PREDICTION OF FUTURES PRICES OF RUBBER

By

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THESIS

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Declaration

DECLERATION

I hereby declare that the thesis entitled ***PREDICTION OF FUTURES PRICES OF RUBBER*** *is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree diploma fellowship or other similar title of any other university or society*

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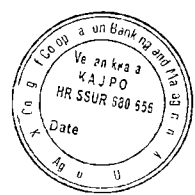

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CHAPTER 1

INTRODUCTION

The importance of the rubber industry ever since it first appeared and the decisive role that it has played in the development of modern civilization has attracted the attention of policy makers and researchers to make this industry a viable one Rubber is well known for its unique properties such as flexibility plasticity adhesiveness durability and resistance to electricity Also the rubber is a material that can keep away hold both air and water and can be made very soft and very tough and hard by special process Owing to these properties rubber was found to serve a number of quite different purposes at one and the same time It resulted in the fast development of a variety of rubber based industries all over the world

India and especially Kerala holds a prominent position among the rubber producing and consuming countries and as such this industry is assuming increasing significance Hence futures trading in rubber was also permitted by the Government of India though at a later stage with the objective of providing better prices to the farmers for their product Trading in rubber has become more transparent with the introduction of futures trade since futures trading involves the process of price discovery and price risk management The prediction of futures price gain importance over the fluctuating price conditions and the government policies The present study is an enquiry into the price movements of rubber and the techniques for predicting futures prices of rubber

1 1 Significance of the study

Futures prices of any commodity whether it is that of agricultural and mineral products precious metals or financial instruments help in price discovery The price discovery process can help determining the present price in the underlying cash market or the expected futures prices or both That is the price quoted in futures market can be used to predict the spot price prevailing at a future date and can also be used to predict the expected futures price Predictive power of futures prices is more recognized in commodity market than in financial markets as commodity markets in general are less volatile than stock markets

Although the share of primary commodities in global output and trade has declined over the past century fluctuations in commodity prices continue to affect global economic activity For many countries especially developing countries primary commodities remain an important source of export earnings and commodity price movements have a major impact on overall macroeconomic performance Hence commodity price forecasts are a key input to macroeconomic policy planning and formulation

Natural rubber is regarded as an important agricultural commodity vital for the manufacturing of a wide variety of products and new materials Hence increasing volume of rubber are being produced consumed and exported by the rubber producing and consuming countries all over the world India is the third largest producer and fourth largest consumer of natural rubber in the world Just like any other commodity price is a factor determining the volume of production and consumption of rubber A reliable price forecast is desirable from the point of view of both the buyers and sellers Therefore it is essential to have a potential tool for predicting rubber prices for producers and consumers Furthermore the prediction over time horizon will be beneficial for the Government and concerned agencies for making short and long term planning policies in this industry

Rubber futures are standardized exchange traded contracts in which the contract buyer agrees to take delivery from the seller a specific quantity of rubber at a predetermined price on a future delivery date Consumers and producers of rubber can manage rubber price risk by purchasing and selling rubber futures Rubber producers can employ a short hedge to lock in a selling price for the rubber they produce while businesses that consume rubber can utilize a long hedge to secure a purchase price for the commodity Rubber futures are also traded by speculators who assume the price risk that hedgers try to avoid in return for a chance to profit from favourable rubber price movements Price discovery in futures markets is commonly defined as the use of futures prices to determine expectations of (future) cash market prices (Schroeder & Goodwin 1991 Working 1948) According to Black (1976) the primary benefits from commodity futures markets are informed production storage and processing decisions Thus the price discovery performance of commodity

futures markets is vital to the use of these markets Given the economic importance of futures markets the efficiency of price discovery in these markets is of crucial interest If prices are not discovered in an efficient manner incorrect price signals will be communicated to producers and consumers This will result in either a shortage or surplus of output and a loss in economic welfare (Stein 1981)

Worldwide the automobile industry is the single largest consumer of natural rubber in the form of auto tyres and tubes and certain other parts and accessories Rubber is a significant commodity for Kerala economy and any price falls follows political ramifications in the State Price increases are also not received well by the tyre manufacturers and other consuming industries Moreover large number of small growers significant presence of growers cooperatives state administered procurement programmes inconsistent import and export policies and manufacturing facilities spread across the country are factors that has made rubber prices significantly volatile

Rubber prices in India have shown considerable volatility in the recent past especially since 1994 Futures trading in agricultural commodities was introduced to provide an efficient price discovery mechanism and to provide a hedging mechanism against the risk of price instability (Arshad and Mohamed 1994) Like any other agricultural commodity natural rubber is also subject to significant price fluctuations The volatility of the natural rubber prices is a significant risk to producers traders consumers and others involved in the production and marketing of natural rubber In situations of considerable uncertainty and high risk price forecasts are necessary to help in decision making Accurate price forecasts are particularly important to facilitate efficient decision making as there is considerable time lag between making output decisions and the actual output of the commodity in the market (Nasir and Fatimah 1991) Hence price forecasting mechanism is necessary for the market participants to guide them in their production consumption and financing decisions Furthermore hedging on futures is another effective risk management strategy available to reduce the associated risks that producers and traders are exposed to Industries with natural rubber as the raw material too would be able take advantage of rubber futures to manage the price risk in a better way It is expected that rubber futures could help the rubber cooperatives who has commitment to provide

remunerative prices to growers significantly because futures contracts will help them to decide the procurement price will help to design forward contracts to suit the needs of growers and also will help growers through price discovery Hence the present study on prediction of futures prices of rubber and the identification of a suitable technique for predicting futures prices of rubber is of contemporary significance to the rubber growers and other market participants of this industry as well as to Kerala which contributes nearly 90 per cent of the rubber production of India

1 2 Statement of the problem

Indian farmers are handicapped by many systematic inadequacies They have been vulnerable for long to price distortions due to the long supply chain in marketing their produce Lack of organized and formal marketing channels have resulted in lower price realisations making their investments non viable and unattractive in many commodity segments Moreover in the absence of a developed and accessible futures market the farmers direct exposure to wild price fluctuations in commodities markets often makes it too risky for them to invest in otherwise profitable farming activities

Price fluctuations are a matter of concern among consumers farmers and policy makers and its accurate forecast is extremely important for efficient monitoring and planning Several attempts have been made in the past to develop price forecast models for various commodities (Sharma et al 1992 Ghosh and Prajneshu 2003 Pavlista and Feuz 2005) Rubber prices fluctuate over seasons due to the variations in production and market arrival Thus modelling and forecasting the monthly price behaviour over the years is of much practical importance

The present problem under study is an attempt in this direction in as much as to analyse the movements in spot prices and futures prices of the open high low and close since the inception of futures trading in rubber to identify the fluctuations in its prices The change in volume traded of rubber futures over the years using monthly averages was also under observation Forecasting of futures prices of rubber using univariate and multivariate models and their comparative performance is also attempted

1 3 Objectives of the study

The objectives of the study are

i) to examine the price movements of rubber futures through National Multi Commodity Exchange of India Limited (NMCE)

ii) to predict the futures prices of rubber and

iii) to compare the forecasting performance of univariate and multivariate models

1 4 Utility, scope and limitations of the study

Instability of commodity prices has always been a major concern of the producers as well as the consumers in an agriculture dominated country like India Farmers direct exposure to price fluctuations for instance makes it too risky for them to invest in otherwise profitable activities There are various ways to cope with this problem Apart from increasing stability of the market by direct government intervention thwarting the market mechanism various actors in the farm sector can better manage their activities in an environment of unstable prices through derivative markets These markets serve a risk shifting function and can be used to lock in prices instead of relying on uncertain price developments Commodity derivatives have a crucial role to play in the price risk management process especially in agriculture dominated economy Rubber prices during a few decades before 1997 was remunerative owing to protection given by the government through market intervention and import restriction Remunerative price is essential to sustain the interest of farmers in a growing crop Price fluctuations of commodities according to market forces of demand and supply are common Uncertainty due to the agricultural commodity price fluctuations hampers the growth and is associated with increasing poverty and suicide among the farming community In this context the study of the prediction of futures prices of rubber will be useful for both the farming community as well as the traders because the futures trading is as to ensure a better price for their commodities The rubber dealers and exporters a so benefit from the futures trading because the supply of quality product at a pre determined price is assured The traders will be able to pass on the price risk to futures market thus enabling him to offer the

best price to the grower without resorting to grading abuses and discounted prices In view of the above expected benefits the need for prediction of futures prices of rubber has been considered desirable

The scope of the study is restricted to the rubber futures and spot prices from April 2003 to August 2008 from National Multi Commodity Exchange of India Limited (NMCE) because the trading volume in National Commodity and Derivatives Exchange (NCDEX) and Multi Commodity Exchange (MCX) is not sufficient for the prediction of futures prices as compared to NMCE A limitation of the study is that there was an unexpected ban of rubber futures for a period of four months from 7th May 2008 to 6h September 2008 which was extended upto 30h of November This ban might affect the prediction accuracy of futures prices of rubber to a certain extent For availing the benefits from futures trading the reluctance of farmers towards trading being a computer based online trading system will have to be removed by creating a sense of confidence in futures trading as a tool for price risk management

1 5 Organisation of the thesis

The report of the study has been spread out under five chapters The first chapter deals with the significance of the study statement of the problem objectives of the study utility scope and the limitations The second chapter on review of literature provides the theoretical orientation about the study The third chapter gives a description about the methodology adopted in the process of investigation The fourth chapter is earmarked for the results and discussion of the study The last chapter highlights the summary of findings and the conclusion followed by references and abstract of the thesis

Review of Literature

CHAPTER 2

REVIEW OF LITERATURE

A literature review can be just a simple summary of the sources of literature but it usually has an organizational pattern and combines both summary and synthesis A summary is a recap of the important information of the source but a synthesis is a re organization or a reshuffling of that information It might give a new interpretation of old material or combine new with old interpretations or it might trace the intellectual progression of the field including major debates And depending on the situation the literature review might evaluate the sources and advise the reader on the most pertinent or relevant According to Cooper (1988) a literature review uses as its database reports of primary or original scholarship and does not report new primary scholarship itself The primary reports used in the literature may be verbal but in the vast majority of cases reports are written documents The types of scholarship may be empirical theoretical critical/analytic or methodological in nature Second a literature review seeks to describe summarize evaluate clarify and/or integrate the content of primary reports

The ultimate goal of literature review is to bring the reader uptodate with current literature on a topic and forms the basis for another goal such as the justification for future research in the area A good literature review is characterized by a logical flow of ideas current and relevant references with consistent appropriate referenc ng style proper use of terminology and an unbiased and comprehensive view of the previous research on the topic With these goals and observations in mind a review of the available literature covering the various aspects of the study is presented in this chapter under four sub headings viz

2 1 Futures trading in commodities

2 2 Price behaviour of commodities

2 3 Price behaviour of rubber

2 4 Prediction or forecasting models

2 1 Futures trading in commodities

The history of futures trading in commodities in India dates back to the later part of the nineteenth century when the first commodity exchange viz The Bombay Cotton Trade Association Ltd was set up for organizing futures trading Futures contracts provide the investors called hedgers a measure of protection from price volatility in the open market The abstract of the various studies related to commodity futures trading is discussed in this section

Cramer *et al* (1999) found that an efficient futures market could be used as a risk management tool for the rice market The study examined the market efficiency of the United States rough rice futures market using the Dickey Fuller test for data stationarity standard regression models Johansen s cointegration test and an additive Autoregressive Integrated Moving Average (ARIMA) model Stationarity tests indicated that the price series for both cash and futures tend to be non stationary during the growing season April to August but are stationary during the remaining part of the year or the storage season Initial results indicated that the long grain rough rice futures market was efficient in the state of Arkansas of USA Hence market participants can use futures market in conjunction with other management tools to manage price risk

According to Jain (1999) moving from today s still heavy dependence on public management schemes of essential commodities to tomorrow s system of commodity futures and forward trading is likely to be a long and painful process The move towards a more open and transparent system of commodity futures and forward trading implies greater scrutiny and the need for more resources to coordinate many diverse interests In return it offers the promise of greater accountability reliability and cost effectiveness

Brorsen and Fofana (2001) examined the effects of several factors on the success or failure of agricultural futures contracts Commodities with futures markets and without futures markets were included Characteristics for which no data existed such as homogeneity vertical integration buyer concentration and activeness of the cash market were measured by the Delphi approach An active cash market was

found to be necessary for the success of the futures contract since this variable alone perfectly predicts whether or not a commodity has a futures market

Bryant and Haigh (2001) applied various bid ask spread estimators to transaction data of cocoa and coffee futures markets of London International Financial Futures and Options Exchange (LIFFE) and the resulting estimates were compared to observe actual bid ask spreads Results indicated that actual bid ask spreads which are not reported by most open outcry futures markets can be reasonably estimated using readily available transaction data This is especially important since some research studies have indicated that efforts to estimate effective spreads using data commonly available from futures markets have not been successful Estimates of actual spreads can give market participants and researchers some idea of potential transaction costs Accurate estimates of bid ask spreads will also be needed to assess the relative efficiency of electronic versus open outcry trading Results indicated that estimators using averages of absolute price changes perform significantly better at estimating actual bid ask spreads in futures markets than estimators using the covariance of successive price changes

Williams (2001) opined that organized exchanges have evolved methods for enforcing contracts which allow the contracts themselves to be traded at low cost The study revealed that Theorists have modeled futures contracts as tools for risk management despite an extensive empirical literature that does not support predictions about bias in prices or speculators behaviour Another perspective models commercial firms as using futures contracts to arbitrage to minimize transaction costs and to substitute temporarily for merchandising contracts Because commercial firms tie their processing and storage decisions to the constellation of futures prices futures prices have major allocative effects even if their forecasting power is inevitably poor

Morgan *et al* (2002) looked into four commodities cocoa coffee sugar and wheat and analyzed the efficiency of associated futures markets in terms of price discovery and risk reduction In essence all four markets exhibited efficiency and therefore provide in theory a viable policy alternative for developing economies

Schouchana and Perobelli (2003) opined that exporters of agricultural products take two risks – one linked to the exchange rate and the other related to the variation in commodity prices To protect themselves from these risks exporters can guarantee their returns with futures contract The authors discussed in detail how futures contact can protect the exporter against the volatility of the exchange rate between US dollar and Indian rupees

Garcia and Leuthold (2004) reviewed the research literature on agricultural commodity futures and options markets focusing primarily on empirical studies The topics featured include development of intertemporal price relationships hedging and basis relationships price behaviour and institutional issues related to futures markets Using this base of information as background future research directions were discussed with respect to risk management and marketing strategies price and volatility behaviour electronic trading price discovery and trading funds and exchange behaviour

Koekebakker and Lien (2004) revealed that agricultural futures price movements have fat tailed distributions and exhibited sudden and unexpected price jumps There was also evidence to prove that the volatility of futures prices is time dependent both as a function of calendar time (seasonal effect) and time to maturity (maturity effect)

Salhofer and Zoll (2004) opined that high volatility and limited predictability of prices as well as high degree of specialization seemed to suggest commodity futures as a useful tool to cope with price risk in the pig market In an ex post analysis for Germany between 1999 and 2003 the study compared revenues at the spot market with those from hedging at the Commodity Exchange Hannover The estimated benefits from hedging were relatively small

A study conducted by Pavaskar (2005) enquired about the differences between the commodity and stock exchanges the liquidity problem of commodity exchanges and the need to restructure the Forward Markets Commission He pointed out that the recommendation of a Government Task Force to integrate the securities and

commodity futures markets in India if implemented will spell disaster to commodity futures trading in the country

Ranjan (2005) in his study delineated the various aspects of futures trading in a single commodity namely refined soyabean oil or soy oil and tested whether any relation exists between spot prices and futures prices of a commodity and whether futures trading leads to price stabilization of an agricultural commodity It also traced the problems of Indian commodity exchanges with respect to non transparency of prices and product standardization It further attempted to find the supply response of futures prices in selected crops on technology adoption yield augmentation crop diversification and income gains The nature and volume of the commodity trading pattern in India was also assessed Data for the study were collected from secondary sources Considering the very small number of commodity markets covered by commodity futures in India it was recommended that the Government of India should take steps to improve the business potential for commodity derivatives exchanges by permitting derivatives on more commodities and liberalising policies He also suggested that the depth of the Indian commodity markets need to be broadened by permitting participation of banks mutual funds and primary dealers

Wang and Ke (2005) in their study enquired about the efficiency of the Chinese wheat and soyabean futures markets Formal statistical tests were conducted based on Johansen s cointegration approach for three different cash markets and six different futures forecasting horizons ranging from one week to four months Weekly futures price data for wheat and soyabeans for the period January 1998 to March 2002 were provided by the China Zhengzhou Commodity Exchange (CZCE) and the Dalian Commodity Exchange (DCE) while cash prices were obtained from the CnGrain online database The results suggested a long term equilibrium relationship between the futures price and cash price for soyabeans and weak short term efficiency in the soyabean futures market The futures market for wheat was found to be inefficient which might be caused by overspeculation and government intervention

Ravikumar (2006) argued that since the 2000s commodity markets have seen a secular bull run Commodities are emerging as an asset class with returns from commodities being better than returns from the stock markets or from the bond

Rejnus (2006) discussed the importance of commodity exchange trading while placing special emphasis on the increasingly close interconnection between commodity markets and financial markets The paper proved that commodity markets cannot be seen as strictly separate from markets trading in financial instruments as there are increasingly close links between the two which effectively lead to the transfer of financial resources invested in the financial market into the real economy The paper analysed the most significant ties that already exist between commodities and financial investment instruments in the financial and capital markets as well as the links that are very likely to come into existence in the near future The paper was concluded summarizing the reasons that will necessarily lead to a further world wide development of commodity exchange trading and a prediction of the lines along which this development is likely to take place

Chandwani (2007) intended to document the usefulness of agricultural futures trading in jeera and channa (Unjha and Delhi) to farmers The study employed both questionnaire based as well as secondary research The questionnaire contained questions on socio economic characteristics trading and marketing aspects margins price discovery modes etc The author demonstrated that a developed commodity market is of utmost importance for an agrarian economy like India They provide the necessary platform for this population to benefit to the fullest

Kabra (2007) opined that the turnover of the Indian commodity futures market has grown exponentially in a short span of time With skewed market participation that largely favours speculators the futures market leaves a lot to be desired as an effective instrument of risk management and price discovery for the benefit of the growers traders processors and other stakeholders in the physical trade It is argued that policymakers have overlooked wider considerations involving the discipline of checks and balances Owing to the massive size and non zero sum game character of these markets they are likely to introduce a series of unsettling macroeconomic effects such as a possible redistribution of incomes from the small players to the big speculative financial market entities The article concluded with a reference to the factors that could have been behind the snags afflicting the present commodity futures policy and suggested how the needs of the real economy could be satisfied by

strengthening the forward trade that was firmly anchored in the physical trade of the farm commodities under reference

Kumar (2007) enquired about the Government s decision of lifting the ban on futures trading of a number of agricultural commodities in February 2003 along with the setting up of nation wide demutualized multi commodity exchanges which has led to the unprecedented growth of futures trading in India The average daily volume of trade at major commodity exchanges viz MCX and NCDEX far exceeds that of securities traded at the Bombay Stock Exchange However there have been apprehensions about undue speculation in commodity futures trading failing the objective of price discovery and thereby accentuating inflationary pressures Co integration tests were carried out to test the efficiency of commodity futures markets and to see whether there is any relation between spot and futures prices The study concluded that futures markets are not efficient in the short run and even though the change in the spot price affects the futures price the effect of change was found to be minimal

Kumar (2007) investigated about the existing marketing channels of wheat in Uttar Pradesh the relationship between the futures and spot prices of wheat and also the futures price dissemination through different sources He employed statistical tools such as correlation standard deviation weighted average mean line graph and bar graph in his study He concluded the paper with the opinion that the farmers are at the mercy of adathiyas of Mandi futures and spot markets are highly correlated and the farmers are not accessible to different sources of futures price information In the light of his research he made some recommendations for the benefit of farmers like strengthening of warehouse receipt finance reforms in the marketing channel and involvement of private players for the efficient functioning of the futures market He also highlighted the importance of creating awareness about the benefits of commodity futures market among the farmers

Parikh (2007) examined different variables trading volumes basis price volatility and causality to enquire about the justifiability of banning the wheat futures Chana sugar pepper and urad were selected for the first three variables and sugar turmeric cotton soy oil and raw jute for the last one The paper also looked into

whether futures trade benefits farmers The main concerns of farmers and consumers were also reviewed In short the study concluded that the causality test is not strongly established Although it is shown that the direction of the influence is from futures to spots the extent to which the futures influence the spot markets seems to be statistically insignificant All the variables seemed to support the view that banning of futures trading was not justified

Ravikumar (2007) argued that commodity exchanges or the futures trade that takes place in them were not to be blamed for the inflation The rise in prices of agricultural commodities was the result of production shortfall and the exchanges merely reflect the reality There had been a shortfall in foodgrain production over last three years which is the main reason for the rise in prices of wheat and rice The prices of non exchange traded goods have also increased sharply

Sehgal and Singh (2007) in their study looked into the question of efficiency and price discovery for the agricultural commodities market They estimated market efficiency for agricultural markets and also enquired whether futures prices are based on cost of carry model and arbitrage conditions are possible between spot and futures market The authors also had the intention of analyzing the working of commodity markets in India The commodity market was established to overcome the inefficiencies of government interventions and wherein free interaction of demand and supply sets the prices It also looked into the pricing of commodity futures Future prices are introduced to reduce the overall price volatility of the spot market as future prices play an important role in price discovery

Sumalatha (2007) studied the structure of commodity markets in the globalization regime of India and examined the role of the commodity futures markets by taking some selected products and the existing price mechanisms in the economy The role of the futures markets in risk mitigation was also analyzed The major data sources were the reports of National Commodity and Derivatives Exchange Multi Commodity Exchange National Multi Commodity Exchange of India and the Reserve Bank of India

Most of the authors have enquired about the efficiency of the futures market price volatility associated with the futures market and the relationship between spot and futures prices The significance or the role of commodity futures market in agricultural commodities was also discussed by some of the authors Futures market is being considered as a risk management tool by many of the authors Some authors have opined that futures trading is not to be blamed for the increasing prices of agricultural commodities it is due to production shortfall and the inefficiencies of government interventions

2 2 Price behaviour of commodities

A study about prediction of futures prices of rubber would be incomplete without going through the available literature on price behaviour of commodities The reviews on price behaviour of all commodities other than rubber are presented in this section while that of rubber which is the commodity under study is presented in the next section as a separate one

Thompson *et al* (1990) examined the price impact of delivery specifications for sugar futures by comparing sugar price behaviour with that in cocoa futures contracts in the United States Their specific focus was on the seven weeks prior to contract expiration Futures contracts for sugar and cocoa exhibited numerous similarities except that cocoa contracts differed from sugar in delivery points Cocoa had three delivery points while sugar had none

Foster (1996) examined the behaviour of crude oil spot and futures markets in the UK and USA during the 1990–1991 Gulf conflict The objective was to investigate the relative ability of spot and futures markets to impound information This was achieved by means of a generalized model of price discovery Emphasis was placed on the time varying nature of price discovery relationsh ps Results indicated that such relationships are strongly temporal These findings offered new insights into the nature of relationships between spot and futures markets

Hennessy and Wahl (1996) stated that existing literature on commodity futures price volatility emphasizes time to expiration and the resolution of uncertainty The

focus here was on the supply and demand inflexibilities arising from decision making A decision made on the supply (demand) side makes future supply (demand) responses less elastic Therefore a shock arising after a decision made was more effective in changing the futures price than a shock before the decision was made The results supported the time to maturity hypothesis but did not conflict with the stated variable hypotheses of futures price volatility Evidence supported the impacts of inflexibilities as presented for US maize soyabean and wheat contracts

