed variables. The first component has maximum variance. Successive components explain progressively smaller portions of the variance. It is used to obtain the initial factor solution. It can be used when a correlation matrix is singular.	(not considered as a part of factor analysis)
Principal axis factoring (PAF)	An iterative process in which changes in communality estimates are made till the changes in the communalities satisfy the convergence criterion for extraction.	
Minimum residuals (Minres) (Unweighted least squares)	Minimizing the sum of squares of differences (residuals) between the input correlation matrix and the reproduced (by the factors) correlation matrix.	Chi squres, Communality estimates less than 1
Generalized least squares (weighted least squares) (GLS)	Modification of Minres. When minimizing the residuals, it weights correlation coefficients differentially correlations between variables with high uniqness (at the current iteration) are given less weight.	Chi squres, Large samples
Maximum likelihhod estimation(MLE)	correlations are weighted by uniqueness in the same fashion as in GLS	Chi squres, Normal dist
Alpha factoring	This method maximizes the alpha reliability of the factors.	Variables are individuals from population
Image factoring	It is based on image theory. The common part of the variable, called the partial image, is defined as its linear regression on remaining variables, rather than a function of hypothetical factors.	Variables are individuals from population

STEP 3.3 ROTATION OF FACTORS

Rotations are of two types. Some methods in each case were explained here. Orthogonal rotations assume that the factors are independent. Varimax, Quartimax, Equimax are some of the highly used methods. Oblique rotations assume that the factors are dependent. Direct oblimin, Promax are some of the highly used methods. Some others less used methods are Oblimax, Quartimin, Oblimin, Biquartimin, Covarimin.

Method	**Type**	**Criteria**
Varimax	Orthogonal	Minimizes the number of variables that have high loadings on each factor. (simplifies factors or columns)
Quartimax	Orthogonal	Minimizes the number of factors needed to explain each variable. (simplifies variables or rows)
Equamax	Orthogonal	Combination of the varimax and the quartimax. (balances between factors and variables)
Direct Oblimin	Oblique	Delta 0 - most oblique solution, delta negative – less oblique and delta less than or equal to 0.8 - preferred.
Promax	Oblique	Used mainly for large data set.

The literature suggests that if a researcher is very sure about the independent nature of the factors (from the past data) then only use orthogonal rotation. Otherwise the researcher has to start with any of the oblique rotation. If the structure of variables (grouping of variables and loadings on factors) using oblique rotation is similar to orthogonal rotation then it can be definitely suggested that the factors are independent. So literature survey suggests that oblique rotations (which allows relationships between factors) should be preferred, unless a strong argument can be made as to why the factors should not be correlated (Baglin J. (2014)).

STEP 3.4 INTERPRETING THE HIDDEN FACTOR STRUCTURE

Interpretation involves the researcher examining which variables are attributable to a factor, and giving that factor a name or theme. Henson and Roberts (2006) noted "the meaningfulness of latent factors is ultimately dependent on researcher definition". In other words, it is a search to find those factors that taken together explain the majority of the responses. It is important that these labels or constructs reflect the theoretical and conceptual meaning. Some authors recommend not including factors with only one significant loading Stevens (2002) summarizes some results that are a bit more specific and backed by simulations. A factor is reliable if it has

3 or more variables with loadings of 0.8 and any n

4 or more variables with loadings of 0.6 and any n

10 or more variables with loadings of 0.4 and ne"150

Factors with only a few loadings require ne"300

STEP 3.5 RETENTION/ REPLICABILITY (CHECKING THE STRUCTURE FOR FUTURE)

The goal of EFA is usually to explore the likely factor structure. It is important to know whether a solution within a particular data set is likely to be observed within another, similar data set.

The practitioners are not checking the retention of factor analysis solution. The literature strongly recommends them to check the replicability of derived factor solution for future. The researcher should perform either internal (a single sample or randomly split) or external (two independently gathered samples) replication.

