

Neural Networks Application in Predicting Stockprice of Pharma Companies a Case Study of Natco Pharma

Ananth Narayan Tripurari¹ And Braj Kishor²

¹ Research scholar, (Part-time Ph.D), JNTUH, Kukatpally, Hyderabad.

² Dr. Braj Kishor is former Dean, Faculty of Commerce and Management, Osmania University, Hyderabad.

Abstract: This paper is a survey on the applications of NEURAL NETWORKS APPLICATION IN PREDICTING STOCKPRICE. In this article various domains of APPLICATIONS TO NEURAL NETWORKS are discussed. The stock market is a complex, non stationary, chaotic and non linear dynamical system. Prediction is the process of estimation in unknown future situations. Predicting stock performance is a very large and profitable area of study. The present study is supported and illustrated by practical application of results. The objective of this project is to understand the performance of pharmaceutical industry in India and also to understand performance of stocks of particular companies in pharma sector. Suggesting the investor the right time to buy and sell the stocks of these companies.

Keywords: Neural Networks, Stock market, Prediction.

I. Introduction

NEURAL NETWORKS are mathematical models originally inspired by biological processes in the human brain. They are constructed from a number of simple processing elements interconnected by weighted pathways to form networks. Each element computes its output as a nonlinear function of the weighted input when combined in to networks. These processing elements can implement arbitrarily complex, non linear networks which can be used to solve classification, prediction, and optimization problems.

Figure - 1

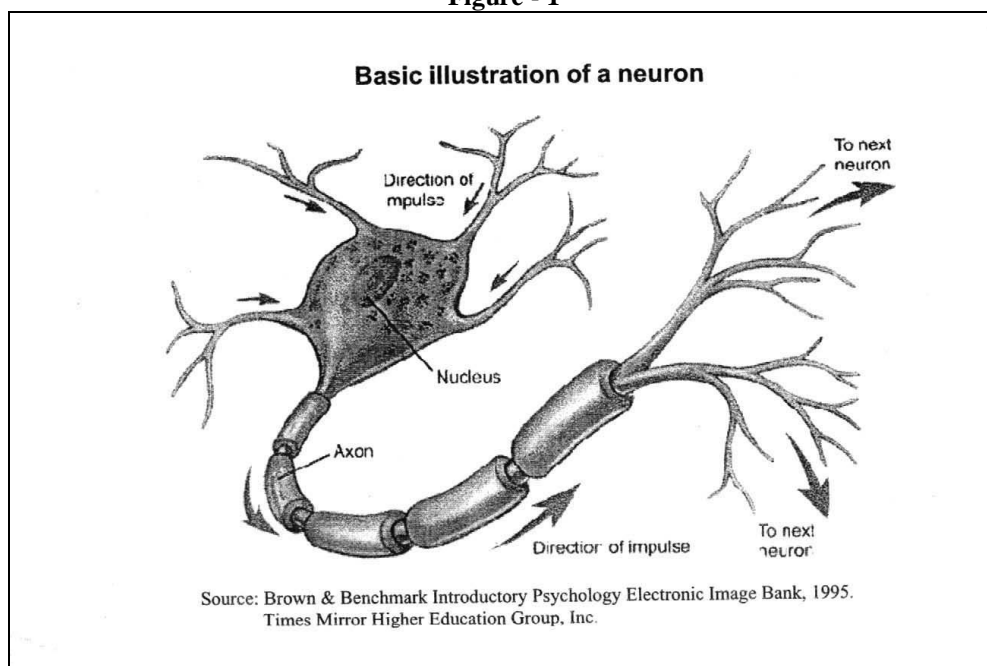
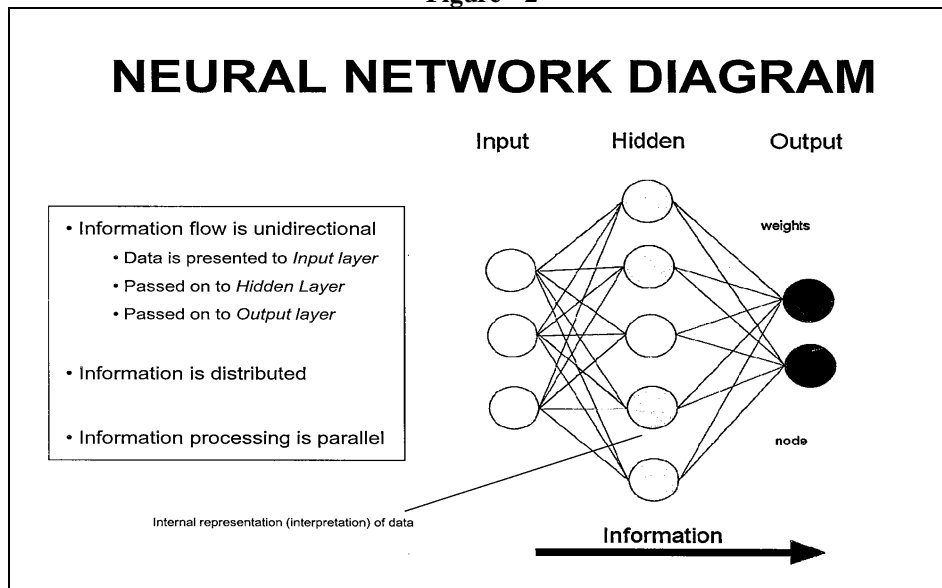


Figure - 2



1. Neural Networks:

Definitions of Neural Networks:

A Neural Network is massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use. It resembles the brain in two respects:

1. Knowledge is acquired by the Network through a learning process.
2. Interneuron connection strengths known as synaptic weights are used to store the knowledge.

According to Haykin S. (1994), *Neural Networks: A comprehensive Foundation*, NY: Macmillan, p 2: Artificial Neural Networks are physical cellular systems which can acquire, store, and utilize experiential knowledge. According to Zurada, J. M (1992) *Introduction to Artificial Neural systems*, Boston: PWS publishing company, p.xv)

The operation of Neural Networks is controlled by three properties

1. The pattern of its interconnections, architecture.
2. Method of determining and updating the weights on the interconnections, training.
3. The function that determines the output of each individual neuron, activation or transfer function.

II. Objective Of The Study

To study the stock price prediction of Pharma sector companies using Artificial Neural Networks.