Baharumshah and Habibullah (1997) revealed that trade theory postulates the hypothesis that exchange rate changes are instantaneously passed on to domestic prices that is the law of one price (LOP) prevails This paper tested the validity of LOP using cointegration technique for Malaysian agricultural exports viz rubber palm oil and timber products Monthly data for the period January 1985 to December 199? were used to analyse the long run equilibrium relationship In general the empirical results were mixed In the case of plywood palm oil and sawn timber LOP generally holds prices in international markets tend to converge However rubber prices were not found to be as flexible as commonly thought

Tomek (1997) found that futures markets provide contemporaneous price quotations for a constellation of contracts with maturities of thirty or more months in the future and a large literature exist about interpreting these prices as forecasts Futures markets simultaneously determine a price level and price differences appropriate to contract temporal definitions The study concluded that futures prices can efficiently reflect a complex set of factors but still provide poor forecasts Forecasts based on quantitative models cannot however improve on efficient futures prices as forecasting agents empirical models provide a poor if not poorer forecasts

The study of Graveline and Boyl (1999) examined asymmetry in futures prices changes for various commodities using daily weekly and monthly data The data ranged from as far back as 1969 for maize and as recent as 1984 for oil with data continuing through to 1995 for each commodity Tests were used to determine whether or not prices move up in the same fashion as they move down over varying frequencies The results indicated that every commodity analysed showed atleast some degree of asymmetry

Stephen (1996) characterized the spot and futures price dynamics of two important physical commodities gasoline and heating oil Using a non linear error correction model with time varying volatility he demonstrated that the convergence of spot and futures prices is asymmetric non linear and volatility inducing Moreover spreads between spot and futures prices explain virtually all spot return volatility innovations for these two commodities and spot returns are more volatile when spot prices exceed futures prices than when the reverse is true Furthermore there are volatility spillovers from futures to spot markets (but not the reverse) futures volatility shocks are more persistent than spot volatility shocks and the convergence of spot and futures prices was asymmetric and non linear In particular since the theory of storage implies that spreads vary with fundamental supply and demand factors the strong relation between spreads and volatility suggests that these fundamentals — rather than trading induced noise — are the primary determinants of spot price volatility The volatility spillovers differences in volatility persistence and lead lag relations are consistent with the view that the futures market is the primary locus of informed trading in refined petroleum product markets Finally the finding that error correction processes may be non linear asymmetric and volatility inducing suggested that traditional approaches to the study of time series dynamics of variables that follow a common stochastic trend and ignore these complexities may be mis specified

Kumar (2000) concluded that price discovery is the process that throws out a figure at which one person will buy and another person will sell a futures contract for a specific expiration date Prices determined via these open and competitive processes are considered accurate reflections of the supply and demand of a commodity Futures contracts are standardized as to quantity quality and location Speculation is generally frowned upon by some societies But the presence of speculators is the sure sign of a healthy market

Labys *et al* (2000) examined the chronology frequency duration and amplitude of 21 primary commodity price series of export importance to developing countries over the period 1960 95 The findings provided evidence for the cyclical behaviour in the expansion contraction and overall phases for a number of commodities These findings which suggested the existence of shorter term cycles

than were previously recognised may be associated with the ability of the structural time series (STS) approach to improve the detrending process by the use of Kalman filter methods that incorporate a trend with both stochastic level and stochastic scope The results indicated the predominance of two types of cycles Over the total time span the first cycle usually showed a periodicity of less than one year This was confirmed for most of the commodities The second cycle showed a periodicity close to two years or more This was particularly evident for cocoa copper maize and tea though the amplitude of the cycles was low The shorter term cycles of less than a year reflected the speculative influences that commodity futures trading can have on spot markets The duration of the second cycles reflected some of the basic findings on the duration of short term macroeconomic cycles in the US economy

Booth and Ciner (2001) in their paper investigated alternative explanations of long term co movements among the prices of agricultural commodity futures contracts An analysis of Tokyo Grain Exchange future prices for maize redbean soyabean and sugar during the period from July 1993 to March 1998 supported the common economic fundamentals hypothesis It was concluded that a long term interdependency of these prices can exist because of common economic fundamentals or herd behaviour by market participants

Miffre (2001) studied the link between the predictable variation in futures returns and the business cycle Consistent with market efficiency the instruments predicted futures returns because of their ability to proxy for change in the business cycle While the pattern of predictability for metal stock index and interest rate futures was consistent with economic theories an anomaly in the pricing of agricultural commodity and currency futures was detected

Turvey (2001) in his paper investigated whether the assumption of Brownian motion often used to describe commodity price movements is satisfied Using historical data from 17 commodity futures contracts specific tests of fractional and ordinary Brownian motion were conducted The analyses were conducted under the null hypothesis of ordinary Brownian motion against the alternative of persistent or ergodic fractional Brownian motion Tests for fractional Brownian motion were based on a variance ratio test and compared with conventional rescaled adjusted range

analyses (R S analyses) However standard errors based on Monte Carlo simulations were quite high meaning that the acceptance region for the null hypothesis was large The results indicated that the null hypothesis of ordinary Brownian motion could not be rejected for most part i e 14 of 17 series The three series that did not satisfy the tests were rejected because they violated the stationarity property of the random walk hypothesis

Yoon and Brorsen (2001) opined that as opposed to a normal market an inverted market has a negative price of storage or spread Market inversions in nearby spreads rarely occur during early months of the crop year since stocks are usually abundant after harvest However market inversions frequently occur when the spreads are observed across crop years near the end of the crop year The regressions of spreads on the logarithm of US quarterly stocks showed that there exists a positive relationship between the spread and the level of stocks which further implies that when stocks are scarce markets will be inverted Simulations were conducted to determine whether a market inversion is a signal to sell the stocks The results of the paired difference tests revealed that as the crop cycle advances towards the end of the crop year market inversions clearly reflect the market s signal to release stocks in anticipation of new crop supplies The regressions of actual returns to storage on predicted returns to storage clearly showed that a market inversion is a signal to sell The results supported the behavioural finance hypothesis that producers are choosing to hold excess stocks because of some type of biased expectations

Chatrath *et al* (2002) conducted tests for the presence of low dimensional chaotic structure in the futures prices of four important agricultural commodities soyabean maize wheat and cotton in the USA from the late 1960s to the mid 1990s Though there was strong evidence of nonlinear dependence the evidence suggested that there was no long lasting chaotic structure The dimension estimated for the commodity futures series were generally much higher than would be for low dimension chaotic series Test results indicated that autoregressive conditional heteroskedasticity type processes with controls for seasonality and contract maturity effects explained much of the nonlinearity in the data It was made clear that employing seasonally adjusted price series was important in obtaining robust results via some of the existing tests for chaotic structure

Salhofer and Zoll (2004) opined that high volatility and limited predictability of prices as well as a high degree of specialization seem to suggest commodity futures as a useful tool to cope with price risk in the pig market In an ex post analysis for Germany between 1999 and 2003 this study compared revenues at the spot market with those from hedging at the Commodity Exchange Hannover The estimated benefits from hedging were relatively small

Mashamaite and Moholwa (2005) tested the existence of price asymmetry in South African futures markets for white and yellow maize wheat and sunflower seeds using a dynamic price asymmetry model The sum of coefficients test and the speed of adjustment test were used to determine whether or not prices move up in the same fashion as they move down over daily and weekly data frequencies Data ranged from 1996 (for white and yellow maize) 1997 (for wheat) and 1999 (for sunflower seeds) with data continuing through 2003 for each commodity Out of the four commodity futures markets studied over varying data frequencies only daily wheat was price asymmetric Wheat daily prices responded faster to price decreases than to price increases The implication of the results was that past prices do affect current prices and contain information Hence the weak form efficient market hypothesis appears to be contradicted for the wheat futures market Another important implication of the results was that implementing policies accounting for asymmetric behaviour through price limit and margin policies would improve the functioning and stability of the wheat futures market in South Africa

Bhar and Hamori (2006) examined the study of Booth and Ciner (2001) which stated that the prices of commodities (maize red beans soyabeans and sugar) traded at the Tokyo Grain Exchange (TGE) did not move together in the long run They analysed whether their empirical results remained true The empirical results suggested that the cointegrating relation exists among commodity future contracts from 2000 to 2003 but not during the 1990s This indicated that the price mechanism works better and the long run relationships among prices become more apparent as a market develops

Bowman and Husain (2006) in their study assessed the accuracy of alternative price forecasts for 15 primary commodities over the past decade Three types of

forecasts were considered (i) judgmental forecasts or those based on quantitative and qualitative analysis of a variety of factors including analysis of supply and demand fundamentals thought to determine the price of the commodity in question (ii) forecasts based on statistical models relying exclusively on historical price information and (iii) forecasts based on models that purport to systematically incorporate all available information as captured by commodity futures prices at the time of the forecast together with historical price data The analysis indicated that although judgmental forecasts tend to outperform the model based forecasts over short horizons of one quarter for several commodities models incorporating futures prices generally yield superior forecasts over horizons of one year or longer Spot and futures prices were generally found to be non stationary and in most cases spot and futures prices appeared to be cointegrated Although there was considerable co movement between spot and futures prices futures prices tend to exhibit less variability than spot prices Hence futures prices tend to act as an anchor for spot prices and error correction models that exploit the long run cointegrating relationship provide better forecasts of future – spot price developments

Mohan (2007) pointed out in his study that coffee is characterised by high levels of price fluctuation which exposes producers to price risk Its wide trading in international commodity futures markets offers scope for producers to manage the risk by hedging on these markets the mechanism which is based on the use of put options The author used historical London International Financial Futures and Options Exchange (LIFFE) and New York Board of Trade (NYBOT) data of actual coffee put options contracts to estimate the costs of the mechanism the benefits being inferred from field evidence It emerged that the costs were relatively low and outweighed by the benefits for most producers The article also enquired at the operational feasibility of the mechanism for producers and compared it with other hedging mechanisms

Ederington and Salas (2008) proved that in many markets changes in the spot prices are partially predictable They also showed that (i) although unbiased traditional regression estimates of the minimum variance hedge ratio are inefficient (ii) estimates of the riskiness of both hedged and unhedged positions are biased upward and (iii) estimates of the percentage risk reduction achievable through

hedging are biased downward For natural gas cross hedges they found that both inefficiency and bias are substantial They further found that incorporating the expected change in the spot price as measured by the futures spot price spread at the beginning of the hedge into the regression results in a substantial increase in the efficiency and reduction in the bias

Nath and Lingareddy (2008) in their study explored the effect of the introduction of futures trading in India on spot prices of pulses Price data were obtained from the wholesale price index series compiled and published by the Central Statistical Organization for the commodities under study covering the period from January 2001 to August 2007 while commodity wise futures volumes were collected from the web sites of the respective exchanges and the Forward Markets Commission It was shown that futures activity has a significant and direct causal influence on urad prices and volatilities whereas the same has not been statistically significant in the case of gram Nevertheless average price changes and volatilities have increased during the period of futures trading in the case of urad gram and total pulses

Most of the reviews discussed in this section related to agricultural commodities although pricing of other commodities have also been debated Some of the authors pointed out the significance of futures trading in determining the price mechanism of agricultural commodities Past prices do affect current prices and contain information Spot and futures prices were generally found to be non stationary and in most cases they were integrated Price mechanism works better and the long run relationship among prices become more apparent as a market develops

2 3 Price behaviour of rubber

Rubber one of the major cash crops of the country occupies a significant role in the commodities market At present India is the third largest producer of natural rubber in the world From the very beginning of rubber plantations Kerala possessed a dominant role in the production of natural rubber in India Futures trading in rubber has been initiated to bring in a better price discovery mechanism for the farmers and traders Hence price behaviour is an important part of the proposed study Observations of various authors regarding the price behaviour of rubber in the spot

and futures markets with reference to both the domestic and international markets are depicted in this section

Chen (1999) in his article pointed out that many major tyre manufacturers and their suppliers sign long term variable price contracts where the contract price is determined at a future date based on the future market price of rubber at the time of shipment The tyre manufacturers also buy rubber in the spot market from their suppliers By adopting these buying and selling patterns these contracted parties leave their selling and purchasing prices to the vagaries of the market

Damodaran (2000) opined that various players of the rubber industry suffer from volatile prices and declining margins They can hedge their positions and lock in prices The recent years have been seen the progressive irrelevance of bench mark prices on different types of natural rubber According to the author futures trading is the best bet under these circumstances

In his paper Naranpanawa (2000) looked at the factors (demand and supply forces) influencing long term rubber prices in the world market at a descriptive level Analysis of the possible behaviour of the variables which affect the demand and supply suggested that rubber prices would be unattractive in the short run but would start to pick up in the long run Sri Lanka being a small producer in the world market cannot influence the global rubber demand and supply and hence acts as a price taker Hence some drastic policy shift is inevitable in the commodity export industry to insulate it as well as to protect the country s economy from possible external commodity shocks

Nugawela (2002) in his paper explored the impact of low rubber prices and its resulting decrease in profitability on the cropping and cultivation practices of the Sri Lankan rubber industry The main factors identified for the poor performance of the rubber industry are the non adoption of technology developed by the Rubber Research Institute of Sri Lanka despite its accessibility and non or partial adoption of fertilizer use and soil conservation methods because of cost considerations Such poor cultivation practices lead to low production levels and rubber products of poor quality which will result in reduced rubber prices

Joseph and George (2002) studied the implications of WTO agreements on natural rubber in India and opined that classification of rubber as an industrial raw material was unjustifiable The study also revealed that natural rubber is a price sensitive crop that has to be closely monitored for any surge in imports from other countries consequent to the elimination of quantitative restrictions (QR) They advocated ban on the import of natural rubber under the Advance License Scheme (ALS) in order to protect the domestic interest of producers

Budiman (2003) discussed about the natural rubber prices prevailing in the year 2001 and the factors influencing prices of natural rubber In particular the effects of currency movements and supply/stocks on prices were discussed Thailand s price support scheme was also briefly examined According to him the fundamental factors influencing natural rubber prices are demand and supply while all other factors have indirect effects through changes in the fundamentals of demand and supply Changes in relative exchange rates could affect rubber prices directly or indirectly He suggested a market intervention scheme with the objective of supporting the prices received by rubber smallholders

George (2003) opined that the very small and marginal farmers can also reap the benefit of futures trading by participating through rubber marketing/producing societies which are in a position to take intelligent market positions based on scientific analysis of supply and demand These intermediaries large dealers and major consumers will eventually set up futures trading desks for price risk management Within the first month of trading itself there was evidence of this as marketing societies started trading in futures The major beneficiaries of futures trading would be the primary dealers as they can hedge the price risk associated with every ready market transaction by taking an opposite position in the futures market Actually it was the absence of such a hedging mechanism that forced the primary dealers to quote discounted rates to growers which were used mostly to cover the risk too

Peyman (2003) in his paper forecasted the price performance of rubber and the reasons why rubber prices are expected to increase worldwide It is predicted that

prices could well double within the next three to five years due to a major shortfall between supply and demand looms Underinvestment in new rubber over the last two decades by the main producers where in many places more rubber was pulled out of production than planted will finally be reflected in the price equation It was estimated that even at an assumption that demand grows at 2 5 per cent a year which is below its 20 year average of 3 0 per cent there would be a gap between supply and demand of 3 4 per cent by 2005 and of 8 7 per cent by 2010 Assuming that demand grows by 3 0 per cent annually the gap would increase even more to 7 0 per cent by 2005 and 20 per cent by 2010 In commodity markets where prices are made at the margin these are major gaps It is expected that higher rubber prices will be the result for at least a decade

Edirisinghe and Herath (2004) opined that prices play a key role in the profitability of an enterprise The study attempted to investigate the seasonality in the prices of rubber in different markets of the world The market prices of New York London Singapore Kuala Lumpur and Sri Lanka (Colombo) were studied Data for the period 1980 to 2002 were used and the seasonal indices were calculated using the decomposition technique in time series analysis Study of the seasonal indices revealed that there were considerable differences in the seasonality of prices in different markets The markets in the major consuming areas selected (New York and London) had differences in peaks and troughs achieved in a typical year While Kuala Lumpur and Singapore prices were above average in the first half of the year the Colombo price was above average in the middle and latter part of the year In depth analysis of Colombo market showed that crepe grades of rubber had higher variability than ribbed smoked sheets The authors also observed that the timing of supply (storage) and use of technologies (rain guards) to curtail interference by rain was prudent as it would increase yearly profits

Yogaratnam (2004) defined in his paper sustainable management of rubber as a system that combines policies technologies and activities to integrate socioeconomic principles with environmental concerns so as to simultaneously enhance production and productivity protect the potential of natural resources reduce the level of production risks and be economically viable socially acceptable and politically supportable

Mathew (2007) examined the relationship between spot and futures markets especially in relation to its impact on spot price behaviour and also in the context of international spot and futures markets The study had a detailed investigation of the natural rubber market with special focus on the context in which hedging was introduced and rationalised He also looked into the intricacies of grading as it relates to the demand from the tyre sector which consumes around 65 per cent of the natural rubber in the country The study hypothesized that futures market for natural rubber helped to reduce violent fluctuations in prices and thereby protected the interest of majority of the participants in the market

According to certain authors the increasing prices of rubber can be attributed to the widening gap between demand and supply of rubber Some have recommended for the introduction of hedging in the natural rubber market due to the high volatility of rubber Even the small and marginal farmers can reduce their price risk by participating in futures trading through rubber marketing/producing societies As reported by some of the authors futures market for natural rubber helps to reduce violent fluctuations in prices and thereby protect the interests of the majority of the participants in the market

2 4 Prediction or forecasting models

Prediction is a statement or claim that a particular event will occur in the future in more certain terms than a forecast With regard to predicting the future Howard has stated that Prediction is at least two things important and hard Important because one has to act and hard because one has to realize the future he/she wants and identify the best way to get there The various models commonly used for prediction purposes by different authors are being discussed in this section so as to identify appropriate models for prediction of futures prices of rubber

Cummins and Gary (1985) revealed that automobile insurance companies in the United States utilized simple exponential trend models to forecast paid claim costs an important variable in ratemaking They studied the performance of econometric and ARIMA models as well as the current insurance industry method in forecasting two paid claim cost series The experiments encompassed eight forecast periods ranging

from 1974 through early 1983 The results indicated that automobile insurers could significantly improve their forecasts of property damage liability claim costs by adopting econometric models For bodily injury liability claim costs the accuracy of the econometric and insurance industry methods was approximately the same and both outperformed the ARIMA models Overall a net gain in accuracy could be achieved by adopting econometric models

In the study of Meade (1985) the Autoregressive Autoregressive Moving Average (ARARMA) methodology of time series forecasting introduced by Parzen and compared well with longer established techniques such as Box and Jenkins ARIMA models to the results of a major forecasting competition The two main differences between these methodologies are the way data is transformed to stationarity and the interpretation of the concept of parsimonious models The additional benefits familiarity with the ARARMA approach is identified Following a description and demonstration of the ARARMA methodology a comparison of forecasting performance was made The comparison was carried out on sets of data for which published ARIMA models are available To ensure that the comparison was of genuine forecasting ability rather than fitting ability a portion of data was saved solely for forecasting performance measurement The results indicated that there were additional benefits to be gained from the ARARMA approach The benefits lie in the approach s tendency to avoid over differencing and in the diagnostic tools for identifying the stationary ARIMA model rather than in the different transformation to stationarity

Raftery (1985) in his study reviewed the current univariate and multivariate time series modelling procedures Areas of disagreement were discussed such as the choice of a forecasting method whether to use time series analysis or econometrics for economic data the merits of prior seasonal adjustment and the advisability of prewhitening in multivariate modelling Some recent developments in model identification estimation and model criticism were also described It was argued that too little attention is paid to allowing for departures from the model this has lead to a discussion of exploratory and robust techniques Finally it was pointed out that little has been done on modelling positive and discrete valued time series of importance in Operational Research (OR) such as lifetimes and counts

Epperson *et al* (1987) analysed how probability estimation incorporated within price prediction from a single equation will enhance the usefulness of forecast information and will have greater intuitive appeal The estimated probability is the probability that the price will cross some predetermined threshold of importance a trigger price This procedure is likely to be more useful in economic decision making than the application of prediction interval estimates since the latter approach does not convey threshold probability information Empirical application encompasses forecasting in the watermelon production industry to demonstrate the power and appeal of the approach All probability estimates were more precise than a 0 5 probability of occurrence

Virtanen and Yli (1987) discussed the stock market efficiency concept while forecasting future stock price behaviour In their literature a distinction was made between three potential levels of efficiency Under a weak form of efficiency information on historical price movements is of no value for predicting the future price development Similarly a semi strong form of efficiency holds that no publicly available information can be successfully used in the prediction of prices And finally a strong form of efficiency means that the share prices fully reflect all relevant information including data not yet publicly available Stock market efficiency has been extensively studied in different countries On a thin security market like in the Helsinki Stock Exchange many anomalies and deviations from market efficiency have been obtained It was shown in the paper that both the monthly and quarterly stock market prices (the general stock market index) could be adequately forecasted using either univariate time series analysis or multivariate econometric modelling The univariate ARIMA models seem to be slightly outperformed by the econometric models It is further shown that the forecasting accuracy of the models can be improved when time series and econometric forecasts are combined into a composite forecast The empirical results obtained indicate an absence of efficiency on the Finnish security market

Taylor (1988) pointed out that previous research into forecasts of market prices has shown that sophisticated forecasts are futile for many markets So he reviewed recent research and identified those markets for which non trivial forecasts

could lead to profitable decisions Particular attention was given to futures and options markets and to the application of non linear time series models

Chen and Bessler (1990) studied about the predictive performance of structural and vector autorregressive (VAR) models for forecasting monthly cotton prices Two distinct time periods were selected for testing one a period of major policy shock and second a period of more normal market conditions The study also investigated a composite approach using vector autoregressions to determine the future values of exogenous variables of the structural model Multi dimensional testing procedures were adopted to evaluate the accuracy of the forecasts Simulation results demonstrated the superior performance of the structural model in handling major policy changes while the time series approach showed greater accuracy in forecasting normal price movements Although the composite approach failed to show improvement in forecasting accuracy a joint specification of the structural model and the time series properties of exogenous variables may merit further investigation according to the authors

According to Granger (1992) in recent years a variety of models which apparently forecast changes in stock market prices have been introduced Some of these were summarized and interpreted by him Non linear models were particularly discussed with a switching regime from forecastable to non forecastable the switch depending on volatility levels relative earnings/price ratios size of the company and calendar effects The possible lessons of forecast were emphasised and the relevance of the Efficient Market Hypothesis was discussed

Bonnie (1993) examined a series of monthly International Business Machines Corporation s (IBM) product revenues to illustrate the usefulness of seasonal fractionally differenced Autoregressive moving average (ARMA) models for business forecasting By allowing two seasonal fractional differencing parameters in the model one at lag three and the other at lag twelve the author obtained a stationary series without losing information about the process behaviour through over differencing He also applied modified identification and estimation techniques to the IBM revenue data and compared the resulting model with a specific non fractional seasonal ARIMA model by looking at each model s forecasts The fractionally differenced seasonal model gave more accurate next quarter next half year next year and next

two years forecasts than the non fractional seasonal model based on criteria that are specifically constructed to reflect the accuracy of long range periodic forecasts