The researcher should specify same number of factors, extraction and rotation methods and then the pattern should be checked in final output. If there are a small percentage of items that seems to replicate then the researcher should think either to revise or delete such items. If large number of problematic items are observed then the researcher should revise the scale substantially. (Osborne et al (2012))

STEP 3.6 FUTURE PREDICTIONS USING FACTOR SCORES

There are mainly two types of factor score computation method Refined and non- refined. Non-refined methods are Sum Scores by Factors, above a cut-off value, Standardized variables and weighted sum scores (DiStefano et al. (2009)). These methods are more stable across samples than refined methods (Grice (2001)) but they are not obtained with statistical software such as SPSS or SAS. Refined methods are Regression, Bartllet and Anderson/Rubin methods and can be easily computed by software.

Method	**Criteria**
Regression	The scores produced have a mean of 0 and a variance equals to the squared multiple correlations between the estimated factor scores and the true factor values. The scores may be correlated even when factors are orthogonal. (highly used method)
Bartllet	The scores that are produced have a mean of 0. The sum of squares of the unique factors over the range of variables is minimized.
Anderson/ Rubin	A modification of the Bartlett method which ensures orthogonality of the estimated factors. The scores that are produced have a mean of 0, have a standard deviation of 1, and are uncorrelated.

Factor scores are useful for follow-up analysis but are sensitive to the factor extraction and rotation methods. Researchers are likely to obtain different factor scores when different extraction and/or rotation are used. (DiStefano et al. (2009)) Researchers interested in using factor scores need to be aware of the problem of indeterminacy (selection problems involved regarding number of factors to extract, extraction and rotation methods to use etc.) because it could impact factor scores and even the decisions that rely upon factor scores. Grice (2001) suggested some measures to tackle this indeterminacy of the solutions.

STEP 3.7 FUTURE USAGES OF OUTPUTS OF FACTOR ANALYSIS

The derived factor structure can further verified with Confirmatory Factor analysis (CFA). The predicted factor scores can be used even in Cluster analysis as input data. The ranking of participants can be made on calculated regression scores. These outputs can be taken as the inputs in higher order factor analysis.

4. CONCLUDING REMARKS

Every step of the process in a factor analysis requires the researcher to be firmly grounded in contextual theory and fundamental understanding of factor analysis methodology. Decisions should be supported by strong theoretical and mathematical justification, providing credibility to the final outcome. The researcher should carefully consider all the steps of taking decisions regarding sample size, number of factors to extract, extraction, rotation methods and factor score calculation method. The researcher should also follow an additional step of performing and reporting replication results as a practice, which gives a confidence to the researcher about the stability of the EFA solutions.

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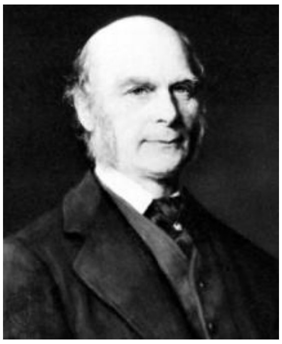
SIR FRANCIS GALTON*



H.D.BUDHBHATTI**

Francis Galton was born on 16th February 1822 at Birmingham, West Midlands, England. It was a large house called "The Larches". His father was samuel Tertius Galton. The Galtons were famous and highly successful Quaker gun-manufacturers and bankers. He was **Charles Darwin's** half cousin, sharing the common grand parent **Erasmus Darwin**. Darwins were distinguished in medicine and science.

Galton was by many accounts a child prodigy – he was reading by the age of two; at age five he knew some Greek, Latin and long division, and by the age of six he had moved on to adult books, including Shakespeare for pleasure, and poetry, which he quoted at length. Later in life, Galton would propose a connection between genius and insanity based on his own experience. He stated, "Men who leave their mark on the world are very often those who, being gifted and full of nervous power, are at the same time haunted and driven by a dominant idea, and are therefore within a measurable distance of insanity"

Galton attended King Edward's School, Birmingham, but chafed at the narrow classical curriculum and left at 16. His parents pressed him to enter the medical profession, and he studied for two years at Birmingham General Hospital and King's

* From wikipedia (the free encyclopedia). We express our sense of gratitude for this assistance.

** Ex. CSO, Head, Statistics Dept., GSRTC, Ahmedabad.

(rcd. Sept. '16 / rvd. Dec. '16)

College, London Medical School. He followed this up with mathematical studies at Trinity College, University of Cambridge, from 1840 to early 1844.