III. Review of literature

Neural Networks have been extensively applied to accounting, finance, and other business studies in areas such as forecasting, pattern recognition, and classification (Wong et al., 1997; O’Leary, 1998; Vellido et al. 1999). Tam and Kiang (1992) find Neural Networks to be a superior approach in bankruptcy predictions. Echoing Tam and Kiang (1992), other researchers in economics and finance recognize the strength of the Neural Networks in handling non-linear relationships and accommodating various probability distributions. Azoff (1994) recommends the Neural Network approach as a “multivariate nonlinear nonparametric inference technique that is data driven and model free.” Beltratti et al. (1996) provide a more fundamental explanation for the appeal of the Neural Network in economic modeling. Kim and McLeod (1999) demonstrated superiority of Neural Network models in bankruptcy prediction, especially when there exist nonlinear patterns in data sets.

In addition, numerous bond rating studies (Kwon et al. 1995; Singleton and Surken, 1995; Maher and Sen, 1997) have demonstrated that Neural Networks are a reliable alternative to traditional statistical techniques such as discriminant analysis for business classification problem. Hill et al. (1994) and Tang and Fishwick (1993) suggest replacing conventional statistical techniques with Neural Networks in building financial forecasting models.

IV. Pharmaceutical Sector Profile

A. About: India's pharmaceutical sector is gaining its position as a global leader. The pharma market in India is expected to touch US\$ 74 billion in sales by 2020 from the current US\$ 11 billion. Indian pharmaceutical industry is mounting up the value chain. From being a pure reverse engineering industry focused on the domestic market, the industry is moving towards basic research driven, export oriented global presence, providing wide range of value added quality products and services, innovation, product life cycle management and enlarging their market reach. India gained its foothold on the global scene with its innovatively engineered generic drugs and active pharmaceutical ingredients (API), and it is now seeking to become a major player in outsourced clinical research as well as contract manufacturing and research. There are 74 U.S. FDA-approved manufacturing facilities in India, more than in any other country outside the U.S, and in 2005, almost 20% of all Abbreviated New Drug Applications (ANDA) to the FDA are expected to be filed by Indian companies.

B. Evolution of Indian pharmaceutical sector: Before 1950:

- Market is dominated by foreign companies, with little domestic participation.
- 1970-1990:
- Indian Patent Act passed in 1970
- Several domestic companies started operations.
- Development of production infrastructure.
- Export initiatives have taken.

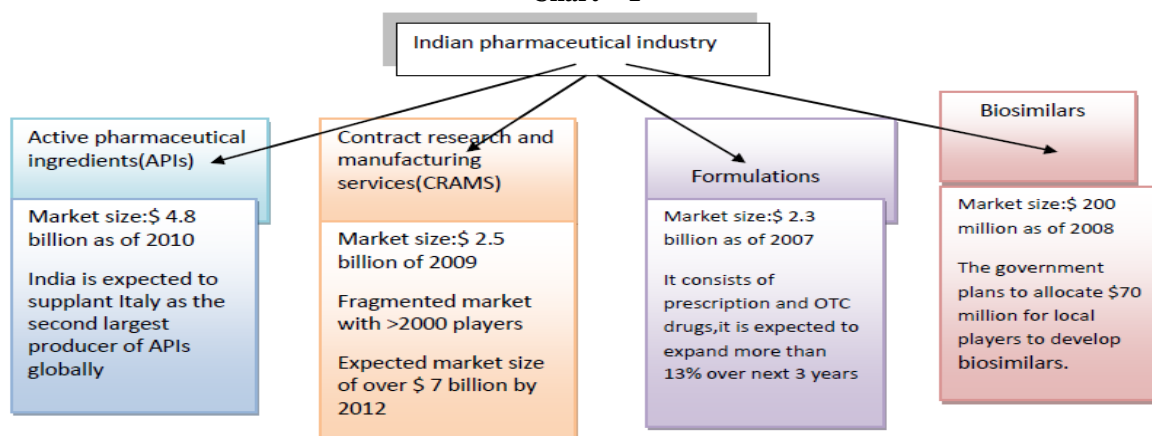
1990-2005:

- Liberalised market.
- Domestic players expand aggressively.
- Increased propensity for R & D.
- 2005 onwards:
- Indian companies increasingly launch operations in foreign countries.
- Indian major destination for generic drug manufacture.
- Higher appending on R & D due to the introduction of product patents.

C. Structure of Pharma Industry: The growth of pharma industry has started on 1953.2. It is a highly fragmented sector composed of more than 20,000 units. In 2003 it was mainly dominated by small players but now big players are dominating the sector. Today firms are typically extremely large to more easily enable big expenditures for research and development. The number of purely Indian pharma companies is fairly low. Indian pharma industry is mainly operated as well as controlled by dominant foreign companies having subsidiaries in India due to availability of cheap labour in India at lowest cost.

Big Pharma: Raise of the Gaints: The trend since the 1980s has been for consolidation among pharmaceutical companies, using a variety of means such as corporate takeovers and buyouts, and business partnerships. This has given rise to very large firms. The combined revenues of Novartis of Switzerland, Pfizer of the U.S., and Bayer in Germany are more than \$150 billion. The phrase Big Pharma is often given to firms with earnings in excess of \$3 billion or with research and development expenses above \$500 million.

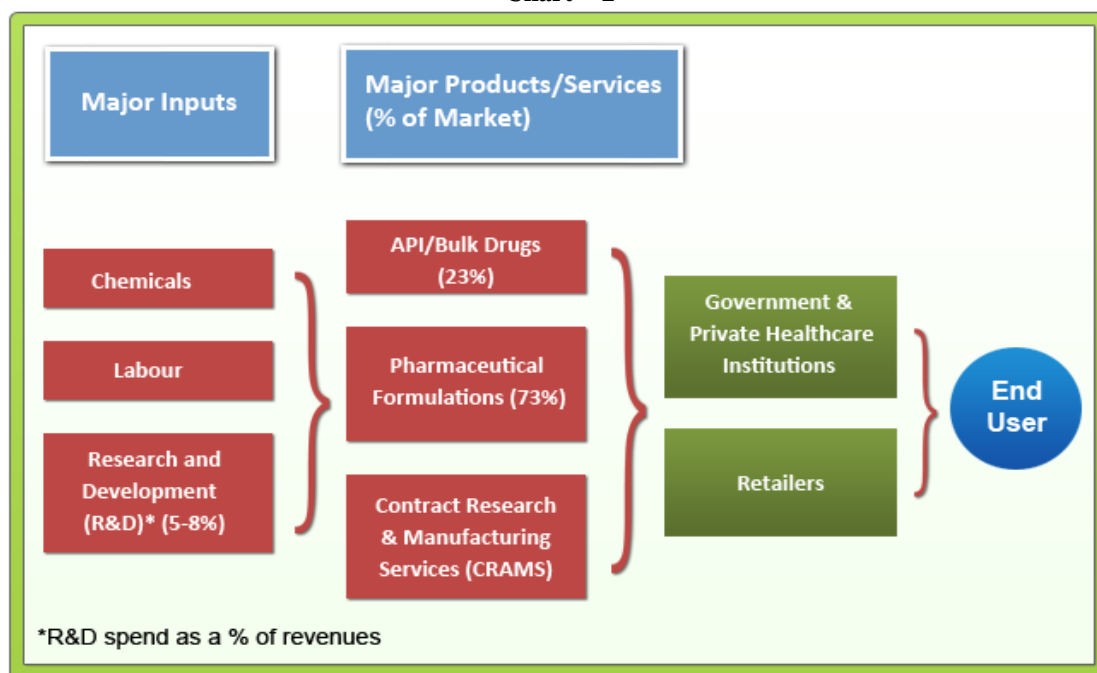
Chart - 1



D. Value chain analysis of the Pharma sector:

The working of the Pharma sector has been explained pictorially below:

Chart - 2



Inputs: The major inputs required for the Pharma sector are basic chemicals, labours and Research and Development (R&D). The sector is a research-driven industry with the focus being on discovering and launching new and innovative drugs. Companies spend millions of dollars/rupees on research and get the competitive advantage of patents if they are successful in launching drugs. In India, R&D costs as a % of revenues are around 5-8% on an average. This is very low compared to the companies in developed countries like US, UK etc. where the average R&D spend is close to 17-20% of the revenues.

Products/Services:

The Pharmaceutical products/services can be broadly divided into 4 segments

- **Active Pharmaceutical Ingredients (APIs)** – These are substances which are responsible for medicinal activity. For e.g. Paracetamol is an API which is present in drugs like Crocin, Anacin etc. and is responsible for relieving the pain. APIs (also called as bulk drugs) are the raw material for the final drug that we consume. Well known API manufacturers include Orchid Chemicals, Elder Pharma etc.
- **Formulations** – While APIs are responsible for the medicinal effect of a drug, we cannot directly consume an API due to different reasons like stability, taste, odour etc. Hence APIs are combined with certain substances called excipients to form the final drugs or formulations which are suitable for human consumption. Continuing the example given above, Crocin is a formulation. Companies like Sun Pharma, Cipla, Dr. Reddy’s etc. are examples of companies manufacturing formulations.
- **Contract Research and Manufacturing Services (CRAMS)** – Just like IT, major Pharma companies outsource their manufacturing work to low-cost centres like India to reduce cost while focusing on drug-discovery and marketing themselves. Further, they also outsource part of their research activities to some of the Indian pharma companies. Over the last few years CRAMS has emerged as a major focus area for many of the Indian Pharma companies. Examples include companies like Divi’s Labs, Jubilant Life Sciences etc.
- **Generics:** Generics are low-cost versions of branded drugs and have the same medicinal effect as the branded or original drug. Once the patent period for a drug expires, companies can come in with generic versions of a drug which provides affordable medicines for consumers. Indian companies have developed an expertise in reverse-engineering and developing generics.

Users: Pharmaceutical products reach the end users through different mechanisms. There have emerged 2 different types of markets globally:

Branded Markets: Countries like India, Brazil, Russia, Mexico, etc. are branded in nature. Consider the mechanism in India. In India, our doctor prescribes us the medicine for a particular disease. The prescription is usually a brand name of a drug for that disease. We also tend to purchase the exact brand prescribed by the doctor even if the chemist offers a different/generic version available at a low cost.

Unbranded Markets: Developed countries like US, UK and some European countries are known as unbranded markets. Here, instead of prescribing the brand, the doctors prescribe the molecule or API (with the dosage) for a particular disease. In these countries, a large percentage of the population (~95%) has medical insurance. Hence, the insurance companies decide which generic drugs will be covered by the insurance; understandably these will be the ones which are sold at the lowest costs. When consumers approach the chemist, they are given the drug as per the prescription and their insurer.

E. Industry trend: India's pharmaceutical market grew at 15.7% during December 2011, with growth in key therapy areas, including anti-diabetics, derma and vitamins outperforming the market. India has every chance to capitalize the opportunity to become a pharmaceutical superpower in 2020 and a hub for all pharmaceutical manufacturing and research needs

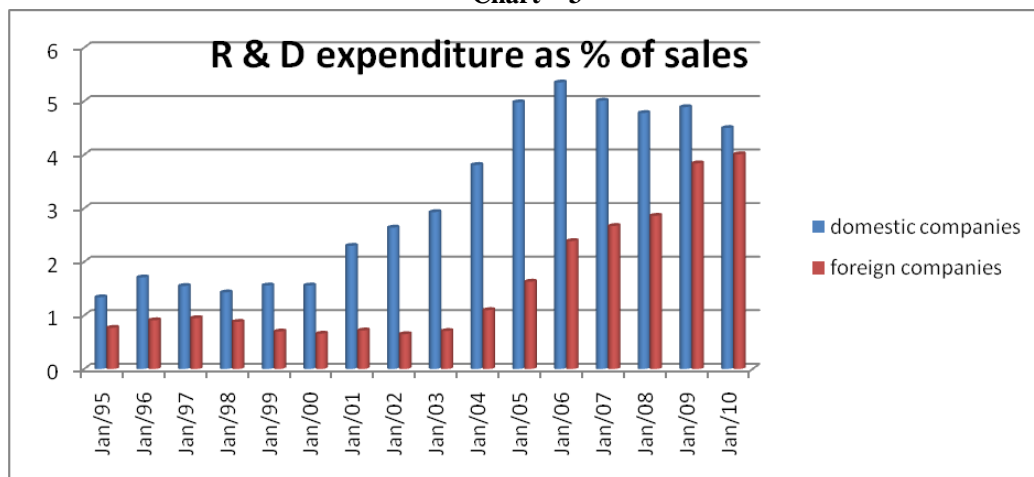
India's pharmaceutical sector is gaining a global leadership position and Indian generics today constitute nearly a fifth of global supplies. India also has a vast pool of trained pharmaceutical scientists, doctors and researchers, which opens up avenues for joint collaborative research for new drug discoveries along with joint intellectual property rights.

Notable trends in the Indian pharmaceutical sector:

1. Research and Development

- Indian pharma (Domestic) companies are spending more percent of their total turnover on R&D compared to foreign companies.
- Expenditure in R&D is likely to increased due to the introduction of product patents, companies need to develop new drugs.
- Outsourcing in the fields of R&D and manufacturing is the next best event in the pharmaceutical industry. Spiraling cost, expiring patents, low R&D cost and market dynamics are driving the MNCs to outsource both manufacturing and research activities.
- India with its apt chemistry skills and low cost advantages, both in research and manufacturing coupled with skilled manpower will attract a lot of business in the days to come.