Gerlow *et al* (1993) opined that price forecasts are typically evaluated on the basis of statistical criteria such as mean error mean absolute error or root mean squared error An alternative approach for evaluating price forecasts is to analyze them using economic criteria Four types of economic criteria were applied to five quarterly hog price forecasting models over the period 1976 to 1985 In general model evaluations under the different economic criteria were consistent with one another However the economic evaluations were not consistent with those found using traditional statistical evaluation

Allen (1994) opined that forecasts of agricultural production and prices are intended to be useful to farmers governments and agribusiness industries Because of the special position of food production in a nations security governments have become both principal suppliers and main users of agricultural forecasts They need internal forecasts to execute policies that provide technical and market support for the agricultural sector Price forecasts are largely made by conventional econometric methods with time series approaches occupying minor roles His findings generally conformed to widely held beliefs For short term forecasting combining leads to more accurate forecasts better than those produced by vector autoregression which according to him is the best single method He also found that econometric models and univariate methods both do badly compared with naive models

AlEbrahiem (1996) analysed the time series of retail prices of eggs between January 1990 and December 1994 and constructed a model which could be used to forecast futures prices Two methods were used in this research the first constructed ARIMA models while the second used multiple regression technique to account for trend and seasonality followed by analysis of the components of the regression error Results indicated that the seasonally adjusted prices resulting from using the first method can be modelled as an ARIMA (0 1 0) while the residuals of the regression can be represented as an AR (1) process

Gil and Albisu (1996) studied about the uncertainty of future cereal prices between harvest periods which has increased considerably since the accession of

Spain to the EU Three forecasting tools were considered univariate time series model (ARIMA) VAR and expert forecasts The out–of sample forecasting accuracy of each procedure was evaluated The relationship between forecasting ability and variable exogeneity was studied showing that time series models are more accurate as the variable predicted is more endogenous Instead of selecting the best forecasting approach alternative ways of combining forecasts from these procedures were elaborated Results from individual and composite methods were compared Ridge regression composite methods outperformed all procedures This method became an optimal strategy to forecast Spanish cereal prices under the new EU market conditions

Silva and Silva (1996) studied the time series analysis of charcoal prices using both classical and Box and Jenkins methodologies with monthly observations covering the period 1980 92 from Minas Gerais Brazil In the classical analysis the additive and multiplicative models gave similar results The seasonal indexes of the multiplicative model did not differ statistically at the 5 per cent level of probability by the F test The small variation of the indexes and hence of prices occurred because companies store large amounts of charcoal during the rainy season Of the five auto correlative (Box & Jenkins) models studied the ARIMA model provided good estimates and forecasting of charcoal prices and gave a better performance than the classical model

Aal and Garni (1997) used Univariate Box Jenkins time series analysis for modeling and forecasting monthly domestic electric energy consumption in the Eastern Province of Saudi Arabia ARIMA models were developed using data for five years and evaluated on forecasting new data for the sixth year The optimum model derived was a multiplicative combination of seasonal and nonseasonal autoregressive parts each being of the first order following first differencing at both the seasonal and nonseasonal levels Compared to regression and abductive network machine learning models previously developed on the same data ARIMA models required less data had fewer coefficients and were more accurate The optimum ARIMA model forecasts of monthly data for the evaluation year was with an average percentage error of 3 8 per cent compared to 8 1 per cent and 5 6 per cent for the best multiple series regression and abductory induction mechanism (AIM) models respectively the

mean square forecasting error is reduced with the ARIMA model by factors of 3 2 and 1 6 respectively

Hamm and Brorsen (1997) compared neural network models to traditional forecasting methods in forecasting the quarterly and monthly US farm price of pigs A quarterly neural network model forecasted poorly in comparison to a quarterly econometric model A monthly neural network model outperformed a monthly ARIMA model with respect to the mean square error criterion and performed similarly to the ARIMA model with respect to turning point accuracy The more positive results of the monthly neural network model in comparison to the quarterly neural network model might be due to nonlinearities in the monthly data which were not in the quarterly data The regression model was used to forecast prices of the first nine months of 1995 Forecasted prices were very accurate since percentage deviation from real values did not exceed three per cent The study recommended for the construction of factories of dried eggs to utilize the excess supply of eggs in the April August period and the examination of the potential of export markets

Lindahl and Plantinga (1997) in their analysis of price series for stumpage in Maine for each available species and product group (sawlogs pulpwood) a test was done for stationarity and fitted ARIMA models to the data based on preliminary diagnostics In sample and out of ample price forecasts were then performed The central objective of this work was to characterize the processes for Maine stumpage prices in order to identify opportunities for using reservation price policies to increase timber and land values These results were of particular value to no industrial timber growers for use in scheduling harvests The price forecasts were also of interest to stumpage buyers and industrial timber growers though as with any forecasts they are subject to qualifications and must be interpreted carefully

Zucchi *et al* (1997) constructed The IMPLAT (milk pr ce market index) by means of the Laspeyres method to show the evolution of milk product prices A basket made up of the most significant Italian or imported milk products was used in its calculation Based on analysis of the historical monthly or weekly series of milk product prices on Italian as well as French and German markets for January 1993 to April 1996 two predictive models were constructed to indicate the short to medium

term price trend The first model involved polynomial and logarithmic functions and the second was based on ARIMA (Box Jenkins) methodology IMPLAT values were reported for the study period and their evolution was traced The estimated IMPLAT value for June September 1996 obtained using the predictive models was also shown

Bianchi *et al* (1998) in their study analysed the existing and improved methods for forecasting incoming calls to telemarketing centers for the purposes of planning and budgeting They studied the use of additive and multiplicative versions of Holt Winters (HW) exponentially weighted moving average models and compared it to Box–Jenkins (ARIMA) modeling with intervention analysis The study determined the forecasting accuracy of HW and ARIMA models for samples of telemarketing data Although there was much evidence in literature that simple models such as Holt Winters performed as well as or better than more complex models finally they found that ARIMA models with intervention analysis performed better for the time series studied

Jason (1998) in his research examined and analyzed the use of neural networks as a forecasting tool Specifically a neural network s ability to predict future trends of stock market indices was tested Accuracy was compared against a traditional forecasting method namely multiple linear regression analysis Finally the probability of the model s forecast being correct was calculated using conditional probabilities While only briefly discussing neural network theory this research determined the feasibility and practicality of using neural networks as a forecasting tool for the individual investor This study was built upon the work done by Edward Gately in his book Neural Networks for Financial Forecasting (1995) This research validated the work of Gately and described the development of a neural network that achieved a 93 3 per cent probability of predicting a market rise and an 88 07 per cent probability of predicting a market drop in the S&P 500 It was concluded that neural networks do have the capability to forecast financial markets and if properly trained the individual investor could benefit from the use of this forecasting tool

RunSheng (1999) conducted the timber price forecasts with univariate ARIMA models employing the standard Box Jenkins modelling strategy Using

quarterly price series from Timber Mart South results showed that most of the selected pine pulpwood and sawtimber markets in six southern US states could be evaluated using ARIMA models and that short term forecasts especially those of one lead forecasts were fairly accurate It was suggested that forecasting future prices could aid timber producers and consumers alike in timing harvests reducing uncertainty and enhancing efficiency

Strand (1999) opined that whatever be the specific definition the common denominator of any kind of forecast was a reference to the future This implied that all sources of uncertainty associated with describing present and past must also be associated with forecasting and also with the specification error inherent in the future dimension In particular this error should be associated with the distinction between causality and correlation i e the understanding of behaviour the necessary prerequisite for prediction Thus the key representational problem the gap between model and reality and the conditions for controlling that gap becomes particularly evident in forecasting This article was an attempt at clarifying some of the uncertainties most prevalent in forecasting as a means to show with what respect they must be treated The discussion related to forecasting in general but with some special references to air traffic

Khim *et al* (2000) in their paper took up time series modelling and forecasting of the Sarawak black pepper price The empirical results showed that Autoregressive Moving Average (ARMA) time series models fit the price series well and they correctly predicted the future trend of the price series within the sample period of study Amongst a group of 25 fitted models ARMA (1 0) model was selected based on post sample forecast criteria

Ahmad *et al* (2001) went through various models including linear regression employing different variables of interest in the past to predict the future market price of shelled eggs These models however could not account for most of the variations in market egg price notwithstanding timely and expensive data collection They adopted a new approach using neural networks a branch of artificial intelligence o forecast egg price The results indicated better fit lines and higher R square A general regression neural network proved more accurate than a back propagation

neural network The authors agreed that neural networks could offer a more efficient alternative to traditional forecasting and prediction techniques However reliable data collection and proper manipulation of such data remains the undergirding of any successful neural network model

A study conducted by Dhuyvetter *et al* (2001) estimated certain models based on futures markets that could be used to forecast crop input prices specifically diesel fuel natural gas and anhydrous ammonia Results suggested that diesel prices forecasted using the crude oil or heating oil futures market were reasonably accurate and that this approach might be superior to using an historical average While diesel prices could be effectively cross hedged with the crude oil or heating oil futures market the contracts represented relatively large quantities which might exceed individual producer s needs Hence cross hedging might be practical only for input suppliers Likewise producers using natural gas for irrigation could use the natural gas futures market to predict what their local cash prices would be Anhydrous ammonia prices could be predicted using natural gas prices however because of a major structural change that occurred in the nitrogen fertilizer industry during the mid 1990s these price forecasts were less reliable

Krishnankutty (2001) in his study predicted the future prices of teak (Tectona grandis) in three girth classes based on mid girth under bark and of logs in Kerala using the ARIMA models The data used for price forecasting was based on the average annual current prices of teak girth class 1 2 and 3 The price forecast in girth classes for the period from 1999 2000 to 2015 2016 were taken for the study

Mastny (2001) studied the ARIMA models also called Box and Jenkins models after their developers which was a group of models for the analysis of time series with various features The article demonstrated the possible usage of the Box Jenkins methodology for the analysis of time series for agricultural commodities The paper contains a basic mathematical explanation of ARIMA models together with a practical illustration of a price development forecast for a selected agricultural commodity

Saab *et al* (2001) forecasted electrical energy consumption in Lebanon since electric power is becoming the main energy form relied upon in all economic sectors of the country The time series of electrical energy consumption in Lebanon is also unique due to intermittent power outages and increasing demand Given these facts it was critical to model and forecast electrical energy consumption The aim of this study was to investigate different univariate modeling methodologies and try at least a one step ahead forecast for monthly electric energy consumption in Lebanon Three univariate models were used namely the autoregressive ARIMA and a novel configuration combining an AR (1) with a highpass filter The forecasting performance of each model was assessed using different measures The AR (1)/high pass filter model yielded the best forecast for this peculiar energy data

ChauKwong and HoKin (2002) provided a time series analysis of the prices of three species of cultured groupers namely the red grouper (Epinephelus akaara) green grouper (Epinephelus coioides) and yellow grouper (Epinephelus awoara) in Hong Kong China An ARIMA model was employed to evaluate monthly raw price data for the period from January 1988 to July 1992 Empirical results suggested that while the ARIMA model predicts surprisingly well for red and green groupers the price series of the yellow grouper was found to exhibit the property of random walk in its first differences

Kaboudan (2003) in his paper compared three forecasts of short term oil prices using two compumetric methods and naive random walk Compumetric methods used model specifications generated by computers with limited human intervention Users are responsible only for selecting the appropriate set of explanatory variables The compumetric methods employed were genetic programming and artificial neural networks The variable to forecast was monthly US imports free on board (FOB) oil prices Each method was used to forecast one and three months ahead The results suggested that neural networks deliver better predictions

Zhang (2003) pointed out that ARIMA is one of the popular linear models in time series forecasting during the past three decades Recent research activities in forecasting with Artificial Neural Networks (ANN) suggested that ANN could be a

promising alternative to the traditional linear methods ARIMA models and ANN are often compared with mixed conclusions in terms of the superiority in forecasting performance In this paper a hybrid methodology that combines both ARIMA and ANN models was proposed to take advantage of the unique strength of ARIMA and ANN models in linear and nonlinear modeling Experimental results with real data sets indicated that the combined model could be an effective way to improve forecasting accuracy achieved by either of the models used separately

Clements *et al* (2004) discussed the current state of the art in estimating evaluating and selecting among non linear forecasting models for economic and financial time series They reviewed theoretical and empirical issues including predictive density interval and point evaluation and model selection loss functions data mining and aggregation In addition they argued that although the evidence in favour of constructing forecasts using non linear models was rather sparse there was reason to be optimistic However much remains to be done Finally they outlined a variety of topics for future research and discussed a number of areas which have received considerable attention in the recent literature but where many questions remain

A study by Dimitrios *et al* (2004) examined the forecasting performance of a number of parametric and nonparametric models based on training validation sample approach and the use of rolling short term forecasts to compute root mean squared errors They found that the performance of these models was better than that of the naive no change model The use of bivariate models like VAR and transfer functions provide additional root mean squared error reductions In many cases the nonparametric models forecasted as well or better than the parametric models Their analysis suggested that nonparametric models are attractive complements to parametric univariate models and that simple VAR models should be considered before attempting to fit transfer function models

Timmermann and Clive (2004) suggested that the efficient market hypothesis gives rise to forecasting tests that mirror those adopted when testing the optimality of a forecast in the context of given information set However there are also important differences arising from the fact that market efficiency tests rely on establishing profitable trading opportunities in real time Forecasters constantly search for

predictable patterns that affect prices when they attempt to exploit trading opportunities Stable forecasting patterns are therefore unlikely to persist for long periods of time and will self destruct when discovered by a large number of investors This gives rise to non stationarities in the time series of financial returns and complicates both formal tests of market efficiency and the search for successful forecasting approaches

Yamin *et al* (2004) in their paper proposed a comprehensive model for short term electricity price forecasting using ANN in the restructured power markets The model consisted of price simulation price forecasting and performance analysis The factors impacting the electricity price forecasting including time factors load factors reserve factors and historical price factor were discussed They adopted ANN and proposed a new definition for the Minimum Absolute Percentage Error (MAPE) using median to study the relationship between these factors and the market price as well as the performance of the electricity price forecasting The reserve factors were included to enhance the performance of the forecasting process The proposed model handled the price spikes more efficiently due to considering the median instead of the average

Goodwin *et al* (2005) opined that commodity price forecasting procedure used routinely by the US Department of Agriculture in their policy and market analysis activities is a simple linear and reduced form regression model that predicts season average farm prices (SAFP) using policy variables and the ratio of total ending stocks to use This approach was extended to the soyabean SAFP to estimate a benchmark model using annual data spreading the period from 1942 to 2000 Several specification issues related to this estimation framework were addressed Evaluation suggested that the standard forecasting procedure might be affected by the fact that the ratio of stocks to use is endogenous to prices In addition important structural changes were revealed in these relationships over time A model was then considered that allows parameters to shift gradually Improvements in the accuracy of model forecasts allowed by this parameter switching technique were identified and discussed In addition the exact nature of the structural shifts was evaluated using dynamic impulse response functions

Yukutake *et al* (2005) conducted a time series analysis on thirteen monthly timber price data for sugi (Cryptomeria japonica) hinoki (Chamaecyparis obtusa) hemlock (Tsuga) and Douglas fir (Pseudotsuga menziesii) logs and lumber The timber price data were from the Japanese market as well as two private auction markets in Kyushu Japan They applied a multiplicative model for the analysis of timber prices and a seasonal ARIMA model for prediction In the first auction market their analyses showed that in recent years peaks of seasonal variation tend to occur in September October or later Seasonal fluctuations for lumber prices were observed more clearly than for log prices Price trend fluctuations for hinoki were larger than for sugi Cyclical fluctuations were observed for longer cycles of six to fifteen years as well as shorter cycles of about three years From the correlogram of residuals a four year cycle was observed for hemlock and Douglas fir in another market The authors predicted that the prices of sugi logs in the first market and hemlock lumber in the other market increased until March 2006 and May 2006 respectively while the other prices decreased

Koutroumanidis *et al* (2006) revealed that forecasting using historic time series data has become an important tool for fisheries management ARIMA modeling Modeling for Optimal Forecasting techniques and Decision Support Systems (DSS) based on fuzzy mathematics might be used to predict the general trend of a given fish landing time series with increased reliability and accuracy The authors applied these three modeling methods to forecast anchovy fish catches landed in a given port namely Thessaloniki Greece during 1979 to 2000 and hake and bonito total fish catches during 1982 2000 The paper attempted to assess the model s accuracy by comparing model results to the actual monthly fish catches of the year 2000 According to the measures of forecasting accuracy established the best forecasting performance for anchovy was shown by the DSS model The optimal forecasting technique of genetic modeling improved significantly the forecasting values obtained by the selected ARIMA model Similarly the DSS model showed a noteworthy forecasting efficiency for the prediction of hake landings during the year 2000 as compared to the other two modeling techniques Optimal forecasting produced by combined modeling scored better than application of the simple ARIMA model Overall DSS results showed that the Fuzzy Expected Intervals methodology could be used as a very reliable tool for short term predictions of fishery landings

Nwogugu (2006) in his article criticised models of market risk like ARMA Generalized autoregressive conditional heteroskedasticity (GARCH) Autoregressive conditional heteroskedasticity (ARCH) Expectancy violations theory (EVT) Vector autoregression(VAR) and Stochastic Volatility (SV) The existing metrics for quantifying risk such as standard deviation VAR GARCH EVT ARMA and SV are inaccurate and inadequate particularly in emerging markets and do not account for many facets of risk and decision making According to the authors they do not incorporate the many psychological legal liquidity knowledge and price dynamic factors inherent in markets and asset prices

Phukubje and Moholwa (2006) in their paper tested for weak form efficiency in the South African futures markets for wheat and sunflower seeds by examining the predictability of daily futures price changes over the period 2000 03 The results suggested that futures price changes for both wheat and sunflower seeds were partially predictable from past price information The implication was that past price information does contain additional information that could be used to forecast the future price once the current future price is known But when taking into account the brokerage costs and the time value of money out of sample predictive performance of the model indicated that trading decisions based on the direction of predicted futures price changes do not lead to profitable trades for either crop Hence the evidence suggested that there is no strong support for weak form inefficiency in South African futures markets for wheat and sunflower seeds The results further revealed that there is no trend in market efficiency over time for wheat and sunflower seeds except for the wheat December contract

Batchelor *et al* (2007) tested the performance of popular time series models in predicting spot and forward rates on major seaborne freight routes Shipping is a nonstorable service so the forward price was not tied to the spot by any arbitrage relationship The developing forward market was dominated by hedgers and it was an empirical question whether forward rates contain information about future spot rates They found that vector equilibrium correction (VECM) models give the best in sample fit but implausibly suggested that forward rates converge strongly on spot rates In out of sample forecasting all models easily outperform a random walk benchmark Forward rates do help to forecast spot rates and suggested some degree of

speculative efficiency However in predicting forward rates the VECM is unhelpful and ARIMA or VAR models forecast better The exercise illustrated the dangers of forecasting with equilibrium correction models when the underlying market structure was evolved and coefficient estimates conflict with sensible priors

Biswal and Badaskar (2007) in their study examined the role of commodity futures market in providing a price discovery mechanism The extent to which futures market perform this function could be measured from the temporal relation between futures and spot prices If information is reflected first in futures price and subsequently in spot price futures price should lead spot prices indicating that the futures market performs the price discovery function The price linkage between futures market and spot market was investigated using cointegration (Johansen) 1991) analysis which offers several advantages To examine the cointegration and error correction dynamics the authors used futures and spot indices of NCDEX and MCX

Dey (2007) argued that there is a strong need for a regression model and a dependence predictor for the Indian futures metal market because it is getting efficient day by day and a constant correlation is seen among Indian and worldwide prices A multiple regression model with independent variables like crude oil silver euro and US Dollar were used for predicting gold and the most leading base metal copper A general R squared elimination was followed and multicolinearity was reduced by removing correlated independent variables Upon regression the equation was stress tested for errors and residual errors The model showed a greater degree of fit i e R square of 0 9 and hence considered as a good model for gold price prediction

Granger and Jeon (2007) opined that looking ahead thirty years was a difficult task but was not impossible In this paper they illustrated how to evaluate such long term forecasts Long term forecasting is likely to be dominated by trend curves particularly the simple linear and exponential trends However there were certainly breaks in their parameter values at some unknown points so that eventually the forecasts were unsatisfactory They also investigated whether or not simple methods of long run forecasting can ever be successful after one takes into account the uncertainty level associated with the forecasts

Gupta and Bawa (2007) found that commodities have emerged as an investment class Before checking the volatility clustering some data on commodity and financial markets were examined for stationarity by applying Autocorrelation Augmented Dicky Fuller and Phillip Perron Unit Root tests The forecast was based on Adaptive Exponential Smoothing ARIMA and neural network models Policy measures were recommended for enhancing the involvement of investors in commodity markets

Hetamsaria and Maity (2007) examined the models for price movements of gold Of the total turnover of the commodity futures markets globally gold accounts for roughly 45 per cent Gold is a keenly traded commodity Investors shift away from the dollar denominated markets to gold whenever they expect the US economy to weaken Moreover investing in gold has always been found to be safe against geopolitical tensions as well as inflationary pressures The ARIMA model has been used for understanding past price movements and to forecast the future prices

Sehgal and Rajput (2007) examined the lead lag relationship between futures trading activity (volume and open interest) and cash price volatility and between cash price volatility and open interest for major agricultural commodities in India The study also examined the stabiliz ng and destabilizing effects of future trading volume in India in relation to selected agricultural commodities The data for the analysis consisted of daily cash closing prices daily futures settlement prices total futures trading volumes (TV) and total futures open interest (OI) for selected agricultural commodities such as wheat rice oilseed etc for the period mid 2002 to September 2007 Time series of spot market volatility as well as future market volatility and option market liquidity measures were tested for stationarity The spot market volatility was estimated using the GARCH model The association between spot market liquidity and future market volatility was tested using causality test based on which a predictive model was developed The study proved that the introduction of derivatives contract improved the liquidity and reduced informational asymmetries in the market

Silvey (2007) in his study presented a new explanation of why GARCH forecasts are often bettered by simpler naive forecasts based on linear filter methods

even when the in sample characteristics of the data are best explained by a GARCH model This was accomplished by deriving an analytical formula for the Mean Square Error (MSE) of these linear filter forecasts when the underlying model is GARCH and the proxy for volatility is the squared return The results were compared with the MSE of GARCH forecasts from a simulation experiment The results demonstrated that linear filter based forecasts could result in smaller MSE values than GARCH forecasts in some circumstances particularly in small sample sizes where estimated GARCH parameters were inaccurate Other proxies of volatility were considered and an additional simulation experiment demonstrated the predictive power of GARCH With these results in mind an empirical study of the UK stock market was undertaken The empirical results echoed the theoretical results derived in the study

Jatinder (2007) investigated the price forecasting performance hedging efficiency spot and futures price relation arbitrage opportunities with respect to mispricing of futures prices convenience yield and backwardation behaviour and temporal price relationships of futures contracts Price forecasting was based on the rational expectation hypothesis of futures prices assuming complete information and predicting spot market prices at maturity with precision The correlation of spot and futures prices variance comparison of spot prices and basis as well as more rigorous econometric methodology like GARCH was used to estimate hedging efficiency The pricing effects of agricultural futures markets were appraised for the short run seasonal and yearly time horizons The analysis related to volatility behavior spot and futures price spreads successive futures contract price spreads and maturity month price convergence had conclusions with significant policy implications

Yayar and Bal (2007) provided a method to predict corn oil price based on ARIMA methodology ARIMA models have been applied to forecast commodity prices These models are based on time series analysis and provided reliable and accurate forecasts This approach is suitable for short term price forecasting i e a week a month a quarter and a year In this study monthly corn oil prices from January 1994 to December 2005 were used Monthly corn oil price of 2006 2007 year were forecasted