According to the records of the United Grand Lodge of England, it was in February 1844 that Galton became a freemason at the so-called Scientific lodge, held at the Red Lion Inn in Cambridge, progressing through the three masonic degrees as follows: Apprentice, 5 February 1844; Fellow Craft, 11 March 1844; Master Mason, 13 May 1844. A curious note in the record states: "Francis Galton Trinity College student, gained his certificate 13 March 1845". One of Galton's masonic certificates from Scientific lodge can be found among his papers at University College, London.

A severe nervous breakdown altered Galton's original intention to try for honours. He elected instead to take a "poll" (pass) B.A. degree, like his half-cousin Charles Darwin. (Following the Cambridge custom, he was awarded an M.A. without further study, in 1847.) He then briefly resumed his medical studies. The death of his father in 1844 had left him financially independent but emotionally destitute and he terminated his medical studies entirely, turning to foreign travel, sport and technical invention.

In his early years Galton was an enthusiastic traveller, and made a notable solo trip through Eastern Europe to Constantinople, before going up to Cambridge. In 1845 and 1846 he went to Egypt and travelled down the Nile to Khartoum in the Sudan, and from there to Beirut, Damascus and down the Jordan.

In 1850 he joined the Royal Geographical Society, and over the next two years mounted a long and difficult expedition into then little-known South West Africa (now Namibia). He wrote a successful book on his experience, "Narrative of an Explorer in Tropical South Africa". He was awarded the Royal Geographical Society's Founder's Gold Medal in 1853 and the Silver Medal of the French Geographical Society for his pioneering cartographic survey of the region. This established his reputation as a geographer and explorer. He proceeded to write the best-selling “The Art of Travel”, a handbook of practical advice for the Victorian on the move, which went through many editions and is still in print.

In January 1853 Galton met Louisa Jane Butler (1822–1897) at his neighbour’s home and they were married on 1 August 1853. The union of 43 years proved childless.

Galton was a polymath who made important contributions in many fields of science, including meteorology (the anti-cyclone and the first popular weather maps), statistics (regression and correlation), psychology (synaesthesia), biology (the nature and mechanism of heredity), and criminology (fingerprints). Much of this was influenced by his penchant for counting or measuring. Galton prepared the first weather map published in The Times (1 April 1875, showing the weather from the previous day, 31 March), now a standard feature in newspapers worldwide.

He became very active in the British Association for the Advancement of Science, presenting many papers on a wide variety of topics at its meetings from 1858 to 1899. He was the general secretary from 1863 to 1867, president of the Geographical section in 1867 and 1872, and president of the Anthropological Section in 1877 and 1885. He was active on the council of the Royal Geographical Society for over forty years, in various committees of the Royal Society, and on the Meteorological Council.

In 1888, Galton established a lab in the science galleries of the South Kensington Museum. In Galton's lab, participants could be measured to gain knowledge of their strengths and weaknesses. Galton also used these data for his own research. He would typically charge people a small fee for his services.

The publication by his cousin Charles Darwin of The Origin of Species in 1859 was an event that changed Galton's life. He came to be gripped by the work, especially the first chapter on "Variation under Domestication," concerning animal breeding.

Galton invented the term **eugenics in 1883** and set down many of his observations and conclusions in a book, **Inquiries into Human Faculty and Its Development.** He believed that a scheme of 'marks' for family merit should be defined, and early marriage between families of high rank be encouraged by provision of monetary incentives. He pointed out some of the tendencies in British society, such as the late marriages of eminent people, and the paucity of their children, which he thought were dysgenic. He advocated encouraging eugenic marriages by supplying able couples with incentives to have children. On 29 October 1901, Galton chose to address eugenic issues when he delivered the second Huxley lecture at the Royal Anthropological Institute.

The Eugenics Review, the journal of the Eugenics Education Society, commenced publication in 1909. Galton, the Honorary President of the society, wrote the foreword for the first volume. The First International Congress of Eugenics was held in July 1912. Winston Churchill and Carls Elliot were among the attendees.

Innovations in statistics and psychological theory

Historiometry

The method used in Hereditary Genius has been described as the first example of historiometry. To bolster these results, and to attempt to make a distinction between 'nature' and 'nurture' (he was the first to apply this phrase to the topic), he devised a questionnaire that he sent out to 190 Fellows of the Royal Society. He tabulated characteristics of their families, such as birth order and the occupation and race of their parents. He attempted to discover whether their interest in science was 'innate' or due to the encouragements of others. The studies were published as a book, **English men of science: their nature and nurture**, in 1874. In the end, it promoted the nature versus nurture question, though it did not settle it, and provided some fascinating data on the sociology of scientists of the time.