Chart - 3



2. Clinical trial:

- Due to the cost advantage, India is increasingly becoming a hub for clinical trails. Clinical trails market is estimated to be worth US\$ 400 million in 2009.

3. Export revenue:

- The pharmaceutical export market in India is thriving due to strong presence in generic species.

4. Joint ventures:

- Several multinational companies are collaborating with Indian pharma firms to develop new drugs
- Pfizer partnered with Aurobindo Pharma to develop generic medicines

5. Product patents:

- The introduction of product patents in India in 2005 has boosted the discovery of new drugs.
- India has reiterated its commitment to IP protected following the introduction of product patents.

6. Geographical expansion:

- Expanding their presence in rural market(67% of the total population)

7. Acquisition by MNCs:

- Acquisition by MNCs to gain quick foothold in the fastest growing Indian pharma market.

F. Advantage India:

Cost efficiency:

- Low cost of production and R&D boosts efficiency of Indian pharma companies
- Comparative cost advantage enhances Indian pharma exports

Economic Drivers:

- Economic prosperity to improve affordability of drugs
- Increasing penetration of health insurance

Diversified Portfolio:

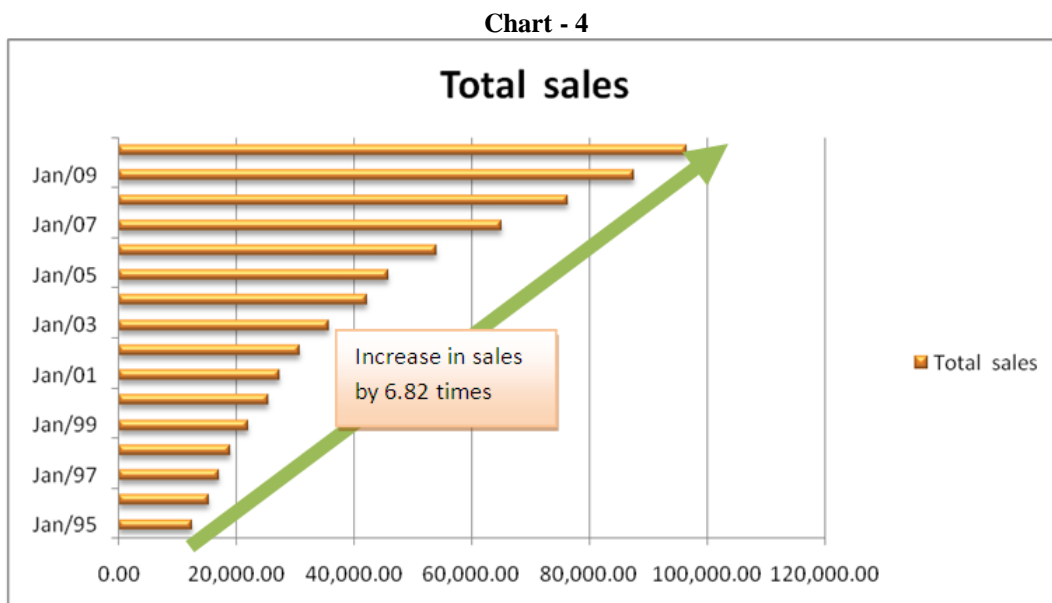
- Accounts for over 8 per cent of global pharmaceutical production
- Over 60,000 generic brands across 60 therapeutic categories
- Manufactures more than 500 different APIs

Policy support:

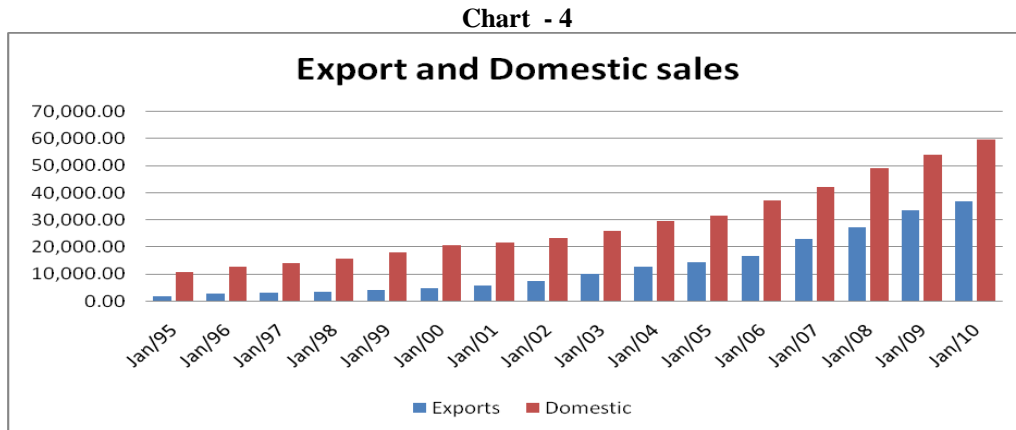
- Government unveiled ‘Pharma Vision 2020’ aimed at making India a global leader in end-to-end drug manufacture
- Reduced approval time for new facilities to boost investments