Lam *et al* (2008) examined the degree of performance excellence that an enterprise can achieve which according to them greatly depends on the business process flow that the enterprise adopts The more efficient and effective the business process flow the greater the degree of performance excellence the enterprise can achieve Most conventional business process analysis focus on qualitative methodologies but these lack solid measurement for supporting the business process improvement Therefore a quantitative methodology using an activity model was proposed in this paper This model involves the use of an adjacent matrix to empirically identify inefficient and ineffective activity looping after which the business process flow can be improved With the proposed quantitative methodology a time series intervention ARIMA model was used to measure the intervention effects and the asymptotic change in the simulation results of the Business Process Reengineering (BPR) that is based on the activity model analysis The approach was illustrated by a case study of a purchasing process of a household appliance manufacturing enterprise that involved 20 purchasing activities The results indicated that the changes could be explicitly quantified and the effects of BPR measured

A study by Vahidinasab *et al* (2008) revealed that over the past 15 years most electricity supply companies around the world have been restructured from monopoly utilities to deregulated competitive electricity markets Market participants in the restructured electricity markets found short term electricity price forecasting (STPF) crucial in formulating their risk management strategies They need to know future electricity prices as their profitability depends on them The authors classified and compared different techniques of electricity price forecasting in the literature and selected ANN as a suitable method for price forecasting To perform this task market knowledge should be used to optimize the selection of input data for an electricity price forecasting tool Then sensitivity analysis was used in this research to aid in the selection of the optimum inputs of the ANN and fuzzy c mean (FCM) algorithm was used for daily load pattern clustering Finally ANN with a modified Levenberg Marquardt (LM) learning algorithm was implemented for forecasting prices in Pennsylvania New Jersey Maryland (PJM) market The forecasting results were compared with the previous works and showed that the results were reasonable and accurate

Khashei *et al* (2009) revealed that time series forecasting is an active research area that has drawn considerable attention for applications in a variety of areas ARIMA models are one of the most important time series models used in financial market forecasting over the past three decades Recent research activities in time series forecasting indicate that two basic limitations detract ARIMA models from their popularity for financial time series forecasting firstly ARIMA models assume that future values of a time series have a linear relationship with current and past values and hence approximations by ARIMA models may not be adequate for complex nonlinear problems and secondly ARIMA models require a large amount of historical data in order to produce accurate results Both theoretical and empirical findings have suggested that integration of different models could be an effective method of improving upon their predictive performance especially when the models in the ensemble are quite different In this paper ARIMA models were integrated with Artificial Neural Network (ANN) and Fuzzy logic in order to overcome the linear and data limitations of ARIMA models thus obtaining more accurate results Empirical results of financial markets forecasting indicated that the hybrid models exhibited effectively improved forecasting accuracy so that the model proposed could be used as an alternative to financial market forecasting tools

The review of prediction models have outlined the different tools used for forecasting in the commodity and financial markets and made it clear that there is no single model univariate or multivariate without limitations that can be applied in forecasting Some of the authors consider econometric methods superior to traditional methods of forecasting Certain others are of the view that forecasting accuracy will be better if time series and econometric methods are combined to a composite forecast Taking lessons from the earlier studies the econometric methods of Multiple Linear Regression (MLR) Principal Component Analysis (PCA) and ARIMA are used in this study for predicting the futures prices of rubber The results obtained from these univariate and multivariate methods are compared to find out the level of accuracy of prediction of these models The studies particularly related to the prediction of futures prices of rubber are very limited which justifies the commodity selected for the study

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

Futures contracts were originally developed as financial instruments for price discovery and risk transfer The essence of the price discovery function depends on whether new information is reflected first in futures market or cash market Both markets contribute to the discovery of a unique and common unobservable price that is the efficient price Price discovery and information flow across cash and futures markets is an area that has received good deal of attention from academicians regulators and practitioners alike This is due to the fact that the issue is inextricably bound up to key central notions in financial theory notable market efficiency and arbitrage In perfect efficient markets profitable arbitrage should not exist as price adjusts simultaneously and fully to incoming information Therefore new information disseminating into the market should be immediately reflected into the cash and futures prices by triggering trading activity in one or all of the markets simultaneously so that there should be no systematic lagged responses long enough to profitably exploit given the transaction costs involved The theoretical relationship between cash and futures prices can be explained by the cost of carry model According to this view futures prices depend on the cash prices of the asset from the present to the delivery date of the futures contracts The present study is an attempt in this direction in as much as to predict the futures prices from the historical prices of a commodity

The study entitled prediction of futures prices of rubber was conducted with the main objectives of examining the price movements of rubber futures through NMCE to predict the rubber futures prices and to compare the forecasting performance of univariate and multivariate models This chapter elucidates the methodology and data sources adopted in conducting this study

3 1 Sources of data

The study was based on secondary data Major sources of secondary information were the commodity exchanges of India and the publications of Rubber Board Futures prices of daily open low high close and spot and volume traded of rubber were collected for a period from April 2003 to August 2008 from National Multi Commodity Exchange (www nmce com) since NMCE is the only commodity exchange in India which has been continuously trading in rubber since April 2003 except during the ban period imposed by the Forward Market Commission (FMC)

Data regarding the global scenario of rubber was made available from the website (www rubbberstudy com) of International Rubber Study Group Singapore Data on rubber producing countries rubber consuming countries major importers and exporters of rubber were collected from the Rubber Statistical News published by Statistics and Planning Department Rubber Board Kottayam

3 2 Statistical tools used for the study

The price movements of rubber futures have been examined using ordinary line graph candlestick chart and Compound Annual Growth Rate (CAGR) To find out whether there is any significant difference between the CAGR of rubber prices and volume traded worked out for different periods ANOVA was employed Correlation has been found for studying the relation between crude oil prices and domestic prices of rubber Prediction of futures prices of rubber has been done using Multiple Linear Regression (MLR) Principal Component Analysis (PCA) and ARIMA after which their forecasting performance as multivariate and univariate models has been compared The various tools employed for the study form the contents of this section

3 2 1 Ordinary line graph

To examine the price movements of rubber futures through NMCE ordinary line graph was used Ordinary line graph is the simplest price chart The daily data on futures and spot prices of rubber were collected from the website of National Multi

Commodity Exchange of India As a contract starts on 16^{h} of a month and ends on 15th of the sixth month from 16^{h} to 15th of the next month was considered as one month The daily data were converted into monthly averages The prices and volume traded were plotted on the XY chart where X axis represent the time (month) and Y axis represents the prices and volume traded Thus the time prices and volume traded were represented graphically

3 2 2 Candle stick chart

Candlestick charts are the oldest type of charts used for prediction of price movements Candlestick charts were derived over 200 years ago by the Japanese who used them for the purpose of doing analysis of the rice markets The technique evolved over time into what is now the candlestick technique used in Japan and indeed by millions of technical traders around the world Candlestick charts are much more visually appealing than a standard two dimensional bar chart As in a standard bar chart there are four elements necessary to construct a candlestick chart the **open high low** and **close** prices for a given time period The major component of a candlestick is the body i e the part that forms the rectangular shape between the open and close points While traditional Japanese candlesticks use black and white bodies here green and red are used since colours better define the market direction and are visually more striking The candlestick charts of bullish and bearish trends are depicted in Fig 3 1 and 3 2 respectively

Fig 3 1 Candlestick with bullish trend

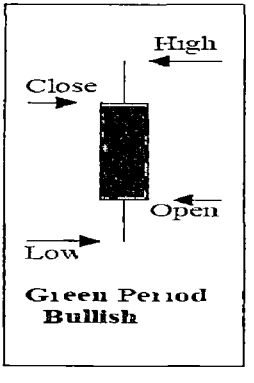
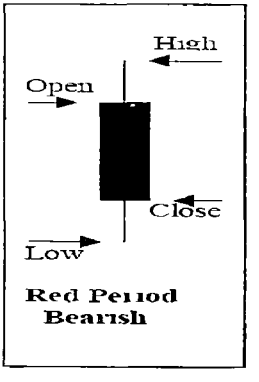


Fig 3 2 Candlestick with bearish trend



The body of the candlestick is called the *real body* and represents the range between the open and closing prices A green body means that the close is higher than the open and thus the price has increased over the period whereas in a red body the closing price is lower than the opening price and the value has decreased over the period The extension lines at the top and lower end of the candlestick bodies are called the shadows The pinnacle point on the upper shadow is the high price of the period while the lowest point on the lower shadow represents the low price of the period If there is no shadow on the upper end of the candlestick body it means that the close price (in the case of a green period) or the open price (in the case of a red period) equals the high price Conversely if there is no shadow at the lower end of the candlestick body it means that the open price (in the case of a green period) or the close price (in the case of a red period) equals the low price of the trading period

3 2 2 1 Common candlestick terminology

Many formations occur within the context of the candlesticks depicted in Fig 3 1 and 3 2 and are used for examining the price movements of rubber futures in the study which is explained in the next section Here what follows in F g 3 3 to 3 9 is merely a definition of some of the candlestick terms and not formations

i) Long Periods

A candlestick that has a long day is one in which there has been a big difference in opening and closing prices compared with typical trading days in the previous five to ten days Generally speaking the longer the body is the more intense the buying or selling pressure

Fig 3 3 Long period bullish

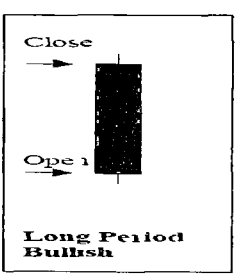
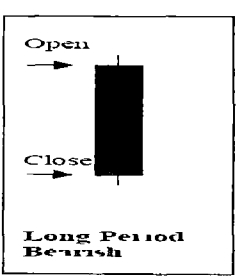


Fig 3 4 Long period bearish



Long periods show a significant gap represented by the body between the open and close prices during the trading period Usually the shadows at either end of the candlestick body are quite short indicating that the market movement was primarily one directional during the same period

ii) Short periods

Short candlestick indicates little price movements and consolidation A candlestick that has a short day is one in which there has been a small difference in opening and closing price compared with typical trading days in the previous five to ten days

Fig 3 5 Short period up

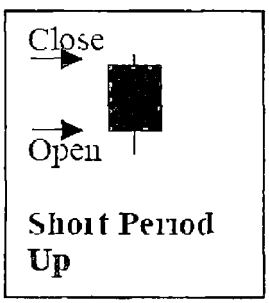
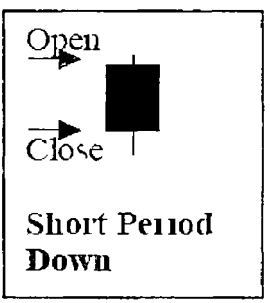


Fig 3 6 Short period down



Short periods with compressed candlestick bodies indicate that there was very little price movement during the trading period and what little movement there was had been upwards in the case of a green candlestick body or downwards in the case of a red candlestick body As with a long period candlestick a short period candlestick has short shadows at either end indicating very little price fluctuation for example between open price and low price and between close price and high price for a bullish green candlestick

iii) Spinning tops

A spinning top or (koma) is a candlestick in which the body of the candlestick is smaller than the lower and upper wicks This candle represents a neutral position in which neither the bulls nor the bears are able to gain control during the trading session If a spinning top arises after a strong uptrend or downtrend it is an

early sign that the trend could be reversing Traders should wait for more confirmation that the trend is changing prior to taking a short or long position

Fig 3 7 Spinning top green

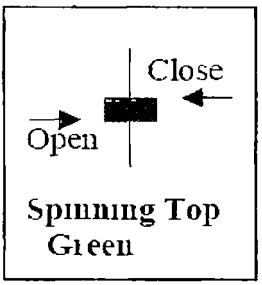
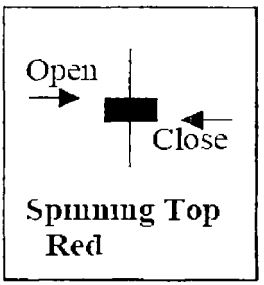


Fig 3 8 Spinning top red

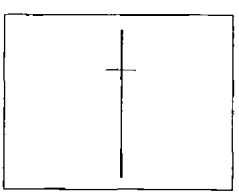


Spinning tops have longer shadows than bodies and whether they are green or red is usually not significant as they imply market indecision and the trend is neither bullish nor bearish The open and close prices for the period are very close so in real terms the market has not really shifted although there might have been a high or low spike (or both) during that period

v) Doji lines

Doji are important candlesticks that provide information on their own and as components of in a number of important patterns The length of the upper and lower shadows can vary and the resulting candlestick looks like a cross inverted cross or plus sign Alone doji are neutral patterns Any bullish or bearish bias is based on the preceding price action and future confirmation The word Doji refers to both the singular and plural form

Figure 3 9 Doji lines



Doji lines have no real body but instead have a horizontal line This is represented when the open and close are the same or very close The length of the *shadow* can vary While a doji with an equal open and close would be considered more robust it is more important to capture the essence of the candlestick Doji convey a sense of indecision or tug of war between buyers and sellers Prices move above and below the opening level during the session but close at or near the opening level The result is a stand off Neither bulls nor bears are able to gain control and a turning point could be developing

3 2 2 2 Formation

The price movements of rubber futures through NMCE are examined using the candlestick chart The monthly averages of futures and spot prices were taken for drawing the candle stick chart To create the candlestick chart the data set containing open high low and close prices for each time period were taken The green or red portion of the candlestick is called the body (also referred to as the real body) The long thin lines above and below the body represent the high/low range and are called shadows (also referred to as wicks and tails) The high is marked by the top of the upper shadow and the low by the bottom of the lower shadow If the stock closes higher than its opening price a green candlestick is drawn with the bottom of the body representing the opening price and the top of the body representing the closing price If the stock closes lower than its opening price a red candlestick is drawn with the top of the body representing the opening price and the bottom of the body representing the closing price

Compared to traditional bar charts many traders consider candlestick charts more visually appealing and easier to interpret Each candlestick provides an easy to depict picture of price action Immediately a trader can see and compare the relationship between the open and close as well as the high and low The relationship between the open and close is considered vital information and forms the essence of candlesticks Green candlesticks where the close is greater than the open indicate buying pressure Red candlesticks where the close is less than the open indicate

selling pressure In the study candlestick chart has been used for analysing the price movements of rubber futures traded through NMCE

3 2 3 Compound Annual Growth Rate (CAGR)

CAGR has also been used to examine the price movements of rubber futures CAGR shows the year over year growth rate of prices over a specified period of time It is calculated by taking the n^{h} root of the total percentage growth rate where n is the number of years of the period being considered This can be written as follows

$$\text{CAGR} \quad \left(\frac{\text{Ending Value}}{\text{Beginning Value}}\right)^{\left(\frac{1}{\#\text{ of years}}\right)} \quad 1$$

3 2 4 Analysis of Variance (ANOVA)

Analysis of variance (ANOVA) is a collection of statistical models and their associated procedures in which the observed variance is partitioned into components due to different explanatory variables In its simplest form ANOVA gives a statistical test of whether the means of several groups are all equal ANOVA has been employed for finding whether there is significant variation between the CAGR of rubber prices and volume traded for 64 months which have been split up into three periods of 20 20 and 24 months ANOVA was worked our using EXCEL sheet

3 2 5 Correlation

Correlation often measured as a correlation coefficient indicates the strength and direction of a linear relationship between two random variables In brief it is a single number that describes the degree of relationship between two variables In other words it is a statistical technique that can show whether and how strongly pairs of variables are related The main result of a correlation is called the correlation coefficient or r It ranges from 1 0 to +1 0 The closer r is to +1 or 1 the more closely the two variables are related If r is close to zero it means that there is no relationship between the variables If r is positive it means that as one variable gets larger the other also gets larger If r is negative it means that as one gets larger the

other gets smaller which is often called as an inverse correlation The formula of correlation is as follows

$$r \quad \frac{\text{covariance}(x,y)}{\sqrt{\text{var}(x)\,\text{var}(y)}}$$

$$\frac{\frac{1}{n}\sum(x-\bar{x})(Y-\bar{Y})}{\sqrt{\frac{1}{n}\sum(x-\bar{x})^2 \;\frac{1}{n}\sum(Y-\bar{Y})^2}}$$

For computational purpose deduce the formula to

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)\left(\sum Y^2 - \frac{(\sum Y)^2}{n}\right)}}$$

$$\frac{SP_{XY}}{\sqrt{SS_X SS_Y}} \quad \frac{sum\ of\ products\ of\ X\ \&\ Y}{\sqrt{sum\ of\ square\ of\ X \;\; sum\ of\ square\ of\ Y}}$$

While analysing the price movements of rubber correlation has been found for studying the relation between crude oil prices and domestic prices of rubber

3 2 6 Multiple Linear Regression

Linear regression is a form of regression analysis in which the relationship between one or more independent variables and another variable called the dependent variable is modelled by a least square function called a linear regression equation This function is a linear combination of one or more model parameters called regression coefficients A linear regression equation with one independent variable represents a straight line when the predicted value (i e the dependent variable from the regression equation) is plotted against the independent variable This is called a simple linear regression

Linear regression is mainly used for the following purposes

i) to construct a simple formula that will predict what value will occur for a quantity of interest when other related variables take given values and

ii) to test whether a given variable does have an effect on a quantity of interest in situations where there may be many related variables

n both cases several sets of outcomes are available for the quantity of interest together with the related variables

Multiple linear regression attempts to model the relationship between two or more explanatory variables and a response variable by fitting a linear equation to the observed data Every value of the independent variable x is associated with a value of the dependent variable y The population regression line for p explanatory variables x x_2 x_p is defined to be μ_y $\beta_0 + \beta_1 x_1 + \beta_2 x_2 +$ $+\beta_p x_p$ This line describes how the mean response μ_y changes with the explanatory variables The observed values for y vary about their means μ_y and are assumed to have the same standard deviationσ The fitted values b_0 b b_p estimate the parameters β_0 β_1 β_p of the population regression line

Since the observed values for y vary about their means μ_y the multiple regression model includes a term for this variation In other words the model is expressed as DATA FIT + RESIDUAL where the FIT term represents the expression $\beta_0 + \beta_1 x + \beta_2 x_2 +$ $\beta_p x_p$ the RESIDUAL term represents the deviations of the observed values of y from their means μ_y which are normally distributed with mean 0 and variance σ^2 The notation for the model deviations is ε

Formally the model for multiple linear regression given n observations is

$y_1 - \beta_0 + \beta_1 x_1 + \beta_2 x_{12} +$ $\beta_p x_{1p} + \varepsilon$

In the least squares model the best fitting line for the observed data is calculated by minimizing the sum of the squares of the vertical deviations from each data point to the line (if a point lies on the fitted line exactly then its vertical deviation is 0) Since the deviations are first squared and then summed there are no cancellations between positive and negative values

The values fit by the equation $b_0 + b_1 x_{11} +$ $+ b_p x_{1p}$ are denoted $\hat{y}_1$ and the residuals e are equal to y $\hat{y}$ the difference between the observed and fitted values The sum of the residuals is equal to zero

The variance σ^2 may be estimated by $s^2 = \frac{\Sigma e_i^2}{n\ p\ 1}$ also known as the mean squared error (or MSE) The estimate of the standard error s is the square root of the MSE

For fitting the multivariate model Multiple Linear Regression was used In order to compare the performance of univariate and multivariate model Multiple Linear Regression was developed by regressing the close price on open high low prices and volume traded of rubber futures For the analysis data from April 2003 to August 2008 were taken The daily data were converted into monthly average prices The regression of current month s close price on two month s previous values of open high low and volume traded was tried The series open series high series low and volume traded during the study period were fixed as the independent variables X X_2 X_3 and X_4 respectively The dependent variable was represented by Y the close price The function can be written as

Y f(X_1 X_2 X_3 X_4)

Close – f (Xopen Xhigh Xlow Xvolume)

where X_1 X_2 X_3 X_4 are Xopen Xhigh Xlow Xvolume the independent factors used to predict the futures close prices of rubber traded through NMCE

3 2 7 Principal Component Analysis (PCA)

Principal component analysis (PCA) involves a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components The first principal component accounts for as much of the variability in the data as possible and each succeeding component accounts for as much of the remaining variability as possible Objectives of principal component analysis are to discover or to reduce the dimensionality of the data set and to identify new meaningful underlying variables A major use of principal component analysis is to simplify data by retaining the first two or three principal components in an analysis Principal component analysis deals with all the variability in a set of variables Secondly principal components employ principles and associated computational procedures that are widely applied in multivariate statistics Principal component analysis is appropriate when the researcher has obtained

measures on a number of observed variables and wishes to develop a smaller number of artificial variables called principal components that will account for most of the variance in the observed variables The principal components may then be used as predictor or criterion variables in subsequent analyses Principal component analysis is a variable reduction procedure It is useful when the data is obtained on a large number of variables and believe that there is some redundancy in those variables In this case redundancy means that some of the variables are correlated with one another possibly because they are measuring the same construct Because of this redundancy it is believed that it should be possible to reduce the observed variables into a smaller number of principal components or artificial variables that will account for most of the variance in the observed variables The principal component analysis is performed in the study using low open high prices and volume traded of rubber futures with the software package SPSS 16 0

3 2 8 Autoregressive Integrated Moving Average (ARIMA) Modelling

Autoregressive Integrated Moving Average models also known as Box and Jenkins method are specially suited for short term forecasting as most ARIMA models place great emphasis on recent past rather than distant These models were developed by George Box and Gwilym Jinks in 1970 The real power and attractiveness of this method is that it can handle complex patterns using a relatively well specified set of rules Box and Jenkins method applies only to stationary time series data Otherwise past effects would accumulate and the values of successive x s would move towards infinity A time series is said to be strictly stationary if all the moments of its probability distributions are invariant over time However in time series literature a stochastic process $\{X_t\}$ is said to be stationary if both $E\{x\}$ and $E\{x_t x_{t-k}\}$ exist and are finite and do not depend on t Most non stationary time series are transformed into stationary time series by suitable transformations One of the simplest transformations is differencing The differencing beyond second order is very rare and as and when such a series exhibits such extreme trend it is nonstationary due to nonconstant variance In such a situation the researcher need to go for logarithmic or square root transformations An over differenced series produce less stable coefficient estimates For fitting the univariate model for prediction of

futures prices of rubber ARIMA was used Univariate modelling methods are commonly used in handling time series forecasting problems In an ARIMA model the future value of a variable is supposed to be a linear combination of past values and errors It can be represented as

$Y \quad \Theta_0 + \emptyset_1 Y_{\ 1} + \emptyset_2 Y_{\ 2} + \quad + \emptyset_p Y_{\ p} + Z + q_1 Z_{\ 1} + q_2 Z_{\ 2} \quad + q_q Z_{t\,q}$ where Y is the actual value and Z is the random error at time t $\emptyset_1$ and Θ_J are the coefficients p and q are integers that are often referred to as autoregressive (AR) and moving average (MA) polynomials respectively The AR part of model indicates that the future value of Y are weighted average of current and past realization while the MA part of model shows how current and past random shocks will affect the future values of Y_t

Theoretically ARIMA modelling involves the following steps

i) Stationarity test of time series
ii) Identification of the ARIMA (p d q) structure
iii) Estimation of the unknown parameters
iv) Goodness of fit tests on the estimated residual and
v) Forecast future of outcomes based on the known data

This five step model building process is repeated several times until a satisfactory model is finally selected for forecasting purposes Modelling the commodity futures prices using time series model like ARIMA has been extensively done as revealed by the review of literature The autoregressive (AR) model moving average (MA) model or the more general autoregressive integrated moving average (ARIMA) model are usually fitted to identify the pattern in the given time series In these models the dependent variable is explained by its lagged terms as well as stochastic error terms The error terms are assumed to have mean zero and constant variance σ^2