The lexical hypothesis

Sir Francis was the first scientist to recognise what is now known as the lexical hypothesis. This is the idea that the most salient and socially relevant personality differences in people's lives will eventually become encoded into language. The hypothesis further suggests that by sampling language, it is possible to derive a comprehensive taxonomy of human personality traits.

The questionnaire

Galton's inquiries into the mind involved detailed recording of people's subjective accounts of whether and how their minds dealt with phenomena such as mental imagery. To better elicit this information, he pioneered the use of the questionnaire. In one study, he asked his fellow members of the Royal Society of London to describe mental images that they experienced. In another, he collected in-depth surveys from eminent scientists for a work examining the effects of nature and nurture on the propensity toward scientific thinking.

Variance and standard deviation

Core to any statistical analysis is the concept that measurements vary: they have both a central tendency, or mean, and a spread around this central value, or variance. In the late 1860s, Galton conceived of a measure to quantify normal variation: the standard deviation.

Galton was a keen observer. In 1906, visiting a livestock fair, he stumbled upon an intriguing contest. An ox was on display, and the villagers were invited to guess the animal's weight after it was slaughtered and dressed. Nearly 800 participated, and Galton was able to study their individual entries after the event. Galton stated that "the middlemost estimate expresses the vox populi, every other estimate being condemned as too low or too high by a majority of the voters" and reported this value (the median, in terminology he himself had introduced, but chose not to use on this occasion) as 1,207 pounds. To his surprise, this was within 0.8% of the weight measured by the judges. Soon afterwards, in response to an enquiry, he reported the mean of the guesses as 1,197 pounds, but did not comment on its improved accuracy. Recent archival research has found some slips in transmitting Galton's calculations to the original article in Nature: the median was actually 1,208 pounds, and the dressed weight of the ox 1,197 pounds, so the mean estimate had zero error. James Surowiecki uses this weight-judging competition as his opening example: had he known the true result, his conclusion on the wisdom of the crowd would no doubt have been more strongly expressed.

Experimental derivation of the normal distribution

Studying variation, Galton invented the quincunx, a pachinko-like device, also known as the bean machine, as a tool for demonstrating the law of error and the normal distribution.

Bivariate normal distribution

He also discovered the properties of the bivariate normal distribution and its relationship to regression analysis.

Correlation and regression

In 1846, the French physicist Auguste Bravais (1811–1863) first developed what would become the correlation coefficient. After examining forearm and height measurements, Galton independently rediscovered the concept of correlation in 1888 and demonstrated its application in the study of heredity, anthropology, and psychology. Galton's later statistical study of the probability of extinction of surnames led to the concept of Galton–Watson stochastic processes. This is now a core of modern statistics and regression.

Galton invented the use of the regression line and for the choice of r (for reversion or regression) to represent the correlation coefficient.

In the 1870s and 1880s he was a pioneer in the use of normal theory to fit histograms to actual tabulated data, much of which he collected himself: for instance large samples of sibling and parental height. Consideration of the results from these empirical studies led to his further insights into evolution, natural selection, and regression to the mean.

Regression to mediocrity

Galton was the first to describe and explain the common phenomenon of regression toward the mean, which he first observed in his experiments on the size of the seeds of successive generations of sweet peas.

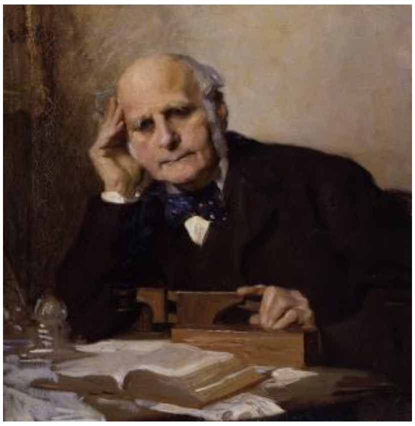
The conditions under which regression toward the mean occurs depend on the way the term is mathematically defined. Galton first observed the phenomenon in the context of simple linear regression of data points. Galton developed the following model: pellets fall through a quincunx or "bean machine" forming a normal distribution centered directly under their entrance point. These pellets could then be released down into a second gallery (corresponding to a second measurement occasion.) Galton then asked the reverse question "from where did these pellets come?"