G. Growth in Pharma sector:

The following graph shows the growth in the sales of Pharma sector



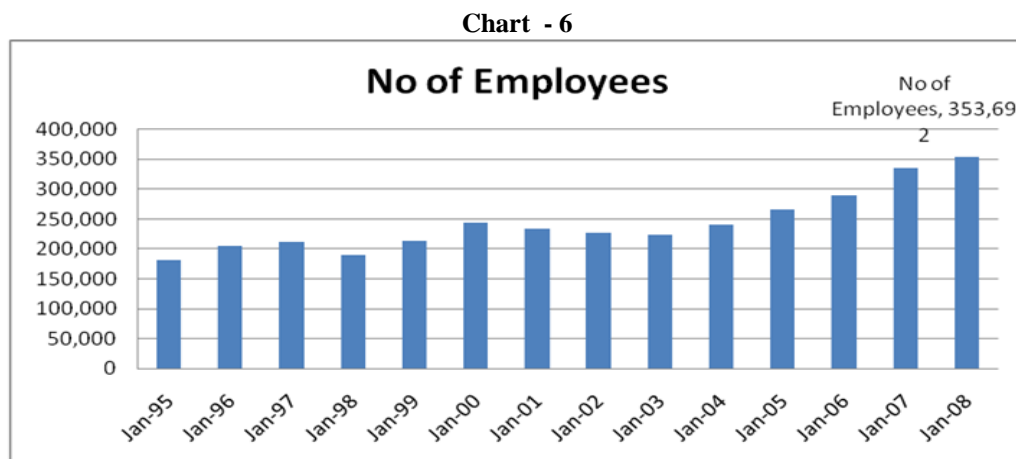
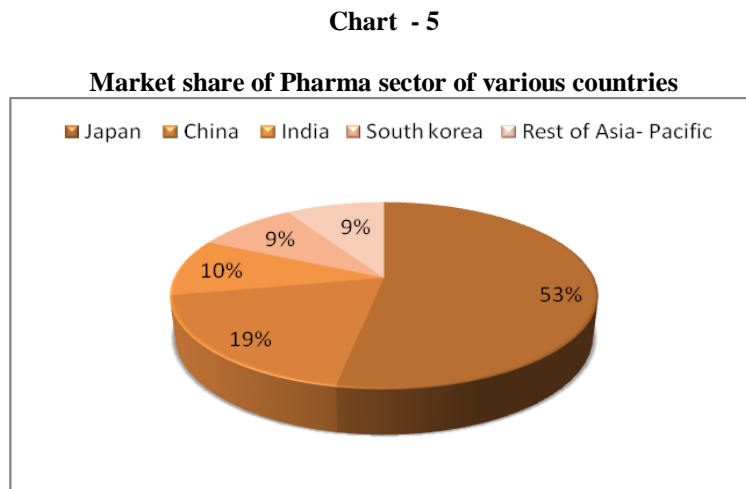
The following graph indicates the Exports and Domestic sales of Pharma sector



Alimentary drugs lead the market, India is third in Asia-Pacific

- Japan takes the first place in Asia-Pacific market with a market share of 53%,
- China stands in the second place with a market share of 19%.India with market share of 10% stands in third place.
- Alimentary drugs command the largest share (over 13 per cent) in the Indian pharma market.
- The cardiovascular segment represents 10 per cent of the market share; its contribution is likely to rise due to the growing number of cardiac cases in India.

The following diagram shows market share of different countries in Pharma sector globally:



H. Employment in pharma sector:

- The number of employees in pharma sector in 1995 was 1, 81,497.
- Employment rate has increased in every year.
- In 2008 employment rate has almost doubled.

I. Growth drivers:

Demand side drivers:

Accessibility

- Over USD200 billion to be spent on medical infrastructure in the next decade
- New business models expected to penetrate tier - 2 and tier - 3 cities.
- Over 160,000 hospital beds expected to be added each year in the next decade

Acceptability

- Rising levels of education to increase the acceptability of pharmaceuticals
- Patients to show greater propensity to self medicate, boosting the OTC market
- Acceptance of biologics and preventive medicines to rise
- Vaccine market could grow 20 per cent per year in the next decade

Affordability

- Rising income could drive 73 million households to the middle class over the next ten years
- Over 650 million people expected to be covered by health insurance by 2020
- Government-sponsored programmes expected to provide health benefits to over 380 million BPL people

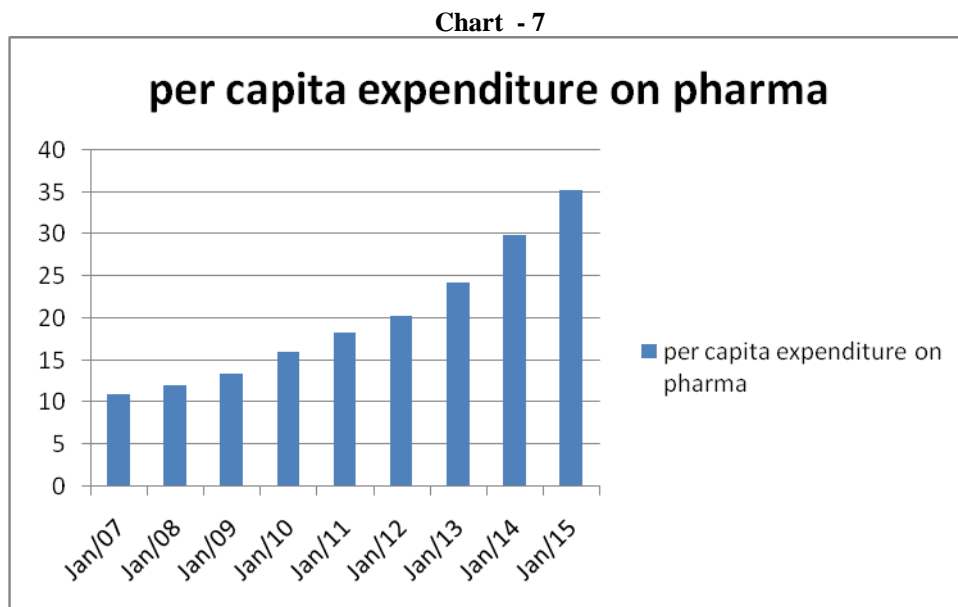
Epidemiological factors

- Patient pool expected to increase over 20 per cent in the next ten years mainly due to a rise in population
- Newer diseases and changes in lifestyle to boost demand

Anticipated growth in expenditure:

- From 28 per cent in 2007, expenditure on pharmaceuticals is likely to increase to over 40 per cent of the total spending on healthcare by households by 2015
- Growing per capita expenditure on pharmaceuticals in India offers ample opportunities for players in this market

The following graph indicates the increase in Per capita expenditure on Pharma



Supply side drivers:

Launch of patented drugs

- Following the introduction of product patents, several multinational companies are expected to launch patented drugs in India
- Growth in the number of lifestyle related diseases in India could boost the sale of drugs in this segment.

Scope in generics market

- Due to its cost advantage, India has emerged as a major producer of generic drugs with several companies focusing on this sector
- With an expected market size of USD35 billion in 2015 vis-à-vis USD15 billion currently, there is immense potential for growth in India's generic market.

Medical infrastructure

- Pharma companies have increased spending to tap rural markets and develop better medical infrastructure.