While identifying an ARIMA model it is specified based on the estimated autocorrelations and partial autocorrelations Possible work in this area may be divided into four classes

i) If autocorrelation do not die out completely even though they taper off this is a sign of non stationarity and differencing (in most cases not more than once or twice) is required An ARIMA model of the differenced series is thus identified

ii) To determine the order of the MA process if autocorrelation of order k become zero for all $k>q$ and the partial autocorrelations taper off then the underlying MA process is an MA (q)

iii) For an AR process if partial autocorrelation of order k become zero for $k>t$ and the autocorrelation taper off then there is an AR (p) process before the researcher

iv) If the cut off points (that is zero values) of neither the autocorrelation nor the partial autocorrelation are available an ARMA model may be appropriate The degrees of the AR and MA processes have to be ascertained from the underlying autocorrelation and partial autocorrelation patterns

The well known ARIMA (p d q) model (Box and Jenkins 1976) was tried for the prediction of the futures prices of rubber The parameter p signifies the amount of back tracking needed to estimate the next value and it is calculated by taking the first significant partial autocorrelation coefficients The parameter q signifies the dependence of forecast on the difference between the actual and estimated values by autoregressive process and is calculated by the first significant autocorrelation coefficients The parameter d is the number of differencing used to remove the non stationarity in the trend type from original data

Autoregressive Integrated Moving Average or ARIMA (p d q) models are the extension of the AR model that uses three components for modelling the serial correlation in the time series data The first component is the autoregressive (AR) term The AR (p) model uses the p lags of the time series in the equation An AR (p) model has the form $y - a_1 y_1 + + a_p y_p + e_t$ The second component is the integration (d) order term Each integration order corresponds to differencing the time series I (1) means differencing the data once I (d) means differencing the data d times The third component is the moving average (MA) term The MA (q) model uses the q lags of

the forecast errors to improve the forecast An MA (q) model has the form y_t e+ b e + + $b_q e_q$ Finally an ARMA (p q) model has the combined form $y_t - a_1 y_t$ $_1$+ +$a_p y_{t\,p}$+ e+ $b_1 e$ + + $b_q e_{-q}$ The R Squared or Coefficient of Determination indicates the per cent variation in the dependent variable that can be explained and accounted for by the independent variables in this regression analysis However in a multiple regression the Adjusted R Squared takes into account the existence of additional independent variables or regressors and adjusts this R Squared value to a more accurate view of the regression s explanatory power

3 2 8 1 Practical steps involved in ARIMA model building

i) Identification

The foremost step in time series modelling is to check for stationarity A cursory look at the graph of the data and structure of autocorrelation and partial auto correlation coefficients will give clues about stationarity The time series is stationary if the autocorrelation function dies out fairly quickly If the estimated autocorrelation coefficients decline slowly at longer lags first order differencing is usually needed However some time series may require no differencing and that over differenced series produce less stable coefficient estimates Another way of checking stationarity is to fit a first order autoregressive model for the raw data and test whether the coefficient ϕ is less than 1

The next step is to find initial values for the orders of parameters p and q They can be obtained from the significant autocorrelation and partial autocorrelation coefficients When autocorrelations drops off exponentially to zero it is an autoregressive model whose order is determined by the number of partial autocorrelations which are significantly different from zero On the other hand if partial autocorrelations drops off exponentially to zero it is a moving average model whose order is determined by the number of autocorrelations which are significantly different from zero When both autocorrelation and partial autocorrelation move exponentially to zero it is an ARMA model The final models are achieved after going through the stages repeatedly Majority of empirical time series patterns can be sufficiently approximated using one of the five basic models that can be identified based on the shape of the autocorrelogram (ACF) and partial auto correlogram (PACF)

ii) Estimation

At the identification stage one or more models are tentatively chosen that seem to provide statistically adequate representations of the available data Then attempt is made to obtain precise estimates of the parameters of the model by least squares as advocated by Box and Jenkins Iterative procedure for finding the estimate could be done through SPSS

iii) Diagnostic Checking

Different models can be obtained for various combinations of AR and MA individually and collectively The best model is obtained with the following diagnostics like Low Akaike Information Criteria (AIC) / Bayesian Information Criteria (BIC) / Schwarz Bayesian information Criteria (SBC or SC) Residual ACF plot and Ljung Box Q tests The Durbin Watson statistic measures the serial correlation in the residuals Generally DW less than 2 implies positive serial correlation

The Multiple Correlation Coefficient (Multiple R) measures the correlation between the actual dependent variable (Y) and the estimated or fitted (Y) based on the regression equation This correlation is also the square root of the Coefficient of Determination (R Squared) The Standard Error of the Estimates (SEy) describes the dispersion of data points above and below the regression line or plane This value is used as part of the calculation to obtain the confidence interval of the estimates later The AIC and SBC are often used in model selection SBC imposes a greater penalty for additional coefficients Generally the user should select a model with the lowest value of the AIC and SC or SBC

The prediction of futures prices of rubber using MLR PCA and ARIMA and the comparison of these multivariate and univariate models respectively to identify their forecasting performance forms the core of the analysis of the study

Results and Discussion

CHAPTER 4

RESULTS AND DISCUSSION

Futures trading is an agreement between a buyer and a seller obligating the seller to deliver a specified asset of specified quality and quantity to the buyer on a specified date at a specified place and the buyer in turn is obliged to pay to the seller a prenegotiated price in exchange of the delivery Futures trading perform two important functions price discovery and hedging of price risk The ability of a futures exchange to function properly depends in part upon the ability of the exchange and the regulator to ensure that the prices of the contracts traded on the exchange reflect the forces of supply and demand An efficient futures market is intended to discover the right price based on fundamentals while ensuring that there is discipline in the market and that there is no case for either hoarding or price manipulation or speculation Futures prices also reflect the expectations of production and hence supply flows Futures market and forward contracts compliment each other for effective price discovery Forward contracts are bilateral contracts to manage price risk and quantity risk to a certain extent and would act as a boost for the futures market Forward contracts do give rise to price risk yet provide vehicle for managing the price risk also

Given the significance of futures market in price discovery and hedging of price risk an effort to predict the futures prices of rubber a predominant crop of Kerala is of contemporary significance to the rubber growers and traders Prediction of futures prices of rubber is attempted using econometric forecasting models Multiple Linear Regression and ARIMA which are commonly accepted methods of forecasting as revealed by the review of literature In addition to prediction of futures prices a comparison of the forecasting performance of these multivariate and univariate models is also done As a prelude to the prediction of prices the price movements of rubber futures throug NMCE is analysed using line chart correlation candlestick chart Compound Annual Growth Rate (CAGR) and ANOVA Since the commodity under study is rubber the chapter starts with an overview of the rubber economy depicting the global Indian and Kerala scenario with respect to rubber followed by a discussion about commodity futures and the prediction techniques the topic under investigation Hence the chapter is presented under seven sub headings as follows

Table 4 2 Country wise consumption of natural rubber 2007 2008 (in 000 tonnes)

Country	2007	2008	% growth
China	2550 (25 80)	2435(25 49)	4 5
U S A	1018 (10 30)	1041(10 90)	2 3
Japan	887 (8 80)	858 (8 98)	3 3
India	851 (8 60)	878 (9 19)	3 2
Malaysia	446 (4 61)	461 (4 82)	3 4
Indonesia	391 (3 95)	414 (4 33)	5 9
Republic of Korea	377 (3 81)	358 (3 74)	5 0
Thailand	374 (3 78)	367 (3 84)	1 9
Brazil	345 (3 49)	352 (3 68)	2 0
Germany	283 (2 86)	211 (2 20)	25 4
Others	2362 (23 90)	2175 (22 77)	7 9
World Total	9884 (100 00)	9550 (100 00)	3 4

Source International Rubber Study Group Singapore 2008
Note Figures in parenthesis show percentage share to total consumption

Table 4 2 reveals that China is the largest consumer of natural rubber with more than one fourth of the world total while it has only sixth position in production with less than 6 5 per cent share of global production It implies that China is importing natural rubber to meet its increased demand which is also a positive indication of its level of industrial development India was in the fourth position with respect to both production and consumption of natural rubber but has come to third position in consumption in the year 2008 But it is noteworthy that her consumption of rubber which had exceeded her production in 2007 (Table 4 1) has been reversed in the year 2008 More than half of the global consumption is shared by China USA Japan and India Whereas India can meet most of her consumption out of her own production China USA and Japan have to import most of the natural rubber that they consume

Another interesting feature with global production and consumption is that the main rubber producing countries like Thailand Indonesia and Malaysia are the consuming at a lower rate Thailand the largest producer of rubber with nearly one third of global production consumes only less than four per cent of global consumption

4 1 2 Indian scenario of rubber

As already seen India is the fourth largest producer and third largest consumer of natural rubber in the world Rubber plantation industry in India is dominated by small growers with an average holding size of about 0 05 ha Nearly 1 09 million small farmers are engaged in rubber cultivation in India At present small holdings account for 89 per cent of the area and 93 per cent of the production in the country Natural rubber is produced from latex or field coagulam obtained from rubber trees planted in plantations

4 1 2 1 Area under cultivation production and productivity of natural rubber

The rubber plantation industry in India has achieved the highest growth rate among the major crops in the country in terms of area production and productivity Area under rubber cultivation in India has increased from 6 15 200 ha in 2006 2007 to 6 35 000 ha in 2007 2008 registering a growth rate of 3 2 per cent During the year 2007 2008 the production of NR in the country declined to 8 25 345 tonnes from 8 52 895 tonnes during 2006 2007 recording a negative growth rate of 3 2 per cent The fall in production of NR in the country during the year 2007 2008 was mainly due to vector borne diseases affecting tappers in the major rubber growing areas in Kerala unfavourable weather conditions and abnormal leaf fall Consequent to the above factors average productivity declined to 1799 kg/ha from 1879 kg/ha during 2006 2007 (Indian Rubber statistics Vol 31 2008) The most important forms in which NR is processed and marketed are sheets crepes block rubber and preserved latex concentrates In India sheet rubber called Ribbed Smoked Sheets (RSS) designated as RSS1 RSS 2 RSS 3 RSS 4 and RSS 5 are the commonly produced and marketed grades of rubber RSS account for 72 per cent and block rubber 10 per cent of the rubber production of India

4 1 2 2 Consumption of natural rubber

The rubber goods manufacturing industry comprising of 4641 units consumed 8 61 455 tonnes of NR during 2007 08 as compared to 8 20 305 tonnes during 2006 07 registering a growth rate of 5 0 per cent Due to increased production in various categories of tyres and the growth in exports the auto tyre sector consumed 4 95 577

tonnes of NR during 2007 08 as against 4 62 081 tonnes during 2006 07 registering a significant growth of 7 2 per cent The tyre industry consumes almost 58 per cent of the rubber produced in the country The general rubber goods sector also recorded a growth of 2 1 per cent during 2007 08 as compared to 0 01 per cent during the previous year (Indian Rubber Statistics Vol 31 2008)

4 1 2 3 Production and consumption of synthetic rubber

Synthetic Rubber (SR) production in the country registered a growth of 1 8 per cent during 2007 08 compared to the previous year This increase was mainly in the poly butadiene rubber The relative share of consumption of NR and SR in India changed to 74 26 during the year 2007 08 from 75 25 previously The import of SR by the rubber goods manufacturing industry also increased by 13 78 per cent during the same period Details of consumption of NR and SR during 2007 08 and 2006 07 are summarized in Table 4 3

Table 4 3 Consumption of NR and SR 2007 08 (in 000 tonnes)

Item	2006 07	2007 08	Growth (%)
Natural Rubber(NR)			
Autotyres & tubes	462081 (56 33)	495577 (57 62)	7 2
General Rubber goods	358224 (43 66)	365878 (42 47)	2 1
Total NR	820305 (100) [75 18]	861455 (100) [74 35]	5 0
SyntheticRubber(SR)			
Autotyres& tubes	170809 (63 86)	191507 (64 44)	12 1
General Rubber goods	100021 (36 93)	105648 (35 55)	5 6
Total SR	270830 (100) [24 82]	297155 (100) [25 64]	9 7
NR & SR			
Autotyres & tubes	632890 (58 01)	687084 (59 30)	8 6
General Rubber goods	458245 (41 99)	471526 (40 69)	2 9
Total NR & SR	1091135 (100)	1158610 (100)	6 2

Source Indian Rubber Statistics Vol 31 2008

Note (i) Figures in simple brackets represent percentage share to total of respective category

(ii)F g res in double brackets represent percentage share to the grand total

It is evident from Table 4 3 that natural rubber (74 34%) constitutes major portion of the consumption of rubber of the country India s rubber industry manufacture high amount of auto tyres and tubes Hence auto tyres and tubes are consuming bulk of the natural and synthetic rubber The per cent growth over previous year in both natural rubber and synthetic rubber shows positive figures which implies that the consumption of rubber is increasing year after year Out of the total natural rubber and synthetic rubber auto tyres consume nearly 58 per cent and the rest by general rubber goods The other general rubber goods include foot wears belting hoses etc Tyre and non tyre grade rubber is made out of latex obtained from rubber tree and hence it requires large amount of natural rubber

4 1 2 4 Import and export of natural rubber

Ribbed Smoked Sheets account for 45 per cent and block rubber 40 per cent of the imports Duty free imports against the advance license scheme is permitted for re export and rules mandate that only 44 kg of natural rubber can be imported against 100 kg of exports India s imports vary between years and is currently around 80000 90000 tonnes a year (www mcxindia com) The import of NR during 2007 08 showed a negative growth of 3 8 per cent over the previous year while its value showed a positive growth of 1 2 per cent This was inspite of the reduction in the customs duty of NR from 25 per cent to 20 per cent since 2004 This implies that there was an increase in the international price of rubber during the period Ninety eight per cent of the import was through advance license (Directorate General of Commercial Intelligence and Statistics Kolkata)

Tyre is the major form in which rubber is exported from India India s tyre exports are around Rs 1200 1300 crores a year (www mcxindia com) Analysis of the exports of NR of India showed a positive growth of 6 7 per cent during the period under observation This also justifies the reason for the decrease in the imports of rubber The increase in the international prices of rubber led to increase in exports and decrease in imports But it is to be noted that the foreign exchange earnings during the period showed a decrease of 3 8 per cent from Rs 513 74 crore in 2006 07 to Rs

494 30 inspite of a 6 7 per cent increase in exports This was due to the weakening of the US Dollar and firming up of the Indian Rupee in the foreign exchange market The stock of NR in the country at the close of 2007 08 also showed a decline of 0 61 per cent compared to the previous year This also justifies the increase in the rubber exports to avail the opportunity of the discrepancy in the domestic and international prices

Import and export of natural rubber from India is shaped by the gap between global and Indian prices If global prices are ruling higher compared to the domestic prices imports would be less while the opposite would take place in the case of domestic price staying higher compared with global prices

4 1 2 5 Domestic and international prices of natural rubber

The price of NR both in domestic and international markets has remained volatile since April 2007 The price of RSS 4 grade has dwindled between Rs 7250/100 kg and Rs 9175 during April 2007 to September 2007 Since the second week of September the price was hovering around Rs 9200 to Rs 9700 till the third week of February 2008 with some ups and downs On 20th February 2008 the price of RSS 4 grade was Rs 10100 and the surge continued till the end of the year The domestic price has been ruling above the international price during August 2007 to October 2007 The annual average price of RSS 4 grade rubber for the year 2007 08 was Rs 9085 compared to Rs 9204 in 2006 07 The increase in domestic rubber price could be attributed to various factors including increased economic activity shortage in NR production unfavourable climatic conditions government policies increase in international NR prices and increase in oil prices

There have been fluctuations in the prices of international market also The price of RSS 3 grade which stood at Rs 10057/100 kg on 2nd April 2007 declined to Rs 9375/100 kg during the last week of May Although the price declined in the subsequent months it picked up since August 2007 and shot up to Rs 11177/100 kg at the end of March 2008 The average annual price of RSS 3 grade rubber in the international market for the year 2007 08 was Rs 9675/100 kg as compared to Rs 9779/100 kg during the previous year This boost in international prices contributed to the negative growth of 3 8 per cent in imports and 6 7 per cent positive growth in

exports of natural rubber during 2007 08 as revealed earlier (Para 4 1 2 4) Domestic climatic conditions government policies and global prices are key factors that influence domestic rubber prices

4 1 2 6 Rubber futures in India

Futures trading in rubber flagged off on 15 [h] March 2003 for the very first time in India through NMCE and the product soon became a role model as a truly efficient and liquid market The main spot markets for rubber in the country are Kottayam Cochin and Kozhikode in Kerala The most commonly used grade in the futures market is the RSS 4 grade and the minimum lot size for one trade is 100 kg After a detailed cost study by the Costing Branch of Finance Ministry in 1998 Government of India announced Rs 35 per kg as the benchmark price But historical prices of rubber showed that from 1998 99 to May 2002 the price of RSS 4 remained lower than Rs 3 500 per quintal Since rubber futures trading started in India it has never gone below this scale and also absurd volatility in its prices has now become unusual This might be due to the market participation by the actual rubber growers who are now benefited by the futures trading mechanism and have consistently managed to gain a price that is approximately 94 per cent higher than the cost price of rubber (Indian Rubber statistics Vol 31 2008) The rubber growers of Kerala have heaved a sigh of relief by getting consistently good prices due to the efficient price discovery and price dissemination contributed by futures trading

4 1 3 Rubber Scenario in Kerala

Kerala is the leading rubber plantation state in India accounting for nearly 90 per cent of India s rubber production the next being Karnataka Most of the Malanaadu and Idanaadu areas of Kerala are growing rubber Years back people used to plant coconut in their fields But now people plant rubber trees instead as it gives a daily income This plant which was brought to India during the British rule has spread all over Kerala and other parts of India and provides daily income to the growers as well as the workers

The introduction of natural rubber cultivation by the British opened up a new vista of enterprise for the peasantry in the State to channel the surplus generated from

the commercial cultivation of traditional crops and those from trading and banking Ever since the beginning of commercial cultivation of natural rubber (NR) in India during the early 20th century the planters in Travancore Cochin and Malabar regions in Southern India had been experiencing the necessity for research on problems of rubber planting and upkeep Initially the scientific department of the United Planters Association of Southern India (UPASI) was largely responsible for the initiative in research on rubber Later the Indian Rubber Board was established on the 19th April 1947 to look after the rubber plantation industry in the country Its functions include the development of the NR industry by devising suitable promotional measures and undertaking scientific technological and economic research Researches made at the research centre at Puthuppally in Kottayam District have produced good varieties of rubber plants giving a very good yield

4 2 Concept of commodity futures

Commodity markets across the world are experiencing an exponential growth in recent years Everyone from the common investor to foreign institutional investors is concerned about commodities traded and their prices Participants are looking towards exchanges as instruments for risk mitigation and price insurance This makes an understanding of commodity markets vital for any finance professional

A futures contract is a legally binding agreement made between two parties to buy or sell a commodity or financial instrument at an agreed price on a specified date in the future With futures contracts the quantity and quality of the underlying commodity are specified and the future delivery date is fixed Price is the only variable and is determined through the interaction of buyers and sellers at the time when the contract is first opened Futures contracts are mainly of two types commodity futures contracts and financial futures contracts The difference between futures trading and commodity futures trading is that in equity futures the underlying asset is the equity share of any company whereas in commodity futures the underlying asset is the commodity itself Commodity futures contracts are contracts which end with a physical delivery They include agricultural commodity futures like rice sugar wheat oats soybeans etc energy commodity futures like heating oil crude oil natural gas etc metals and stones like gold silver diamond etc and others such as animals wood

etc Financial futures contracts are contracts which end with a cash settlement They include futures for shares mutual funds bonds treasury bills etc

Futures trading involves two steps as short and long Going long means buying a contract and going short means selling a contract Like futures contract futures traders can also be grouped into two large categories as hedgers and speculators Hedgers are the issuers of futures contracts doing so to tackle the risk of low price at the actual product delivery time Speculators are the actual futures traders trading for profit Commodity futures trading is one of the very few ways to make good profits in a shorter time with low investment

Commodity trading works exactly like stock futures Inorder to buy a futures one does not have to pay the entire amount just a fixed percentage of the cost This is known as the margin For example one person decides to buy 100gms of gold futures which is the minimum contract size for gold for a certain price He/she has to pay a certain amount of margin set by the commodity trading exchange they are trading on which would be an amount lower than the original price for 100 gms The next day the price goes up by Rs 1000 then Rs 1000 would be credited into his/her account The following day it dips by Rs 500 then Rs 500 is debited to the account Once he/she feels that the amount already profited is not going to change he/she can choose to sell the futures This is in simple words the working of commodity futures trading

Commodity futures market is expected to help the market participants through two vital economic functions viz price discovery and price risk management At the macro level the liquid and vibrant futures market having nationwide participation also assists in sobering down inter seasonal and intra seasonal price fluctuations This not only helps in bringing about reasonable stability in the prices of commodities but also supports farmers to get remunerative prices without adversely affecting the interests of consumers Such a market also provides a market based alternative to government involvement like procurement at Minimum Support Price and Public Distribution System

Price discovery made in spot markets sometimes also called as cash markets which are mostly fragmented over the counter markets is inefficient Price discovery in spot market is affected by geographical dispersion differential needs of the buyers

and sellers in terms of quality quantity place of delivery and difficulties associated with handling physical delivery and absence of option to settle the contract by payment of price difference In any case the spot market does not meet the need for price forecast felt by participants in the physical markets With convergence of bids and offers emanating from a large number of buyers and sellers from different parts of the country and possibly from abroad futures trading is a very efficient means of forecasting the price for a commodity

Price risk management is very closely related to hedging which means transfer of some or all of that risk to those who are willing to accept it who are in turn called speculators Price risk is managed by taking opposite positions on the two legs of the market e g spot and futures The futures prices are linked to the spot prices through carrying cost which comprises cost of storage interest wastage shrinkage etc Therefore the two prices tend to move in parity Taking opposite positions in the two legs of the market therefore tends to offset loss in any market on account of adverse price fluctuation All the participants in the physical markets like producers processors manufacturers importers exporters and bulk consumers can focus on their core activities by covering their price risk in futures market Their operations become more competitive since the price risk involved in procurement and supply is transferred to the futures market

The industry body of the Associated Chambers of Commerce and Industry of India (ASSOCHAM) has reported that the commodity futures market size is expected to reach more than double by 2010 to Rs 12 00 000 crore and create additional employment avenues for one lakh persons (www zeenews com)

4 3 Commodity futures markets in India

Commodity futures trading in India is not a new concept India has a very rich tradition in commodity futures and has a long history of commodity futures trading extending over 130 years In India futures trading started in an organized manner in 1875 at Mumbai for cotton by the Bombay Cotton Trade Association Certain mill owners unhappy with the working of their association began a new association in 1893 called the Bombay Cotton Exchange Limited It conducted futures trading for cotton In 1890 a Gujarati merchant Mandali started the futures trade of oil seeds

They also did futures trading for cotton and peanuts Although futures trading worked in Punjab and Uttar Pradesh earlier too the Chambers of Commerce Hampur which came into being in 1931 was the first one to get noticed

Soon after wheat futures market started in various places in Punjab like Amritsar Moga Ludhiana Jalandhar Fasilka Dhuri Baamala and Bhatinda and in Uttar Pradesh at Muzzafarnagar Chandahusi Meerut Charanpur Hatras Ghaziabad Bareili etc In due time futures markets were started for pepper turmeric potato sugar and jaggery