The answer was not "on average directly above". Rather it was "on average, more towards the middle", for the simple reason that there were more pellets above it towards the middle that could wander left than there were in the left extreme that could wander to the right, inwards

Differential psychology

Galton's study of human abilities ultimately led to the foundation of differential psychology and the formulation of the first mental tests. He was interested in measuring humans in every way possible. This included measuring their ability to make sensory discrimination which he assumed was linked to intellectual progress. Galton suggested that individual differences in general ability are reflected in performance on relatively simple sensory capacities and in speed of reaction to a stimulus, variables that could be objectively measured by tests of sensory discrimination and reaction time. He also measured how quickly people reacted which he later linked to internal wiring which ultimately limited intelligence ability. Throughout his research Galton assumed that people who reacted faster were more intelligent than others.

Fingerprints



The method of identifying criminals by their fingerprints had been introduced in the 1860s by Sir William James Herschel in India, and their potential use in forensic work was first proposed by Dr Henry Faulds in 1880, but Galton was the first to place the study on a scientific footing, which assisted its acceptance by the courts. Galton pointed out that there were specific types of fingerprint patterns. He described and classified them into eight broad categories: 1: plain arch, 2: tented arch, 3: simple loop, 4: central pocket loop, 5: double loop, 6: lateral pocket loop, 7: plain whorl, and 8: accidental.

Honours and impact

Over the course of his career Galton received many major awards, including the Copley Medal of the Royal Society (1910). He received in 1853 the Founder's Medal, the highest award of the Royal Geographical Society, for his explorations and map-making of southwest Africa. He was elected a member of the prestigious Athenaeum Club in 1855 and made a Fellow of the Royal Society in 1860. His autobiography also lists the following:

- Silver Medal, French Geographical Society (1854)
- Gold Medal of the Royal Society (1886)
- Officier de l'Instruction Publique, France (1891)
- D.C.L. Oxford (1894)

- Sc.D. (Honorary), Cambridge (1895)
- Huxley Medal, Anthropological Institute (1901)
- Elected Hon. Fellow Trinity College, Cambridge (1902)
- Darwin Medal, Royal Society (1902)
- Linnean Society of London's Darwin–Wallace Medal (1908)

Galton was knighted in 1909. His statistical heir Karl Pearson, first holder of the Galton Chair of Eugenics at University College London (now Galton Chair of Genetics), wrote a three-volume biography of Galton, in four parts, after his death. In the early days of IQ testing, Lewis Terman estimated that Galton's childhood IQ was about 200, based on the fact that he consistently performed mentally at roughly twice his chronological age. (This follows the original definition of IQ as mental age divided by chronological age, rather than the modern definition based on the standard distribution and standard deviation.)

The flowering plant genus **Galtonia** was named in his honour.

Sir Francis Galton died on 17 January 1911 at the age of 88 years at Haslemere, Surray, England.

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BOOK REVIEW

Title : **Econometrics For Dummies**

Author : **Roberto Pedace**

Publisher : **John Willey & Sons, Inc., USA**

Pages : **564**

> Econometrics may be defined as a field based on a theoretical -Quantitative and empirical-quantitative approach to econometric problems.
>
> Thus econometricians, are applied economists using the tools developed by theoretical econometricians to examine economic phenomena. * Author

This book on econometrics is a novel approach by the author to explain about clumpsy and difficult models approach into simpler forms that can be used easily with convenience and effective approach. Though it is meant for beginners, this book is also essentially useful for all practioners in the subject.

The coverage area for basic econometric concept is split up into 19 chapters in these 564 pages. There is entirely new and novel approach in each chapter which is as (1) Computer output (2) Remember (3) Technical stuff (4) TIP (5) Warnings etc. These zones express explicitly in a lucid manner about do's and don't do's for application areas.

For beginner, derivations of the results are not needed. However basic principles are to be understood for making valid applications. Each chapter gives sufficient weightage to real life applications of the basic econometric models.

They also illustrate them by means of suitable computer packages. Appropriate consideration is also given for statistical tools in econometric applications.

Some specific observations can be given for the text material of this book as under.