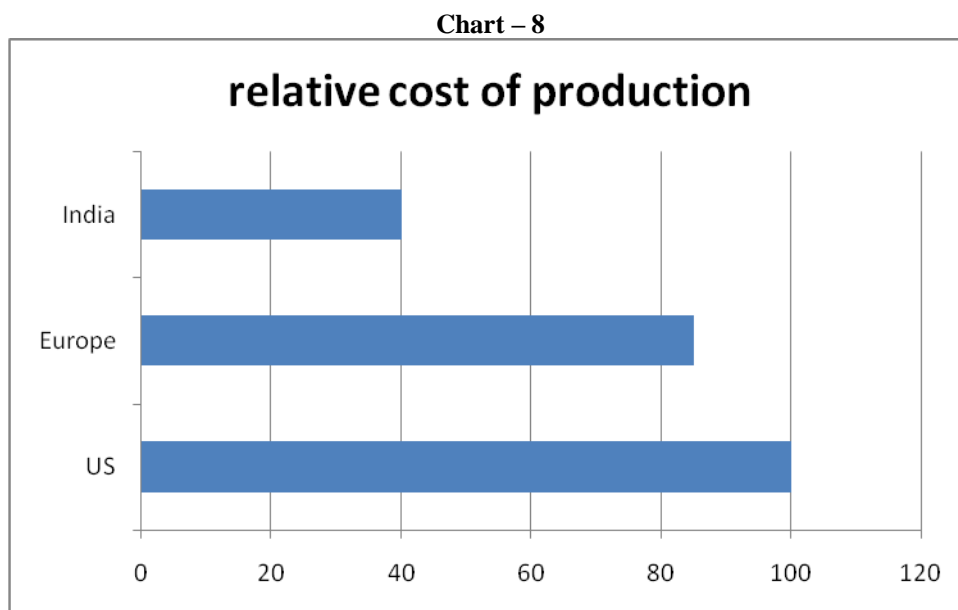
OTC drugs

- Increased penetration of chemists, especially in the rural parts of India would make OTC drugs easily available.

Competency and cost efficiency continue to be India's strength:

- India has over 120 USFDA-approved and 84 UK MHRA-approved manufacturing facilities.
- These facilities significantly support the companies involved in CRAMS.
- The manufacturing cost of Indian pharma companies is up to 65 per cent lower than that of US firms and almost half of that of European manufacturers.
- Cost efficiency continues to create opportunities for Indian companies in emerging markets and Africa.

The following graph relative cost of production of various countries in pharma sector



Policy support:

Reduction in approval time for new facilities

- Steps taken to reduce approval time for new facilities
- NOC for export license issued in two weeks compared to 12 weeks earlier

Collaborations

MOUs with USFDA, WHO, Health Canada, etc. to boost growth of the Indian Pharma sector by benefiting from their expertise

Support for technology upgrades and FDIs

- Zero duty for technology upgrades in the pharmaceutical sector through the Export Promotion Capital Goods (EPCG) Scheme
- The automatic route to facilitate 100 per cent foreign direct investment (FDI)

Industry infrastructure

- Government of India plans to set up a USD640 million VC fund to boost drug discovery and strengthen the pharma infrastructure

J. Factors affecting the pharmaceutical industry:

- Government Regulations- drug prices, FDA regulations, sales & marketing practices.
- Loss of Patent Protection- patent expiration, biogenerics, legal attack of patent validity, patent law reform, health crises. Patent expiration is no longer the only threat to patent protection.
- Industry Player Environment-outsourcing, M&A, spin-outs, future industry structure. A churning of pharma industry players will continue as both large and small companies fight for survival.
- New Product Development- R&D, poor quality drug candidates, slow production of novel drug discovery technology.
- Socio-economic Trends -- greater end-user involvement, threat of bioterrorism, epidemiology, DTC advertising & customer confidence, employment, stock market performance, worldwide market.
- Social and Demographic factors-As the population ages and the diseases increase, new medical needs emerge and the demand for effective medicines rises accordingly. In Russia, around 15% of the population and 40% in China are above the age of 60.

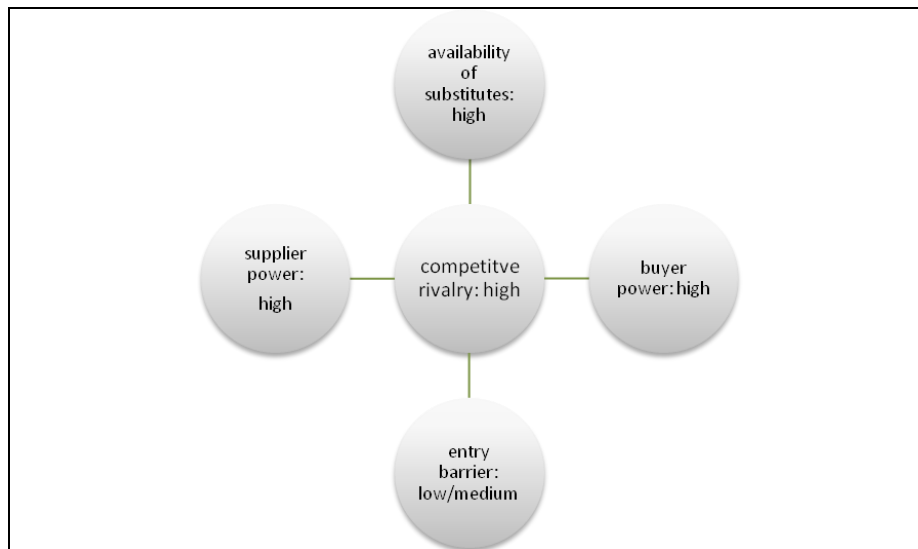
K. Porter’s five forces strategy:

Power of buyers :

Generic [low cost versions of the branded drugs] drugs offer cost effective alternatives to the innovator drugs and thus offer significant savings for buyers. First to market generics and biosimilars offer significant cost savings for insurance companies in the developed markets, branded markets/pharmacists cannot substitute between brands. Thus bargaining of buyers is **high**

Diagrammatic representation of **PORTER’S FIVE FORCES STRATEGY**

Figure - 3



Bargaining power of suppliers:

The bargaining power is high for API companies with difficult to manufacture products. These companies command premium prices. However, a majority of API suppliers have low bargaining power since they produce products which are simple to manufacture or commoditized. Thus, bargaining power of suppliers as a whole is

Medium.

Competitive Rivalry:

The growth opportunities for pharma companies are expected to grow manifold in the new few years with many drugs going off patent in US and developing countries like India coming into the focus. To make the most of the generic opportunities many innovator companies are trying to establish themselves by acquiring or striking joint venture deals with generic companies. Thus, apart from other generic players, Indian companies may also face competition from these big pharma companies who are backed by significant financial muscle. Thus, competitive rivalry is **HIGH**.

Availability of substitutes:

The threat of substitution is higher in unbranded markets where one generic can be substituted by another by the pharmacists. In branded markets and biosimilars, it is the doctor who can substitute one drug for another. Thus availability of substitutes is **HIGH**.

Entry barrier:

Entry barriers in the emerging markets are **high** due to its brand nature. Opportunities (through which generic manufactures can challenge patented products and get an opportunity to sell their products) can be highly lucrative. However the company requires extensive legal knowledge combined with the ability to develop the product earlier than competition, this is possible for only a few top companies.