In1939 Indian Government banned futures trading in several commodities because of the Second World War After independence when the Indian Constitution was framed share market and futures market were put in the Union List So the regulation of futures markets is with the Central Government Until late 60 s the country had vibrant futures market in castor seed mustard linseed sesame seed coconut oil groundnut seed turmeric cotton raw jute jute goods wheat rice sugar gold and silver Because of the apprehensions of the Indian Government that speculators were manipulating the market to the detriment of the farmers futures trading was again banned in the 1960s except for a few commodities

As the country embarked on economic liberalization policies and signed the Uruguay Round General Agreement on Tariffs and Trade (GATT) in the early nineties the Government realized the need for futures trading to strengthen the competitiveness of Indian agriculture and the commodity trade and industry In the wave of liberalization Indian agriculture has to equip with appropriate market instruments i e market based risk management tools and institutions gradually Hence futures trading began to be permitted in several commodities and the ushering in of the 21st century saw the emergence of new national commodity exchanges with countrywide reach for trading in almost all primary commodities and their products

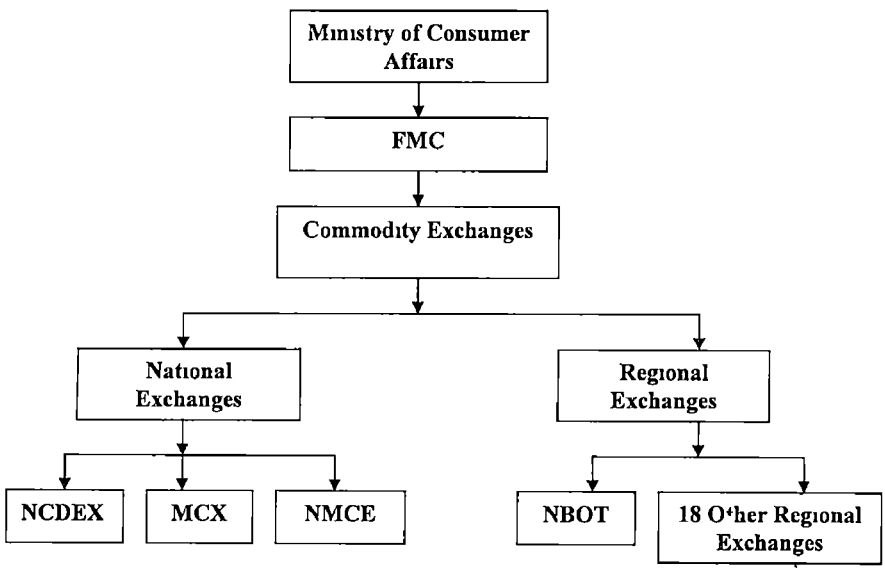
At present futures markets is permitted for about 146 commodities through 22 exchanges (www fmc gov in) These include major agricultural commodities viz jute gur cotton coffee major pulses like urad arahar chana edible oilseeds like mustard seed coconut oil groundnut oil and sunflower spices pepper chillies cumin seed and turmeric guar seeds etc A ban was imposed on futures trading in rice wheat urad and

tur dal since January 2007 to ensure orderly market conditions Recently trading in new generation commodities like carbon credit was launched on the Indian trading platform to help producers earn remunerative returns out of environmentally clean project

4 3 1 Structure and regulation of commodity futures market in India

The Government enacted Forward Contracts (Regulation) Act 1952 (FCRA 1952) set up Forward Markets Commission (FMC) in 1953 and permitted futures trading in several commodities According to FCRA 1952, a three levelled regulatory system came into existence Ministry of Consumer Affairs FMC and the associations which are the commodity exchanges that are recommended by the FMC for conducting futures trading Commodity futures contracts and the commodity exchanges organizing trading in such contracts are thus regulated by the Government of India under the FCRA 1952 and the Rules framed thereunder A graphical presentation of the structure of commodity futures market in India is depicted in Fig 4 1

Fig 4 1 Structure of Commodity Futures Market in India



The nodal agency for the regulation of the commodities futures market is the FMC which functions under the administrative control of the Food and Public

Distribution Department of the Ministry of Consumer Affairs of the Central Government Nation wide there are three commodity exchanges handling multiple products — National Multi Commodity Exchange of India (NMCE) based in Ahmedabad Multi Commodity Exchange of India (MCX) and National Commodities and Derivatives Exchange (NCDEX) both in Mumbai In addition to these three national commodity exchanges there are 19 regional exchanges including the National Board of Trade (NBOT) Indore which is the oldest of the commodity exchanges in India Three nationwide multi commodity exchanges are given permanent recognition to conduct trading in all permitted commodities The regional exchanges are permitted to trade only in restricted number of commodities specific to their region

Merchandising and stockholding of many commodities in India have always been regulated through various legislations like the Essential Commodities Act 1955 (ECA 1955) and Forward Contracts (Regulation) Act 1952 (FCRA 1952) and Prevention of Black Marketing and Maintenance of Supplies of Essential Commodities Act 1980 The ECA 1955 gives powers to control production supply and distribution of essential commodities for maintaining or increasing supplies and for securing their equitable distribution and availability at fair prices Using the powers under the ECA 1955 various Ministries/Departments of the Central Government have issued control orders for regulating production distribution quality aspects and movement of commodities which are essential and administered by them

The FCRA 1952 provides for three tier regulatory system for commodity futures trading in India the Ministry of Consumer Affairs the Forward Markets Commission and an association i e commodity exchanges recognized by the Government of India on the recommendation of Forward Market Commission All types of forward contracts in India are governed by the provisions of the FCRA 1952 The Act classifies forward contracts into two specific delivery contracts and other than specific delivery contracts or futures contracts Specific delivery contract means a forward contract which provides for the actual delivery of specific qualities or types of goods during a specified time period at a price fixed thereby or to be fixed in the manner thereby agreed and in which the names of both the buyer and the seller are mentioned The ready delivery contracts defined by the Act is the one which provides for the delivery of goods and payment of a price therefore either immediately or within

a period not exceeding eleven days after the date of the contract All ready delivery contracts where the delivery of goods and/or payment for goods is not completed within eleven days from the date of the contract are forward contracts

The specific delivery contracts are of two types transferable and non transferable The distinction between the transferable specific delivery (TSD) contracts and non transferable specific delivery (NTSD) contracts is based on the transferability of the rights or obligations under the contract Forward trading in TSD and NTSD contracts are regulated by the Government As per the Section 15 of the FCRA 1952 every forward contract in notified goods (currently 36 commodity items) which is entered into except those between members of a recognized association or through or with any such members is treated as illegal or void Section 18(I) of the Act exempts the NTSD contracts from the regulatory provisions However over the years the regulatory provisions of the Act were applied to the NTSD contracts and 79 commodity items are currently prohibited for NTSD contracts under Section 17 of the Act Moreover another 15 commodity items are brought under the regulatory provisions of Section 15 of the Act out of which trading in the NTSD contract has been suspended in 12 items At present the NTSD contracts in cotton raw jute and jute goods are permitted only between through or with the members of the associations specifically recognized for the purpose Subsequent to the Report of the Committee on Forward Markets known as the Kabra Committee submitted in 1994 Government permitted futures trading in 35 commodities under the auspices of 23 commodity exchanges located in different parts of the country Presently there are 22 commodity exchanges and futures trading are carried out in 146 commodities under eight major categories like fibers and manufactures spices edible oilseeds and oil pulses energy products vegetables metals and others

4 3 2 Leading commodity exchanges of India

The Government of India has allowed national commodity exchanges similar to the Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) to deal in commodity derivatives in an electronic trading environment These exchanges are expected to offer a nation wide anonymous order driven screen based trading system for trading The Forward Markets Commission (FMC) regulates these

exchanges Consequently three national commodity exchanges and 19 regional exchanges have been approved to commence business in this regard Of the 19 regional commodity exchanges National Board of Trade is the oldest commodity exchange of India A brief description about these prominent commodity exchanges in India are given in the ensuing paragraphs

4 3 2 1 National Multi Commodity Exchange of India Ltd (NMCE)

NMCE is the first demutualised electronic multi commodity exchange of India which was granted the national status on a permanent basis by the Government of India and became operational since 26^{h} November 2002 with headquarters in Ahmedabad NMCE is committed to provide world class services of on line screen based futures trading of perm tted commodities and efficient clearing and guaranteed settlement while complying with statutory / regulatory requirements NMCE provides a common ground for fixation of future prices of a number of commodities enabling efficient price discovery/forecast In addition hedging using different and diverse commodities is also possible with help of NMCE

NMCE was promoted by commodity relevant public institutions viz Central Warehousing Corporation (CWC) National Agricultural Cooperative Marketing Federation of India (NAFED) Gujarat Agro Industries Corporation Limited (GAICL) Gujarat State Agricultural Marketing Board (GSAMB) National Institute of Agricultural Marketing (NIAM) and Neptune Overseas Limited (NOL) While various integral aspects of commodity economy viz warehousing cooperatives private and public sector marketing of agricultural commodities research and training were adequately addressed in structuring the Exchange finance was still a vital missing link Punjab National Bank (PNB) took equity of the Exchange to establish that linkage Even today NMCE is the only Exchange in India to have such investment and technical support from the commodity relevant institutions These institutions are represented on the Board of Directors of the Exchange and also on various committees set up by the Exchange to ensure good corporate governance Some of them have also lent their personnel to provide technical support to the management of the Exchange The day to day operations of the Exchange are managed by the experienced and qualified professionals with impeccable integrity and expertise

NMCE is unique in many other respects It is a zero debt company following widely accepted prudent accounting and auditing practices It has robust delivery mechanism making it the most suitable for the participants in the physical commodity markets The exchange does not compromise on its delivery provisions to attract speculative volume Public interest rather than commercial interest guide the functioning of the Exchange It has also established fair and transparent rule based procedures and demonstrated total commitment towards eliminating any conflicts of interest It is the only Commodity Exchange in the world to have received ISO 9001 2000 certification from British Standard Institutions (BSI)

NMCE commenced futures trading in 24 commodities on 26th November 2002 on a national scale and the basket of commodities has grown substantially since then to include cash crops food grains plantations spices oil seeds metals and bullion among others The research desk of NMCE is constantly in the process of identifying the hedging needs of the commodity economy and the basket of products is likely to grow even further NMCE has also made immense contribution in raising awareness about and catalyzing implementation of policy reforms in the commodity sector NMCE has been the pioneer in many aspects – it was the first Exchange to take up the issue of differential treatment of speculative loss to enroll participation of high net worth corporate securities brokers in commodity derivatives market to introduce warehouse receipt system within existing legal and regulatory framework and to complete the contractual groundwork for dematerialization of the warehouse receipts

NMCE has been continuously trading in rubber since April 2003 except during the ban period from 7h May to 4h December 2008 MCX and NCDEX are not trading in rubber at present although they were dealing earlier NBOT has not yet initiated trading in rubber Hence data on daily low price high price close price and volume traded of rubber spot and futures prices were collected for a period of April 2003 to August 2008 from NMCE for the study

4 3 2 2 Multi Commodity Exchange (MCX)

MCX is a demutualised nationwide electronic multi commodity futures exchange set up by the Financial Technologies of India Limited having permanent recognition from the Government of India for facilitating online trading clearing and

settlement operations for futures market across the country The Exchange started its operations in November 2003 Headquarters is in the financial capital of India Mumbai Apart from being accredited with ISO 9001 2000 for quality standards MCX offers futures trading in 59 commodities as on January 31 2009 (www mcxindia com) defined in terms of the type of contracts offered from various market segments including bullion energy ferrous and non ferrous metals oils and oil seeds cereals pulses plantations spices plastics and fibers The Exchange strives to be at the forefront of developments in the commodities futures industry and has forged ten strategic alliances across the world including with Tokyo Commodity Exchange Chicago Climate Exchange London Metal Exchange New York Mercantile Exchange New York Board of Trade and Bursa Malaysia Derivatives Berhad MCX is committed towards revolutionizing the Indian commodity markets It aims to empower the market participants through innovative product offerings and business rules so that the benefits of futures markets can be fully realized MCX focuses its efforts towards meeting the requirements of all the stakeholders in the commodity ecosystem without any bias and establishing globally acceptable industry norms

The key shareholders in MCX are State Bank of India and its associates (SBI) National Bank for Agriculture and Rural Development (NABARD) National Stock Exchange of India Ltd (NSE) SBI Life Insurance Co Ltd Bank of India (BoI) Bank of Baroda (BoB) Union Bank of India Corporation Bank Canara Bank HDFC Bank Benett Coleman & Company Limited Fid Fund (Mauritius) Ltd an affiliate of Fidelity International ICICI Trusteeship Service Limited Industrial Leasing and Financial Services Limited (IL&FS) Trust Company Limited Kotak group Citibank Strategic Holdings Mauritius Limited Merrill Lynch Holdings (Mauritius) and Financial Technologies of India Ltd

4 3 2 3 National Commodity and Derivatives Exchange Ltd (NCDEX)

NCDEX is a professionally managed on line multi commodity exchange It is the only commodity exchange in the country promoted by national level institutions This unique parentage enables it to offer a bouquet of benefits which are currently in short supply in the commodity markets The institutional promoters and shareholders of NCDFX are prominent players in their respective fields and bring with them institutional building experience trust nationwide reach technology and risk

management skills NCDEX is a public limited company incorporated on April 23 2003 under the Companies Act 1956 It obtained its Certificate for Commencement of Business on May 9 2003 It commenced its operations on December 15 2003 NCDEX is a nation level technology driven de mutualised on line commodity exchange with an independent Board of Directors and professional management both not having any vested interest in commodity markets It is committed to provide a world class commodity exchange platform for market participants to trade in a wide spectrum of commodity derivatives driven by best global practices professionalism and transparency NCDEX is regulated by Forward Markets Commission It is subjected to various laws of the land like the Forward Contracts (Regulation) Act 1952 Indian Companies Act 1956 Indian Stamp Act 1899 Indian Contract Act 1872 and various other legislations NCDEX is located in Mumbai and offers facilities to its members at about 550 centers throughout India

NCDEX currently facilitates trading of 57 commodities which includes agriculture metals and energy The promoter shareholders of NCDEX are Life Insurance Corporation of India (LIC) National Bank for Agriculture and Rural Development (NABARD) and NSE The other shareholders include Canara Bank Credit Rating Information Services of India Limited (CRISIL) Goldman Sachs Intercontinental Exchange (ICE) Indian Farmers Fertiliser Cooperative Limited (IFFCO) and Punjab National Bank (PNB)

4 3 2 4 National Board of Trade Ltd (NBOT)

NBOT was incorporated on July 30 1999 to offer integrated transparent and efficient trading platform to various market intermediaries in the commodity futures trade Although a regional commodity exchange located in Indore NBOT is one of the fastest growing commodity exchanges under the aegis of the Forward Markets Commission recognized by the Government of India It trades only in three commodities namely soya oil mustard and crude palm oil With a humble beginning of trading in February 2000 its average daily volume has reached a staggering 60 000 MTs approximately in terms of soya oil It has implemented the state of the art technology and system for efficient handling of trading margining clearing and settlement in respect of all the transactions confirmed by the Exchange The board of

directors adorned by a galaxy of the most respectful personalities drawn from different categories of trade and commerce has been giving necessary impetus and thrust for setting up of the exchange and provide guidance for its proper functioning

NBOT has been constantly endeavouring to strengthen professionalism in the commodities futures market and to provide credible nation wide trading facilities to market players in tune with the international standards It is a catalyst for the development of the Indian oilseeds growers trade and industry by providing the cost effective and efficient services In being so NBOT s sphere of action will synergise and naturally identify with the interests of NBOT members the investors the industry and above all the country NBOT s main objective is to achieve high distinction in integrity for pricing risk management and investment to build an internationally acclaimed innovative commodity exchange in India

4 3 3 Trends in futures trading of agricultural commodities

India s volatile political climate requires the Government to engage in measures regardless of the economic rationale When the Congress Government faced political pressure particularly from India s powerful communist block it had to demonstrate that it was taking action to address soaring food prices Accusations were being flung far and wide across the country over whom to be blamed for the food crisis with the ruling party and the United States on the receiving end of most of the blame While the blame game was highly politicized it failed to take into account the structural reasons behind the global food shortages Hence the political necessity of taming the opposition and keeping the poor fed far outweighed any long term economic strategy to cut down inflation

This section is earmarked for discussing about the increasing price scenario of agricultural commodities the political decision of introducing ban on trading to tackle the issue and the impact of ban on futres trading in rubber

4 3 3 1 Soaring prices of agricultural commodities

Prices of agricultural commodities especially edible oils chana and rubber rose sharply from the last quarter of 2007 Soy oil prices gained by about 35 per cent

within a short span of five months from October 2007 to February 2008 and touched Rs 740 per quintal in domestic markets Domestic prices moved up sharply tracking global prices especially Chicago Board of Trade (CBOT) and Malaysian Derivatives Exchange (MDEX) At CBOT prices gained by about 47 per cent during same period Global soy bean output had declined by seven per cent to 220 million tonnes in 2007 08 as against 237 million tonnes during the previous year Edible oil seeds production had also declined to 390 million tonnes compared to 408 million tonnes in the previous year Major fall in soy bean output was in the United States (US) with decline of around 20 per cent during the respective season Short fall in global output of soy bean and shifting large chunk of agriculture produce for bio fuels led to sharp gain in prices of all the edible oils

Chana prices also gained by more than 30 per cent due to lower output concerns Production of rabi chana 2007 08 was estimated below 50 lakh tonnes compared to 58 lakh tonnes in the previous year There were no carry forward stocks at all Prices were trading at one year low of Rs 2000 per quintal during the end of 2008 and lower estimates led to sharp rise in prices towards Rs 3000 per quintal India imported more than 1 2 million tonnes of pulses in 2007 08 and failed to keep prices low as import prices ruled high India annually produces about 13 14 million tonnes of pulses and this output is almost stagnant for the last 15 years Consumption is rising every year with increasing population India is largest importer of pulses and imports about two to three million tonnes

Rubber prices gained by 23 per cent in the domestic markets Rubber global production was 9 89 million tonnes in 2007 compared to 9 68 million tonnes in 2006 while consumption increased to 9 73 million tonnes from 9 21 million tonnes during the same period India has produced about 8 25 lakh tonnes in 2007 08 compared to 8 53 lakh tonnes in the previous year Increasing demand for rubber in global markets and strong crude oil prices led to sharp rise in prices

Potato prices fell from the high of Rs 650 levels to Rs 450 within a span of one month with increasing arrivals Output was estimated at 28 29 million tonnes in 2007 08 higher from 25 million tonnes in the previous season Higher arrivals and lack

of demand pulled down the prices of potato Some state governments including West Bengal intervened in spot markets to support the prices

4 3 3 2 Government measures to contain prices of agricultural commodities

Government took various measures to control the rising prices of food commodities It reduced import duty on refined edible oil from 40 – 45 per cent to zero per cent in March 2008 to control the rising prices of edible oils India imports about 50 per cent of the total domestic requirement and is price taker in global markets Price movement especially in Malaysia and US has direct impact on the Indian domestic markets Edible oil prices marginally came down after Government reduced import duty on edible oils Soy oil prices fell by Rs 150 per quintal within a span of one month Apart from reducing import duties on edible oils Government also directed the state governments to strictly impose the stock limits on foodgrains and pulses Various states including Maharashtra Andhra Pradesh and Delhi conducted raids on stock hoarders to bring out the excess stocks This led to panic selling of pulses in spot markets and led to sharp fall in prices of most of pulses Chana prices fell from the Rs 3000 levels towards Rs 2300 within one month period

Government of India banned the export of wheat lentils and most rice varieties built up grain reserves imposed export restrictions on steel and cement placed price caps on selected commodities and raised the country s cash reserve ratio in an attempt to reduce liquidity in the system The Government also reiterated that it would not ease up on any of its current bans on food exports any time soon in order to guard the country s food supply

In spite of taking these measures inflation remained high and touched 42 month high of 7 61 per cent for the week ending 26 ^{h} April 2008 Prices of most of the agriculture commodities fell as a result of Government intervention and also declining demand at higher levels apart from fall in prices of edible oils in global markets However higher prices of non agriculture commodities like steel and cement remained high boosting inflation further

4 3 3 3 Ban on futures trading in agricultural commodities

With key state and general elections coming closer the ruling Congress Party was under heavy pressure to bring the country s inflation rate down to a comfortable level of about four percent India was already teetering on the edge of riots breaking out among the country s poor as the global food crisis worsened At this point taking action and issuing statements daily on how prices would come down was the Government s best chance to reassure the public stave off potential food riots and prevent the opposition from accusing the Government of neglecting the poor As a result the Government had been forced into panic mode and was experimenting with a variety of measures to bring food prices down Futures commodities trading was the next target in India s battle against inflation

Producing and consuming companies as well as domestic traders in India are involved in commodities trading Trading in food futures allows these companies and traders to engage in long term planning to ensure that they have enough food supply in the coming months by buying and selling commodities at set prices for delivery by a specific date The logic behind banning futures trading in this market was to keep those in the market from bidding up food prices as perceptions of food shortages turned more severe In other words the Government was trying to cut out a further rise in prices built on speculation

Futures trade in agricultural commodities had a bad day on 7 ^{h} May 2008 with FMC announcing suspension of futures trade in four commodities namely chana soy oil potato and rubber for four months i e till 6th September 2008 Futures trading in these four items came under attack when the country s inflation started climbing at double digit level Government of India had already de listed four major commodities like wheat rice urad and tur during January February 2007 Government was under pressure from various political parties to impose ban on futures trade in essential commodities alleging that futures trading is responsible for the sharp rise in prices Although umpteen number of reports concluded that there is no relation between inflation and futures market trading in chana potato soy oil and rubber were suspended mainly due to the pressure from the then Left party which blamed futures trading for price rise

Inflation remained above seven per cent for four consecutive weeks from March 2008 onwards Commodity futures provide platform for farmers traders exporters and other corporates to hedge their positions Speculators provide liquidity in the market with active participation Prices of any commodity follow its own fundamentals and price manipulation by few traders is not possible if the market is a perfect one But finally the Indian Government placed a ban on futures trading in soybean oil rubber chickpeas and potatoes on May 8 h in its latest attempt to rein in the country s fast growing inflation which reached 7 57 per cent in late April

Although ban was introduced in the first stage in four major commodities – wheat rice urad and tur in early 2007 there was no guarantee that futures trading would significantly alleviate India s inflation woes Therefore Government of India commissioned an Expert Committee in March 2007 under the chairmanship of Abhijit Sen to study the impact of futures trade on agriculture commodity prices and whether futures trading actually drove up spot prices The Committee submitted its report on 29 h April 2008 in which no direct link between commodities futures trading and rising spot prices was established It found no evidence of futures trade affecting the spot prices of agriculture commodities The Committee however suggested continuation of futures ban on wheat rice urad and tur but did not recommend fresh ban on any commodities

The suspension of futures trade on four more agricultural commodities aroused criticism from various corners especially when the prices of edible oils had already eased and were largely influenced by global factors rather than domestic factors It was strange that soy bean was left out from this list and soy oil a byproduct of soy bean had been suspended Chana prices had already fallen by 20 per cent in the previous one month and there was no need to suspend futures but to improve supply Potato prices were already trading at one year low and farmers were affected due to lower prices Those who were demanding imposition of ban on futures trade in agriculture commodities were themselves providing support price to potato in West Bengal Moreover it was very difficult to understand in what way potato prices caused the inflation