[1] Panel data statistics are discussed in sufficient details for application purposes. In particular panel econemetrics is discussed in chap. 17

[2] Dummy variables techniques are described by sufficiently and reasonably appropriate approach.

[3] Logit and Probit techniques with their graphical presentation are lucidly explained.

[4] Autocorrelation and lag models are discussed in easy and suitable forms.

[5] Chap. 14 on Limited Dependent variable models is a very specific approach done by the author.

[6] Chap. 15 contains static and dynamic models. A typical seasonal pattern model (page 492) and estimating seasonality effects are very well illustrated.

[7] Similarly Chap. 16 considers pooled cross section analysis.

[8] In my view, Chap. 18 and Chap. 19 are very nicely presented for econometric applications.

Chap. 18 discusses 10 cmponents of a good econometric project. Chap. 19 gives some caution for applications by means of considering 10 common mistakes in Applied Econometrics. (e.g. Data values that appeal perfectly legitimate are actually censored values. P. 550) Indications are given for obtaining projections based upon data analysis and also to consider their economic significance.

This book is a valuable pearl in the chain of Dummy series publicatons. It is equally good for beginners, practitioners and theoreticians. There is no doubt about usefulness of the material given in the book.

Ahmedabad.
Date : 03-12-2016.

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READERS FORUM

A. M. PATEL*

- **P. S. Pandya**

While reviewing Oct. 2016 issue, I wish to give some comments on the material published.

(1) 'World Statistics Day' - this information is nicely complied in brief. Some honour could be given to our great Indian Stalwarts - Mahalanobius, C. R. Rao etc. along with others. This should also be circulated among the students in statistics.

(2) Article on data management could be more precisely shown by some practical illustrations.

(3) Conjoint Analysis is a really good article. Some reference towards related surveys of market trends, psychological approaches towards utilities could be more fruitful.

(4) Good analysis is carried out in high sugar yielding of sugar cane through the article published. Outcome of analysis may be tried for better judgement as well as practical approach for higher yielding.

(5) There is a large gap in the variational aspect for actual and observed (estimated) data for preharvest yielding of wheat yield. Such analysis may be tried for other crops and other states also.

(6) Trend model for GSRTC data appears to be reasonably good. The forecasted values may be compared with actual as released by GSRTC.

(7) Survey work on educational aspects for their quality management could be more precise and appropriate if actual college setup can be compared by means of quality and infrastructure.

(8) Biography of schewhalt - SQC giant is very very inspiring. It should be circulated to the students of statistics in order to have an inspirational impact.

In general, this published issue is really attractive and provides a platform for inspiring young research workers, students and practioners in the subject.

My blessings - keep it up.

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

Gujarat Statistical Association

Established : 1969

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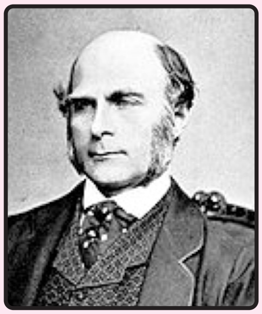
SIR FRANCIS GALTON*



Sir Francis Galton, FRS was born on Feb. 16, 1822 at Birmingham, west Midlands, England and he died on 17 January 1911 at the age of 88 years, in Haslemere, Surrey, England. He was a British scientist who has worked in the field of Anthropology, Sociology, Psychometry etc. along with his notable contributions to statistics. Galton produced over 340 papers and books. He created the statistical concept of correlation and widely promoted regression towards the mean. He was pioneer in **Eugenics**. He founded **psychometrics** (the science of measuring mental faculties).

His innovations in statistics and psychological theory are (1) Historiometry (2) The lexical hypothesis (3) The questionnaire (4) Variance and standard deviation (5) Bivariate Normal Distribution (7) Correlation and regression (8) Perception theories (9) Differential psychology etc. **Willim Hopkins** was his academic advisor and **Karl Pearson** was his notable student. **He was awarded knighthood in 1909.** He was given the following prestigious awards.

Royal Medal (1886)

Darwin-Wallace Medal (Silver 1908)

Copley Medal (1910)

He was made Fellow of Royal Society (FRS) in 1860.

***(Brief Biographical sketch is given inside the journal)**

This page 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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(Journal of GSA, Ahmedabad)

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