Biosimilars which is emerging as the next growth driver requires clinical trails, extensive regulatory know-how, logistics network and branded presence, thus making it difficult for everyone to enter this segment.

L. Future outlook for pharma sector in India:

- Domestic Formulations which are expected to grow at ~15%
- Exports which will see huge growth due to the patent cliff in 2012 and emerging markets like Brazil, Mexico, South Africa driving growth
- CRAMS which is expected to grow at a rate of around 13% globally.

Indian companies have the largest number of US FDA (Food and Drug Administration) approved facilities outside US. They have made regulatory filings for around 70% of the drugs that are going off patent in 2012. Besides many companies have sizable US exposure in their overall revenue. The big pharma companies also seem to have acknowledged capability of Indian companies with many tie-ups, acquisitions and product specific deals happening over the last 2 years.

V. Hypothesis Of The Study

H1: There is a considerable improvement in the rate of return by minimizing the risk and maximizing the profit using Artificial Neural Networks in predicting the stock of price of pharma companies.

VI. Research Methodology

1. The study is based on only secondary data. Secondary data is from journals, various articles, books, metastock data vendor etc.
2. Data of Natco Pharma is taken from inception in trading to till date on a daily basis
3. The entire data sample is split between Training (70%), Testing (20%) and Holdout(10%) on a random basis
4. Relative error is observed for both the scale dependants
5. For those dependent variables where the Relative error is pretty less (<5%) across all the 3 groups, it is concluded that the model can be predicted to a large extent and vice versa

VII. Scope of the Study

The scope of the study is wide from a conceptual point of view because it covers major aspects of Applications of Neural Networks. However from an empirical point of view the scope of the study is narrow.

A. Limitations Of The Study

Error functions of Neural Networks are usually very complex; commonly they have many local minima, unlike the traditional methods. So each time the network is run with different weights and biases it arrives at a different solution. So some kind of averaging needs to be done.

B. Sources And Methods

No data collected here is Primary Data. All data applied under the research is secondary data.

Multi Layer Perceptron

Variables Considered

- Previous Close Price
- Previous Day Volume
- Previous Day Open Interest

Variables Forecasted – Dependent variables

- Current Day Price

VIII. Analysis Of The Study

A. Swot Analysis Of Pharma Industry

Strengths:

- Low cost of production.
- Large pool of installed capacities
- Efficient technologies for large number of Generics.
- Large pool of skilled technical manpower.
- Increasing liberalization of government policies.

Opportunities:

- Aging of the world population
- Growing incomes.
- Growing attention for health.
- New diagnoses and new social diseases
- Spreading prophylactic approaches.
- Saturation point of market is far away.
- New therapy approaches
- New delivery systems.
- Spreading attitude for soft medication (OTC drugs).
- Spreading use of Generic Drugs.
- Globalization
- Easier international trading.
- New markets are opening.

Weakness:

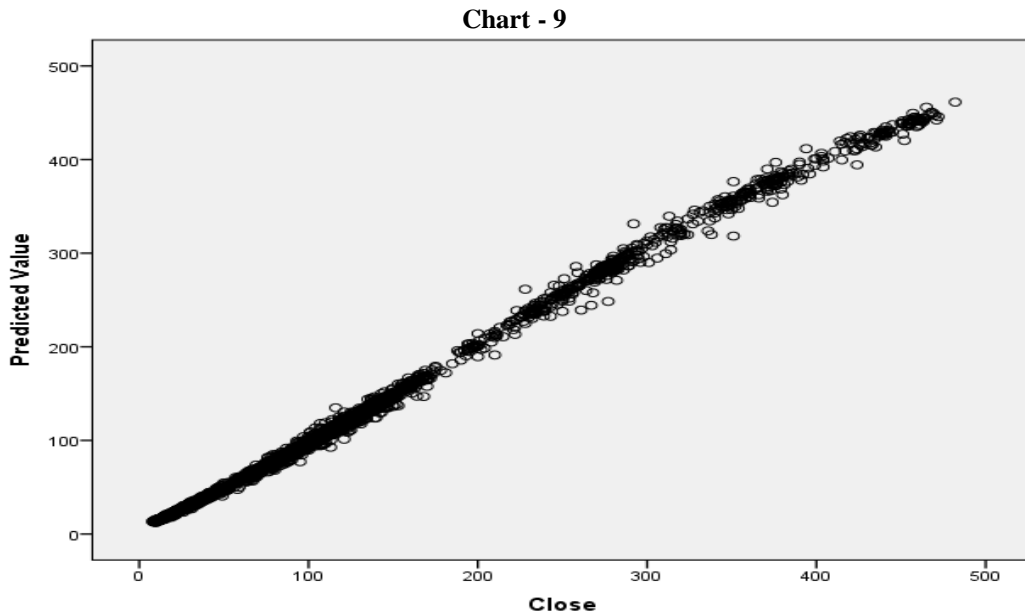
- Fragmentation of installed capacities.
- Low technology level of Capital Goods of this section
- Non-availability of major intermediaries for bulk drugs
- Lack of experience to exploit efficiently the new patent regime.
- Very low key R&D.
- Low share of India in World Pharmaceutical Production (1.2% of world production but having 16.1% of world's population).
- Very low level of Biotechnology in India and also for New Drug Discovery Systems.
- Lack of experience in International Trade
- Low level of strategic planning for future and also for technology forecasting.

Threats:

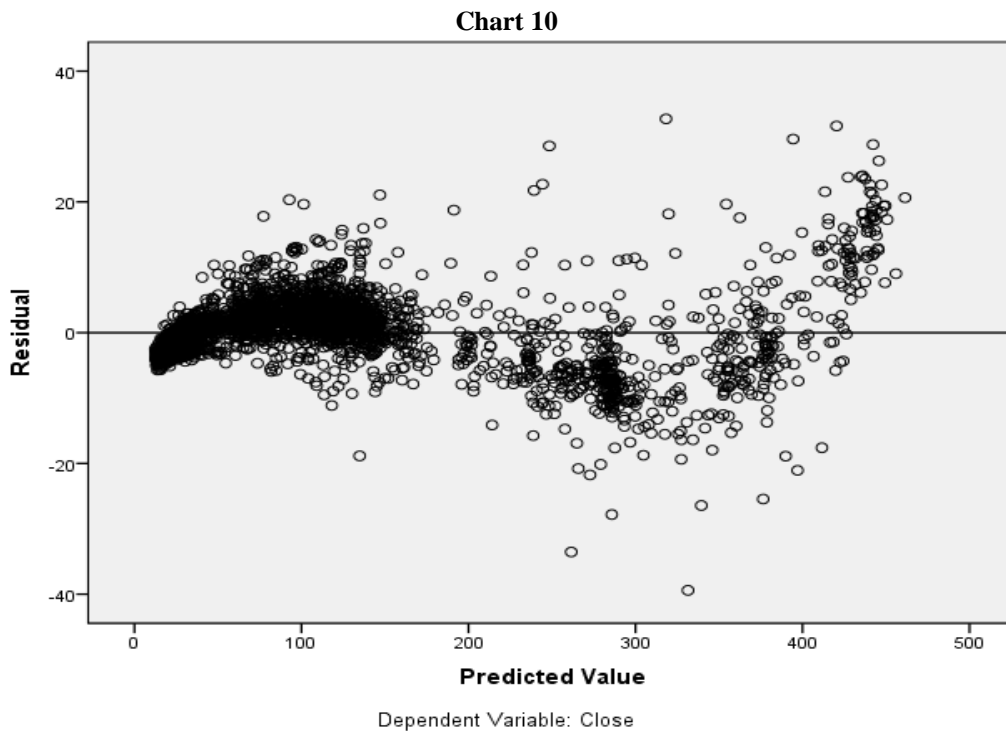
- Containment of rising health-care cost.
- High Cost of discovering new products and fewer discoveries
- Stricter registration procedures.
- High entry cost in newer markets.
- High cost of sales and marketing.
- Competition, particularly from generic products
- More potential new drugs and more efficient therapies.

B. Data analysis using spss

Predicted vs. Actual Plot

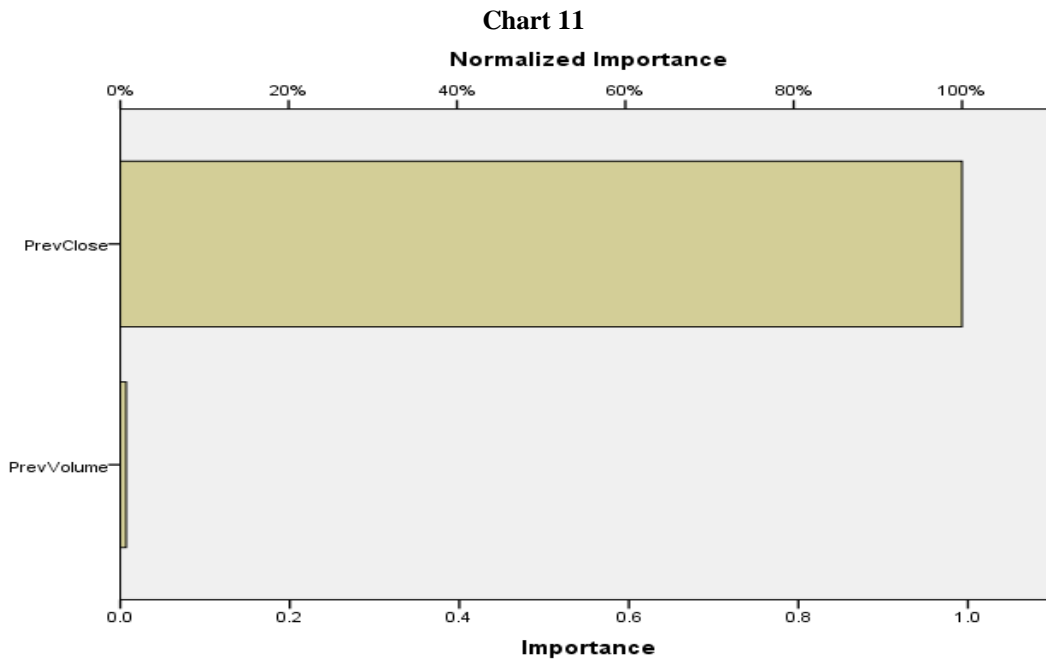


- The values lie along the 45 degree line which clearly indicate that the predicted values are on the lines of actual in most of the circumstances Residuals Plot



- From this chart it can be analyzed that on an average, the residuals are around 0 but the deviations are slightly more towards higher values. When the stock price was around 150 or below, the residuals were very close to zero but for stock price of 400+, the residuals are much higher and much scattered. Though the neural networks model is good enough for the forecasting of stock price, for high stock price, the deviations are quite higher

Normalized Importance of Variables



- This indicates that out of the three variables considered for the analysis, only the previous close price looks to be the most dominant factor determining the future closing price. Volume of transaction is having negligible importance in predicting the stock price

Testing out the consistency in Increase and Decrease between Predicted and Actual Values

Chi Square Test

Table - I

PredIncDec * ActualIncDec Crosstabulation				
Count				
		ActualIncDec		Total
		Decrease	Increase	
PredIncDec	Decrease	1541	1297	2838
	Increase	754	695	1449
Total		2295	1992	4287

Table - II

Chi-Square Tests					
	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.975 ^a	1	.160		
Continuity Correction ^b	1.885	1	.170		
Likelihood Ratio	1.974	1	.160		
Fisher's Exact Test				.164	.085
Linear-by-Linear Association	1.974	1	.160		
N of Valid Cases	4287				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 673.29.
b. Computed only for a 2x2 table

- The Significance level for both 1 tail as well as two tailed test identified by the Chi Square analysis lies to be greater than 0.05 which indicates that there is no evidence to conclude the difference between the distributions between the actual and predicted values. So it can be safely assumed that there is uniformity in the distribution of increases and decreases across the predicted and actual values.

Results

Table - III

Model Summary		
Training	Sum of Squares Error	3.609
	Relative Error	.002
	Stopping Rule Used	1 consecutive step(s) with no decrease in error ^a
	Training Time	0:00:00.06
Testing	Sum of Squares Error	.844
	Relative Error	.002
Holdout	Relative Error	.003
Dependent Variable: Close		
a. Error computations are based on the testing sample.		

C. Implications

The study provides insights for investors and traders to comprehend the concept of a commensurate rate of return they can secure by operating in the stock markets of pharma companies. The quality of prediction concept therefore holds relevance in the stock markets of pharma companies.

IX. Conclusions Of The Study

H1: There is a considerable improvement in the rate of return by minimizing the risk and maximizing the profit using Artificial Neural Networks in predicting the stock price of pharma companies ----- Accepted.

A. Findings And Suggestions:

- In case of Predicting the closing price, the relative error is less than 0.01 for all the three categories and hence closing price of the pharma companies can be forecasted using the Neural Networks comfortably.
- Each of the concepts discussed about Neural Networks in this paper are of research based and it can be further elaborated in separate studies, thus the discussions in this paper are preliminary and do address only the basic structures and further work that can be carried out.

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