Furthermore banning commodities futures trading on a large scale creates a risk of a breakdown in the country s food supply chain If food consumers and traders

cannot plan ahead they will be buying either from local producers to stock up or from the international market to avoid shortages thus creating massive nationwide irregularities in the production supply and distribution of foodstuffs In India however farmers reportedly do not rely very heavily on the futures market for their planning This indicates that the ban on futures trading will not cause major damage to the country s food supply system but it also will not have a major effect in bringing food prices down

This decision of Government has also been criticized on the ground that real market players have lost confidence in futures trade This included representatives of various organizations of exporters importers and processers All these participants were using exchanges to hedge their positions Now that in most of the rural areas NCDEX prices have become the bench mark the farmer and small trader community would be deprived of better price discovery mechanism It was pointed out that since chana and Soy oil future contribute almost 35 per cent of total agriculture futures volumes the future of commodity derivatives market would be under threat

Moreover suspension of futures trade in commodities to tame the domestic inflation would dilute the basic objective of introducing futures trade in India As this was just a suspension and not a complete ban the reintroduction might not result in good volumes since the participants have already lost their trust in Government To conclude the Government should focus more on ensuring enough supplies in the market with measures such as enhancing productivity and better cultivation practices

The lifting of a ban on four agricultural commodities chana potato soya oil and rubber in December ushered the nascent Indian commodity market which witnessed dramatic changes following volatility in the global market and the economic recession in 2008 The ban lapsed on November 30 and these four commodities resumed trading on December 4 ^{h} with the easing of inflation to eight per cent level for the week ended November 29 ^{h} 2008

The futures market is basically a price discovery platform A commodity is traded on an exchange for discovering a price for future months The ban on four farm commodities affected the country s commodity exchanges like MCX NCDEX NMCE and NBOT dearly with those focussed on agri related products witnessing their

turnover slumping by upto 60 per cent Of four banned items chana soy oil and potato are largely traded on NCDEX According to the estimates of analysts the ban has brought down its turnover by 60 per cent The business of NMCE in which rubber is traded was affected by 30 per cent (www janasamchar net)

According to the commodity market regulator Forward Markets Commission the futures market might have lost business worth an estimated Rs 8 00 000 crore due to ban in forward trading of eight commodities such as wheat rice and pulses The average loss in four commodities chana soy oil potato and rubber was around Rs 1 000 crore per day Besides the loss in the case of four other commodities rice wheat urad and tur where trading was banned in early 2007 was around Rs 1 500 crore per day The suspension of the three highly traded items had put NCDEX under immense pressure which is still fighting hard to improve its business on exchange Since chana and soy oil trade contributes about 36 per cent of the total turnover of NCDEX and potato two per cent overall about 30 40 per cent of NCDEX turnover might have washed away because of the ban Experts estimated that in 2008 agri commodities volumes in three national exchanges and 19 regional exchanges dipped by 30 per cent (www janasamchar net)

The ban on four items not only affected the business on exchanges but also killed investors confidence The lower volumes in four banned commodities after they were re launched on December 4^{h} clearly showed that investors were hesitant to participate in futures trading Experts were of the opinion that investors in agricultural commodities were in wait and watch mode because they feared that the Government might impose a ban on these commodities anytime When the Government had announced the ban on commodities like chana in May many investors had to square off their position within a day incurring some losses Nevertheless the losses were covered with the expansion of business in non agriculture commodities

4 3 3 4 Impact of ban on futures trading in rubber

Commodity experts feel that of the four products refined soya chana rubber and potato banned for futures trading restrictions on rubber could have been avoided This is because rubber is not an essential commodity and has no direct impact on Wholesale Price Index (WPI) Price of rubber had been on the rise even before futures

trading began The prices of RSS 4 quality rubber rose from Rs 26 per kg to Rs 44 per kg from 1998 to 2003 From 2003 onwards rubber was caught in a bullish trend The post 2003 period was good for farmers as they managed to reap positive returns on rubber This could be better understood through statistics In 2000 for example the RSS 4 quality rubber cost was Rs 32 per kg Against this the selling price was Rs 30 to Rs 31 implying that the returns were negative for farmers In 2001 the situation worsened but improved after 2002 when the selling price stayed higher than the production cost In 2008 the selling cost rose to Rs 100 as against the production cost of Rs 44 (Economic Times 12 May 2008)

In a meeting organised by NMCE to assess the damage caused due to suspension of running rubber futures it was found that over 750 traders had suffered losses Around 4 300 outstanding positions existed in the rubber contract when the trading was banned Of this nearly 1 200 were for the May contract and 1 800 for the June contract while the rest were spread between the July and August contracts The rubber traders in Kerala demanded compensation from FMC following the Government s decision to ban rubber futures If the Government decides to ban rubber futures the same decision could in future be applied to other commodities like pepper The very concept of closing the trade was wrong The Government appeared to have acted under pressure to take some steps to check inflation but the action amounted to exerting control without addressing the real issue (Business Line 16 May 2008)

It was reiterated that futures trading was not responsible for the rise of rubber prices as was evident from the rubber prices after the imposition of the ban Rubber prices in spot market reached an all time high of Rs 120 in Kottayam and Kochi though futures trading was banned a week ago Rise in the price and supply of crude oil and other fundamentals were responsible for the firming up in rubber price (www thehindubusinessline com)

The Rubber Board also did not favour any ban on futures trading in the commodity At the same time it reinforced that the futures should make a positive effect on the growers The growers would have to get a fair idea of how prices would behave in the future Rumours have become part and parcel of commodity futures

trading ever since the Government banned rice wheat tur and urad without any basis Such rumours only add to volatility Leave alone rubber there is no documentary evidence to prove futures trading is pushing up prices of any commodity in spot market (Business Line 26 May 2008)

Bright days are ahead for agri futures as some of the re launched commodities are expected to score good volumes in 2009 Besides the commodity market is also hopeful that the Government may lift the ban on rice wheat urad and tur imposed in early 2007

It was widely argued as evident from the above discussion that futures trading in natural rubber was the major reason for the increase in natural rubber prices in the domestic market There were chances of manipulations in the futures platform by artificially jacking up/pushing down prices by speculative elements The volatility in daily prices was very high during a certain period which had adverse impact in the spot market prices Rubber Board had taken up the issue with the Forward Markets Commission and the daily price variation in futures trading has been brought down from six per cent to three per cent Thereafter futures prices were more regulated and the impact of futures has been minimized in spot prices Rubber is an internationally traded commodity and hence international prices will have an influence on domestic prices Futures trading was suspended with the aim to control speculative hike in prices which contributes the spiraling inflation But even in the post ban period the country witnessed a hike in the spot rubber prices Even the Government which had set up the Abhijit Sen Committee to probe the link between price rise and futures market failed to come up with concrete evidence and in its report did not recommend ban on commodity futures This indicates that there were over riding factors that influenced rubber spot prices other than futures trade The steep increase or huge fluctuations in natural rubber prices certainly will have adverse impact in rubber goods manufacturing industry To sum up banning of futures trade was a war against inflation and rubber has fallen a victim to it

Being an agro based country the opportunity to flourish commodity futures trading in India is very high It is strongly apprehended by the market experts that the turnover of Indian commodity futures market will overtake the capital market turnover in the near future There is enormous potential in this sector not only in terms of

trading but also in terms of opportunities for developing value added services in terms of quality warehousing gradation and certification services modern marketing practices frontier technology based clearing and settlement dissemination of price and trade information and so on In comparison with the commodity futures market of more developed countries Indian commodity futures market which has set up modern institutions demutualised nation wide multi commodity exchanges and adopted the best practices of electronic trading and clearing is in an ascent/developing stage Once the market attains more depth and volume more awareness among common mass will be generated which in turn will lead to an efficient market in all respects

4 4 Prediction techniques

Predictions concerning futures prices are obtained from conditional probability distributions that depend on recent price information The complexity and difficulty of predicting commodity futures prices with a reasonable level of precision on one hand and the emergence of data mining techniques and computational intelligence techniques such as neural networks fuzzy set etc as alternative techniques to the conventional statistical regression and Bayesian models with better performance on the other hand have paved the road for the increased usage of these techniques in various areas of economics and finance Included in these areas is the utilization of genetic algorithms and genetic programming for portfolio optimization stocks selection using neural network and predicting the Standard and Poor (S&P) 100 index using rough sets Stocks and futures traders have come to rely upon various types of intelligent systems to make trading decisions

Several intelligent systems have in recent years been developed for modelling expertise decision support and complicated automation tasks For predicting the value of commodity futures people use historical price data of that commodity Mathematically values which run in a series and vary over time are known as a time series Technical analysis focuses on the past data of an asset such as a commodity futures contract in order to predict its future behaviour Thus in essence technical analysis is devoted to studying time series of data related to financial instruments including commodities futures stocks etc Technical analysts examine this historical data and attempt to formulate rules which explain the behaviour that they observe They look for patterns in the data and attempt to generalize from those patterns in order

to predict the future behaviour of the variable in question such as the price of the asset Some technical analysts specialize in stocks others in futures or commodities yet others in foreign exchange rates Technical analysts use a variety of methods in their attempts to extract valuable information from time series Some of the methods such as Box Jenkins methods or other linear regression approaches rely on their assumption of a linear relationship among the variables

In recent years there has been continued interest in the issue of the forecastability of future spot prices using econometric model The econometric models commonly used for prediction include Autoregressive Integrated Moving Average (ARIMA) Multiple Linear Regression (MLR) Generalized autoregressive conditional heteroskedasticity (GARCH) Autoregressive conditional heteroskedasticity (ARCH) Vector autoregression (VAR) and Stochastic Volatility (SV) which uses time series data Time series analysis is an important approach to forecasting in which the past observations of the same variable are collected and analysed to develop a model describing the underlying data generating process Much effort has been devoted over the past decades for the development of time series forecasting models One of the most important and widely used time series models is the ARIMA Since its inception and in recent years ARIMA and MLR have gained momentum and been widely used as a viable intelligent and knowledge discovery technique in many applications including financial and investment areas

The present research was motivated by both the need to test the predictability of futures prices and by the desire to evaluate univariate and multivariate forecasting strategies Hence the focus of this study is to present a generic commodity futures price prediction model using these univariate (ARIMA) and multivariate models (MLR) These models are expected to extract knowledge in the form of price from monthly average rubber price movements that would guide farmers traders and investors whether to buy sell or hold rubber To increase the efficiency of the prediction process ARIMA with Statistical Package for Social Scientists (SPSS) has been done using the monthly average close price of rubber futures from National Multi Commodity Exchange (NMCE) for the period April 2003 to August 2008 For comparison of the forecasting efficiency of the models the results of ARIMA were compared with that of Multiple Linear Regression

4 5 Price movements of rubber futures through NMCE

Violent price fluctuations can be minimised through the futures prices as the demand and supply can get adjusted to the changing futures prices It will act as a signal for adopting appropriate strategies by producers consumers exporters and the market regulator FMC to face the situation The main outcome of the futures market is the emergence of an integrated price structure for the product throughout the country The spot prices and futures prices get appropriately linked although they may move in different directions The futures prices act as a benchmark for the decision making of the farmers exporters consumers and traders

The first objective of the study is to examine the price movements of rubber futures traded through NMCE The examination of the price movements starts with an analysis of the trend in rubber prices followed by that of crude oil prices and domestic rubber prices Line graphs correlation candlest ck charts Compound Annual Growth Rate and ANOVA were used Since prices and volume of transactions are closely related trend in volume traded of rubber futures is also discussed in this section

4 5 1 Trend in monthly rubber prices

For examining the trend of rubber prices monthly domestic rubber prices for a period of 25 years have been made available from www indexmundi com for the period July 1984 to June 2009 Prices are plotted on the XY chart where X axis represents the time in months and Y axis represents the prices in rupee terms The trend has been dep cted using line graph in Fig 4 2

Fig 4 2 Trend in monthly rubber prices July 1984 June 2009

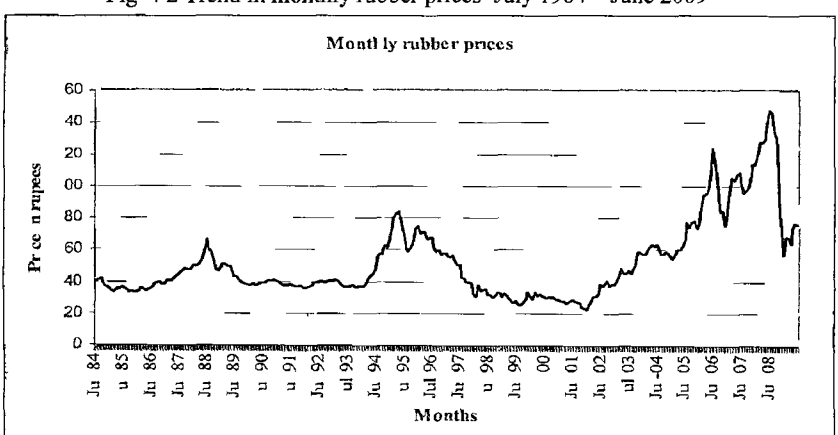


Fig 4 2 reveals a fluctuating trend for rubber prices from1984 to 2003 Prices have been increasing since March 1994 and reached as high as Rs 83 50 per kg in April 1995 This gives an indication that the rubber prices started showing an increasing trend even before futures trading in rubber started in April 2003 It is already reported that the scenario of selling prices of rubber being lower than its production cost gradually improved since June 2002 (Para 4 3 3 4) From February 2002 onwards the prices were showing a bullish trend and farmers started reaping positive returns from June 2002 Since then prices have been continuously increasing with minor falls in between but never below Rs 56 In the meantime ban was introduced in May 2008 when the prices reached as high as Rs 139 on the ground that futures trading was leading to speculative prices The highest monthly price was recorded in June 2008 the next month after the ban at Rs 146 The prices showed a drastic decline only after October 2008 more than five months after the ban It is also to be noted that the prices did not shoot up even after resuming of futures trading in December 2008

The analysis of the import and export of natural rubber of India has already revealed that there was an increase in the international prices of rubber during 2007 08 resulting in increasing exports and declining imports (Para 4 1 2 4) If the increase in rubber prices has been due to futures trading in India this would not have been reflected in the international prices of rubber Moreover rubber is an internationally traded commodity and domestic prices are influenced by the international prices (Para 4 3 3 4) The opportunity of price difference if any between the domestic and international prices would be utilized by the exporters and importers to their advantage as revealed by the increasing exports and declining imports of rubber from India during 2007 2008

Increasing demand for rubber in global markets and strong crude oil prices also led to sharp rise in rubber prices (Para 4 3 3 1) Rubber price has a direct relation with crude price as it is an important ingredient for synthetic rubber Because of rise in synthetic rubber price the demand for natural rubber has increased The relation between rubber and crude oil prices is analysed in the ensuing section

Unseasonal rain also affected the price leading to drop in production (www thehindubusinessline com) No direct link between commodities futures trading

and rising spot prices was established by the Abhijit Sen Committee (Para 4 3 3 3) In the opinion of Rubber Board there is no documentary evidence to prove that futures trading is pushing up prices of any commodity in spot market (4 3 3 4)

The above discussion leads to the inference that the increase in rubber prices cannot be attributed to futures trading alone On the other hand the increase in domestic rubber price could be attributed to various factors including increased economic activity shortage in NR production unfavourable climatic conditions government policies increase in international NR prices and increase in oil prices (Para 4 1 2 5)

4 5 2 Trend in rubber and crude oil prices

The discussion on trend in domestic rubber prices given above gave an indication that the rubber prices and crude oil prices are highly related Hence for examining the relationship between the crude oil prices and rubber prices analysis of these two prices has been done by using line graphs and correlation Data relating to crude oil prices from January 1986 to June 2009 were collected from www eia doe gov Prices were plotted on the XY chart were X axis represents time in months and Y axis represents prices The trend has been depicted using the line graph in Fig 4 3

Fig 4 3 Trend in monthly rubber and crude oil prices January 1986 June 2009

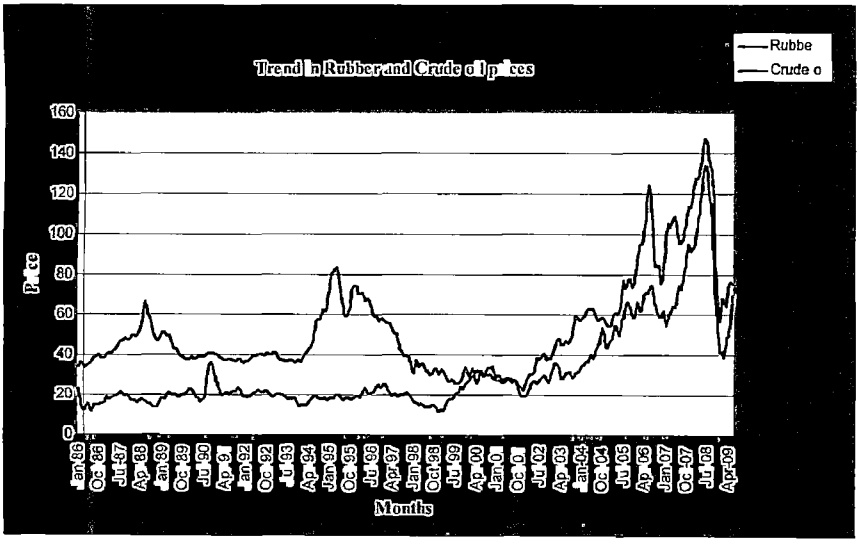


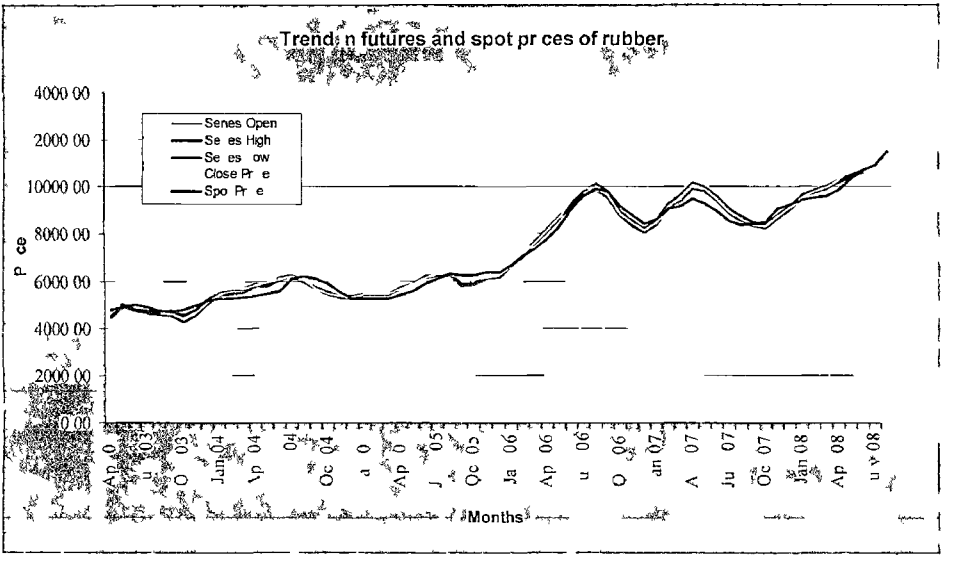
Fig 4 3 reveals a fluctuating trend of rubber and crude oil prices but both moving in tandem in almost all the months But in certain years the increase in crude oil prices was less compared to that of rubber prices In the year 1995 the rubber prices reached Rs 83 50 per kg due to the decline in rubber production in major rubber producing areas like Kerala It did not affect the crude oil prices as revealed by the almost steady trend of crude oil prices Again in the year 2000 to 2001 there was a decline in the rubber prices and it is already reported that the rubber farmers were not able to meet the production cost in those years (Para 4 3 3 4) But the crude oil prices increased slightly compared to the previous years because of the strong growth of natural gas demand in most of the world regions From the middle of 2001 onwards the rubber prices and the crude oil price moved in the same direction since crude oil is one of the major ingredients in the production of synthetic rubber (Para 4 3 3 1) The increase in demand for the synthetic rubber also increase the demand and price of natural rubber Since the commencement of futures trading in rubber in 2003 also the same increasing trend is seen in the case of both crude oil and rubber prices Hence it can be inferred that increase in crude oil prices is one of the reasons for the increase in the rubber prices implying that the futures trading was not responsible for the increase in the domestic rubber prices

Once the relation between the rubber and crude oil prices was established effort was made to prove it statistically For this correlation between rubber and crude oil prices was worked out The correlation between crude oil prices and prices of rubber was found to be 0 845 which means that 72 per cent of the variation in rubber prices could be explained by the variation in crude oil prices Thus the increase in crude oil prices was one of the major reasons for the increase in the rubber prices can be substantiated

4 5 3 Trend of futures and spot prices of rubber

The price movements is analysed here with the data on futures and spot prices of rubber for the period from April 2003 to August 2008 The futures prices include the daily open high low and close prices of NMCE which were converted into monthly averages for drawing the line graph The prices in rupees were plotted on the XY chart where X axis represents the time in months and Y axis the prices and depicted in Fig 4 4

Fig 4 4 Trend in futures and spot prices of rubber April 2003 August 2008



It is evident from Fig 4 4 that the futures and spot prices under the study period are showing an increasing trend For the period from April 2003 to July 2006 close price of rubber futures is showing an upward trend and from July 2006 to January 2007 a decreasing trend Again it recovered to the earlier position and there were fluctuations upto December 2007 From January 2008 onwards the close price of rubber futures increased steadily and continued even after the ban in May 2008 Similar trend was noticed in the analysis of the monthly domestic rubber prices where the prices showed a drastic decline only after October 2008 (Fig 4 2) The spot price of rubber was always below the futures close price except for certain months and this provides an opportunity for hedging Both the futures and spot prices moved in the same direction Since the trend lines are very closely moving it implies that the spot and futures prices are highly related and prediction of one using the other is possible

4 5 4 Trend in volume traded of rubber futures

The trend in volume traded of rubber futures in NMCE for the period from April 2003 to August 2008 is depicted in Fig 4 5 For drawing the line graph the daily data on volume traded in tonnes of rubber futures were collected from the website of

NMCE and converted into monthly averages In NMCE one unit of trading equals one tonne The volume traded of rubber is plotted on the XY chart where X axis represent the time in months and Y axis represent the volume traded

Fig 4 5 Trend in volume traded of rubber futures April 2003 August 2008

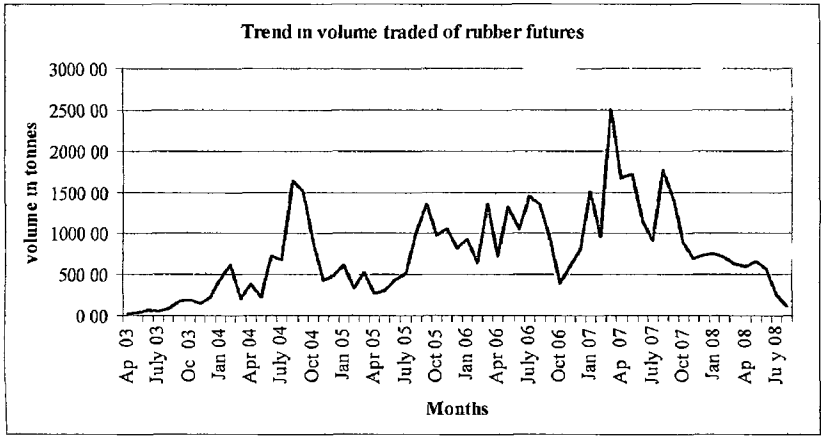


Fig 4 5 reveals a highly fluctuating trend over the period under observation The highest trading volume is observed in the month of March 2007 followed by August 2007 A comparison of Fig 4 4 with Fig 4 5 reveals that prices at these points were also high In the initial months after the introduction of futures trading the volume traded was too low since the people were not that much aware about the futures trading in rubber and there were not enough trading terminals for the traders to trade their products The reduction in volume traded of rubber futures in 2007 08 can also be attributed to the fall in the production and productivity of natural rubber during the year as already revealed (Para 4 1 2 1) The steep decline in the volume traded of rubber was due to the ban imposed from 7th May 2008 to 30th November 2008 After the imposition of ban only the outstanding positions were squared up and settled It is already reported that the ban on four commodities slumped the turnover of the four major commodity exchanges in India by 60 per cent The business of NMCE in which rubber is traded was affected by 30 per cent (4 3 3 3) Even after the ban on rubber futures was lifted and trading was resumed lower volumes were reported due to the loss of confidence of the participants towards futures trading and towards the Government

4 5 5 Price movements of rubber futures through Japanese candlestick chart

Candlestick chart one of the oldest methods is also used for analyzing the price movements of rubber futures through NMCE The Japanese Candlestick Chart shows the highest lowest opening and the closing prices of futures on a day today basis Here the high low close and open prices of rubber futures during the period April 2003 to August 2008 are considered The daily prices were converted into monthly averages and the candlestick chart was drawn with time in months on the X axis and prices on Y axis and graphically illustrated in Fig 4 6 In the chart the highest and the lowest prices of a month are joined by a vertical bar The opening price and the closing price of the month which would fall between the highest and lowest prices would be represented by a rectangle so that the price bar chart looks like a candlestick Thus each month s average trading is represented by a candlestick The green or red portion of the candlestick is called the body (also referred to as the real body) The long thin lines above and below the body represent the high/low range and are called shadows (also referred to as wicks and tails) The high is marked by the top of the upper shadow and the low by the bottom of the lower shadow

Fig 4 6 Price movements through Japanese candlestick chart

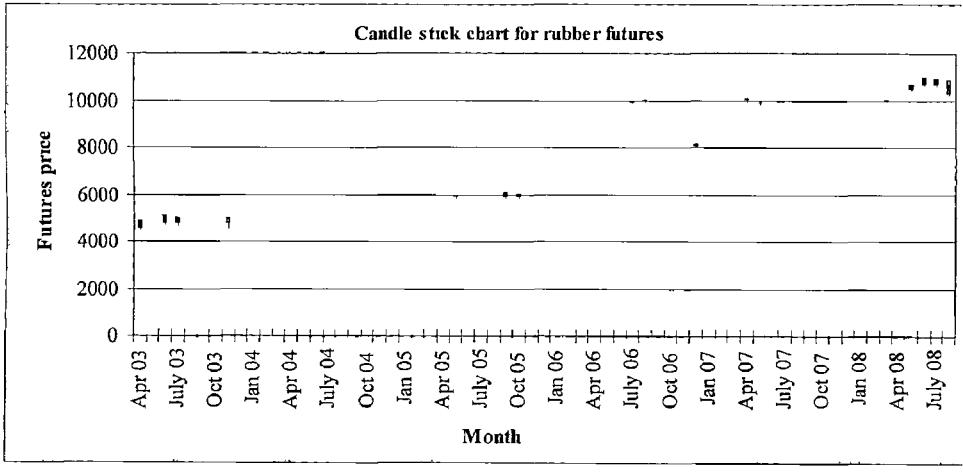


Fig 4 6 depicts more number of green candlesticks during the study period implying that the close price is higher than the opening price in most of the months There is less number of upper shadows for the green candlesticks indicating that in most of the months the high price and close price are equal But there are comparatively more number of lower shadows which means that the prices had gone beyond the open price on some days during that particular month

In the figure plus sign candlesticks (Doji) are also seen which means that the open and close prices of the respective months were same During the initial trading period the price has moved in the direction where the close price was higher than the open price then it started fluctuating from green to red candlesticks indicating that the close price was lower than the open price implying a bearish trend and indicating a selling pressure of rubber futures upto the month of August 2005 From September 2005 onwards there was again hike in the prices upto August 2006 after which a reduction in prices is seen During the end of the study period the price of rubber futures was continuously increasing and the Government banned futures trading in rubber because of the hike in inflation prevailing in the country In general the above candlestick chart reveals that the price movements of rubber futures in NMCE is fluctuating since the red green and doji candlesticks are seen intermittently

4 5 6 Price movements of rubber through Compound growth rate

CAGR shows the year over year growth rate of prices over a specified period of time It is calculated by taking the n^{h} root of the total percentage growth rate in open high low and close prices of rubber and that of volume traded where n is the number of years during the study period The daily data of these indicators for the period from April 2003 to August 2008 are taken and converted into monthly averages consisting of 64 months The compound annual growth rate was calculated by breaking the data of 64 months into three periods ie 20 months 20 months and 24 months

Table 4 4 Compound Annual Growth Rate of prices and volume traded of rubber

Prices	Open	High	Low	Close	Spot	Volume traded
CAGR 1st 20 months	0 008	0 007	0 007	0 003	0 004	0 165
CAGR 2nd 20 months	0 016	0 017	0 017	0 017	0 021	0 052
CAGR 3 d 24 months	0 009	0 008	0 009	0 012	0 014	0 123

From Table 4 4 it is evident that the CAGR of open high low close and spot prices and volume traded are representing a lower annualized gain of prices over the time horizon It implies that even though in absolute terms the futures and spot prices of rubber increased the rate of growth over the study period was low indicating that there was no abnormal increase in the prices as alleged by politicians It is already seen that Government was under pressure from various political parties to impose ban on futures trade in essential commodities alleging that futures trading is responsible for the sharp rise in prices Although umpteen number of reports concluded that there is no relation between inflation and futures market trading in chana potato soy oil and rubber were suspended mainly due to the pressure from the then Left party which blamed futures trading for price rise (Para 4 3 3 3) Increasing crude oil prices has also been pointed out as one of the major reasons for the sudden increase in the domestic prices of rubber from 2003 to 2008 (Fig 4 3) Crude oil prices have also been on the highest at $132 32 per barrel in June 2008 (www eia doe gov) and the domestic rubber prices were also at the highest in June 2008 Hence the finding that the growth rate in CAGR of rubber prices was low supports the argument that futures trading was not responsible for the steep increase in rubber prices This inference is again statistically checked by the analysis of variance of CAGR which is depicted in Table 4 5

Table 4 5 Analysis of variance (ANOVA) of CAGR

Source of variation	SS	df	MS	F	P value	F critical value
Between Groups	0 0065	2	0 00323	1 3252	0 2951	3 6823
Within Groups	0 0370	15	0 0025			
Total	0 0435	17				

The Analysis of variance was performed to test whether there is any significant difference in the growth rate of open high low close spot price and volume traded of rubber futures between the first twenty months second twenty months and third twenty four months The results showed that the rate of growth is not significant over the different periods considered This reinforces the inference that the increase in rubber price was not caused by futures trading

4 6 Prediction of futures prices of rubber

Forecasting is an essential part of the managerial decision making process If decisions involve marketing or sales planning demand has to be forecasted for decisions on inventory level future requirements have to be forecasted and in decisions on new product introduction the market for the product has to be forecasted In case of futures trading also for the benefit of investors the futures price has to be predicted for their investment decision For a systematic approach one needs a forecasting model There are many approaches for developing a forecasting model One approach to forecasting uses time series data

Time series forecasting is a major challenge in many real world applications such as stock price analysis electricity prices natural rubber prices and flood forecasting This type of forecasting is to predict the values of a continuous variable (called as response variable or output variable) with a forecasting model based on historical data There are two types of time series forecasting modelling methods univariate and multivariate Univariate modelling methods generally use time only as

an input variable with no other outside explanatory variables (Celia *et al* 2003) For instance univariate modelling is used to predict the future value based on historical data without considering the cause and effect between input and output A few commonly employed methods in univariate time series models are moving average (MA) exponential smoothing and ARIMA Multivariate models are used to establish cause and effect relationships in the system In other words it is used to discover causal factors that affect the behaviour of the time series data As different from univariate multivariate models contain more than one variable in its equations One of the commonly used multivariate models is the Multiple Linear Regression (MLR)

In this study different techniques of forecasting are discussed and used for predicting the futures prices of rubber all the models using time series data The models are the Multiple Linear Regression Model Principal component analysis and the univariate model of Box Jenkins Autoregressive Integrated Moving Average (ARIMA) Model

4 6 1 Multiple Linear Regression

Regression analysis refers to techniques for the modelling and analysis of numerical data consisting of values of a dependent variable (also called a response variable) and of one or more independent variables (also known as explanatory variables or predictors) The dependent variable in the regression equation is modelled as a function of the independent variables corresponding parameters (constants) and an error term The error term is treated as a random variable It represents unexplained variation in the dependent variable The parameters are estimated so as to give a best fit of the data Most commonly the best fit is evaluated by using the least squares method Regression can be used for prediction or forecasting of time series data inference and hypothesis testing and modelling of causal relationships

For the regression analysis the daily data on open high low and close prices and the volume traded from April 2003 to August 2008 are considered The daily data are converted into monthly average prices The series viz open high low and volume traded during the study period are fixed as the independent variables X_1 X_2 X_3 and X_4 respectively The dependent variable close price is represented by Y The

regression of current month s close price on two month s previous values of open high low and volume traded is tried The resultant regression equation with a R square 92 1 per cent is as follows

$$Y = 374\ 83 + 1\ 22\ X_1 \quad 1\ 38\ X_2 + 1\ 19\ X_3 \quad 0\ 22\ X_4$$

Table 4 6 Summary of multiple linear regression analysis

Model	R	R Square	Adjusted R Square	Std Error of the Estimate
1	960	921	915	575 60121

The R square and Adjusted R square for the analysis are 92 1 per cent and 91 5 per cent respectively The positive square root of R square is called the multiple correlation coefficients and measures the linear association between Y (close price) and the predictor variables X X_2 X_3 and X_4 (open high low and volume traded) The value of R increases as more terms are added to the model even if the new term does not contribute significantly to the model An increase in the value of R square cannot be taken as a sign to conclude that the new model is superior to an older model A better statistic is to use the adjusted R square statistic which is also taken into consideration

Table 4 7 Analysis of variance (ANOVA) of the regression model

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	2238125 91 630	4	55953147 90 8	168 881	000
	Residual	1921637 1 363	58	331316 748		
	Total	2430289 62 993	62			

ANOVA Table indicates that the model as a whole is a significant fit to the data In the analysis of variance displayed in Table 4 7 the F value of 168 881 indicates a significant positive relationship between the dependent variable close price and independent variables open price high price low price and volume traded

Table 4 8 Coefficients of the regression model

Model	Unstandard zed Coeff c ents		Standardized Coeff cients	t	Sig
	B	Std Error	Beta		
(Constant)	374 83	300 16		1 25	0 22
VAR00001	1 22	1 19	1 20	1 03	0 31
VAR00002	1 38	1 58	1 38	0 88	0 38
VAR00003	1 19	1 38	1 17	0 86	0 39
VAR00004	0 22	0 17	0 06	1 29	0 20

The actual and predicted close price of rubber futures using multiple linear regression is depicted in Fig 4 7 The deviation between the actual and predicted close price is shown in Fig 4 8

Fig 4 7 Trend in actual and predicted close prices of rubber futures using MLR

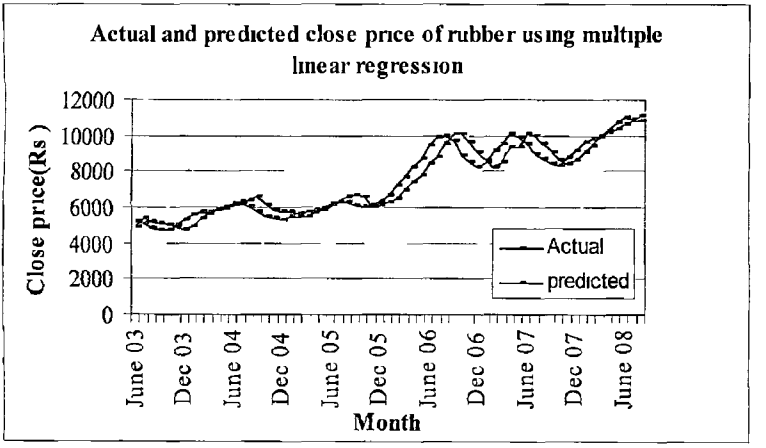
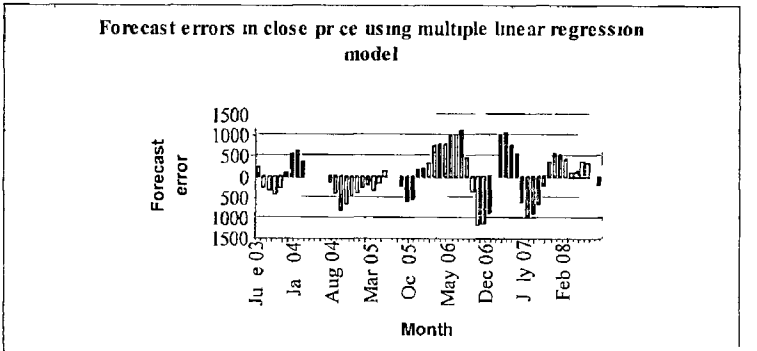


Fig 4 8 Forecast errors in close price using MLR



From Fig 4 7 and Fig 4 8 it can be seen that the variation in the series of actual and close price of rubber futures is very low But it cannot be considered as a good model because of the insignificance of the regression coefficients

Even though the value of R square is very high none of the regression coefficients are significant in the above multiple linear regression model This may be due to the consequence of multicollinearity in the multiple linear regression analysis involving the independent variables viz open high low and volume traded which are highly correlated This problem can be eliminated by the method of Principal component analysis

4 6 2 Principal Component Analysis

The principal component analysis has been done in order to reduce the problem of multicollinearity in the multiple linear regression model The results of the identification of the principal component are depicted in Table 4 9 Fig 4 9 and Table 4 10

Table 4 9 Total variance explained in principal component analysis

Componen t	Init al Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumul at ve %
1	3 385	84 635	84 635	3 385	84 635	84 635
2	614	15 338	99 973			
3	001	018	99 991			
4	000	009	100 000			

Fig 4 9 Screen plot of principal component analysis

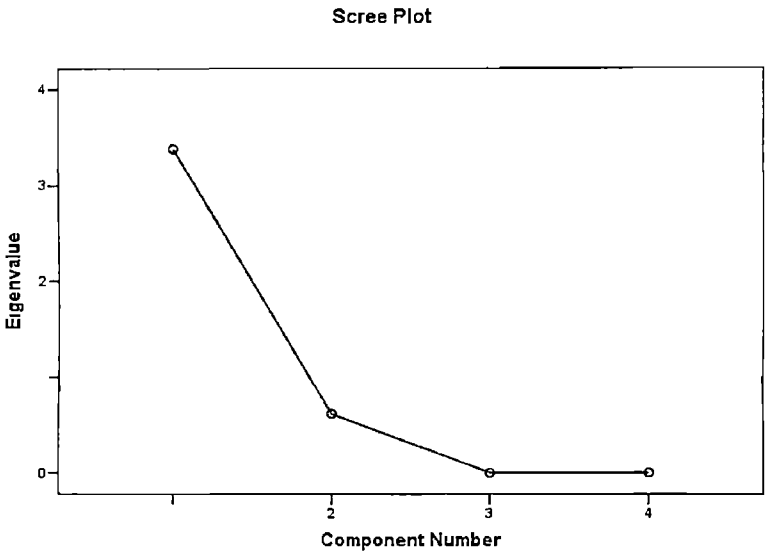


Table 4 10 Component score coefficient Matrix

	Component
	1
VAR00001	291
VAR00002	291
VAR00003	291
VAR00004	203

From the screen plot it can be observed that the first component is a significant contributor towards the variation in the dependent variable Hence using the first component alone ie the first component generated using the open price the prediction of close price of rubber futures can be done The first component itself can predict the variation in the close price accurately

The futures close price of rubber has been predicted using the regression on principal component by means of the following equation and the results are summarized in Table 4 11 Table 4 12 and Table 4 13

$Y = 419.89 + 3.36 P_1$

Table 4.11 Summary of the principal component analysis

Model	R	R Square	Adjusted R Square
1	.958	.917	.916

The R square and Adjusted R square for the regression equation fitted using the Principal components as regressor are 91.7 per cent and 91.6 per cent respectively. Hence with P_1 ie the first component generated using open price 91.7 per cent of the variation in the close price of rubber futures can be predicted.

Table 4.12 Analysis of variance of the principal component

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	2.228E8	1	2.228E8	672.964	.000[a]
	Residual	2.020E7	61	331118.299		
	Total	2.430E8	62			

Table 4.13 Coefficients of the principal component analysis

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	Beta		
(Constant)	419.886	280.455		1.497	.140
VAR00001	3.363	0.130	0.958	25.942	.000

The predictability of the regression model fitted using principal component as the regressor can be depicted through a graph given in Fig. 4.10

Fig 4 10 Trend in monthly or ginal close prices and predicted close prices of rubber futures using regression on principal component

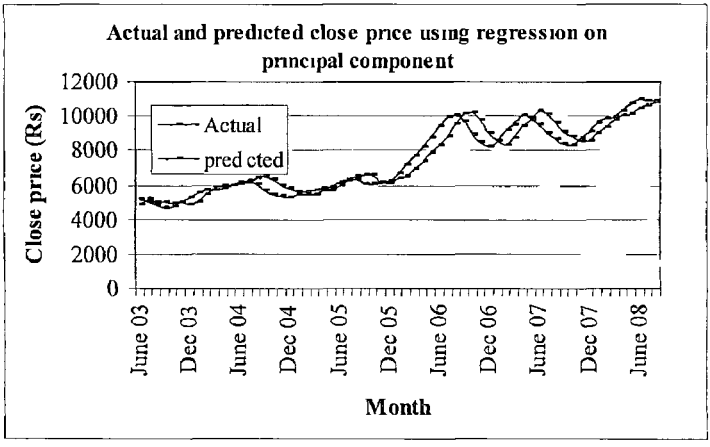
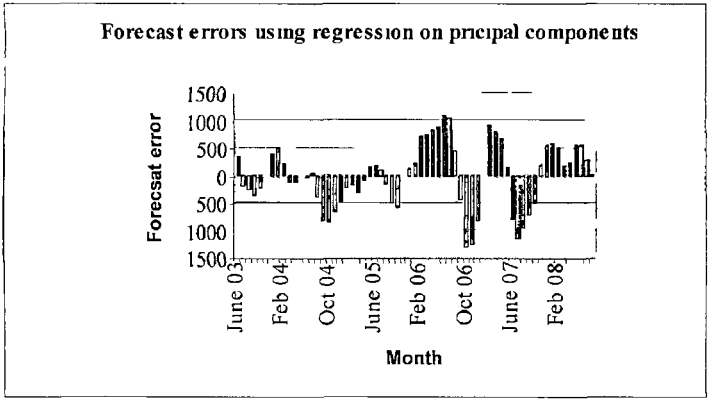


Fig 4 11 Forecast errors using regression on principal components



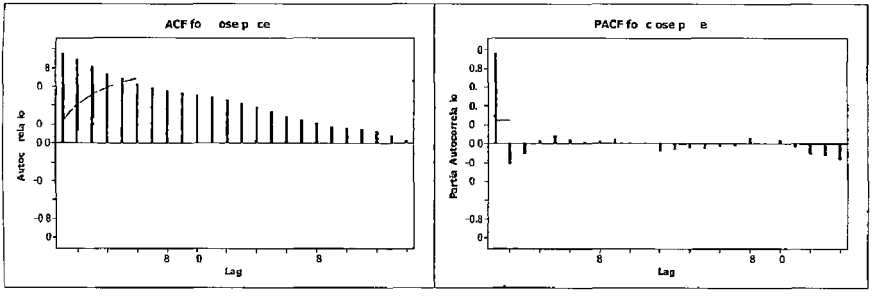
From Figures 4 10 and 4 11 it can be seen that the close price of rubber futures can be predicted with high accuracy using only a single regressor generated from the open price in the model Fig 4 11 explains that the deviations are both negat ve and positive which means that the predicted price has increased from the actual price and also the predicted price has decreased from the actual close price and the resulting errors follow normal distribution

4 6 2 Building ARIMA model for predicting futures price of rubber

Monthly data for the period from April 2003 to August 2008 pertaining to close price of rubber from National Multi Commodity Exchange are analyzed by the univariate time series method of ARIMA Identification of the best model is done by looking at the Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) generated by the software MINITAB 15 and the estimation of the parameters in the model was done by using SPSS 16 0 From the Fig 4 12 it was observed that the series is not stationary So it was differenced once The ACF and PACF of this differenced series are given in Fig 4 12(1) and 4 12(2) The series had not become stationary even after the first differencing and it is evidenced from the figures as the spikes did not fit in the confidence interval

Fig 4 12 (1)
ACF for the close price of rubber

Fig 4 12 (2)
PACF for the close price of rubber



Since the data for the period from April 2003 to August 2008 had been used for the analysis the lag length for calculating ACF and PACF was taken as 24 i e one third of the total number of months Since the ACF and PACF of original series were exponentially decaying it can be modelled as an ARMA (2 4) as the PACF had 2 and ACF had 4 significant sp kes Since the original series had already been differenced twice the model can also be rewritten as ARIMA (0 2 4)

measure of how much a dependent series varies from its model predicted level MXAFE is the largest forecasted error which is considered a measure useful in imagining a worse case scenario for the forecasts Assuming that the estimated model is a true representative of the forecasting period the post sample RMSFE should be consistent with the residual standard error of the estimated model As a result the comparison of forecast performance based on the MAFE MAFPE RMSFE and MXAFE are made

The principal objective of developing an ARIMA model for a variable is to generate post sample period forecasts for that variable Its strength lies in the fact that the method is suitable for any time series with any pattern of change and it does not require the forecaster to choose apriori the value of any parameter Its limitations include its requirement of a long time series

Excellent reviews are documented in the field of ARIMA modelling for the forecast of futures prices of rubber Similar results have been established by several authors in developing ARIMA models with respect to the fact that the model parameters have not gone beyond 3 thus making the model building a much easier task even for the non statisticians Saeed *et al* (2000) found that the best model for forecasting of wheat production in Pakistan was ARIMA (2 2 1) Forecasting sugarcane production in India was well fitted using ARIMA (2 1 0) model by Mandal (2004) Carpio (2002) established that production response of cotton in India Pakistan and Australia could be done using ARIMA (1 0 0) model Price of oil palm could be predicted efficiently using ARIMA (2 1 0) model (Rangsan and Titida (2006) ARIMA model for forecasting wholesale price of oil palm was ARIMA (1 0 1) and pure oil price of oil palm was ARIMA (3 0 0) Sen (2000) found that Time Series Modelling and Forecasting of Sarawak Black Pepper Price could be done using ARIMA (1 0 0) model

The software SPSS 16 0 ranked ARIMA (0 2 4) as the best model with minimum Normalised Bayesian Information Criteria (BIC) It is evident that the nonstationarity of the series is made stationary by taking the second order difference (d 2) The brief output is given in Table 4 14 and Table 4 15

Table 4 14 Statistics calculated of the best diagnosed model for the close price of rubber futures

R squared	0 990	Normalised BIC	10 478
RMSE	182 079	Lung Box Q	18
MAPE	1 971	DF	17
MAE	146 017	Sig	470
MaxAPE	4 612	Transformation	Nil
MaxAE	412 279	Difference	2

Table 4 15 Estimate of the parameters for ARIMA (0 2 4) model for the close price of rubber futures

	Estimate	SE	t	Sig
MA(4)	0 705	0 115	6 113	0 00

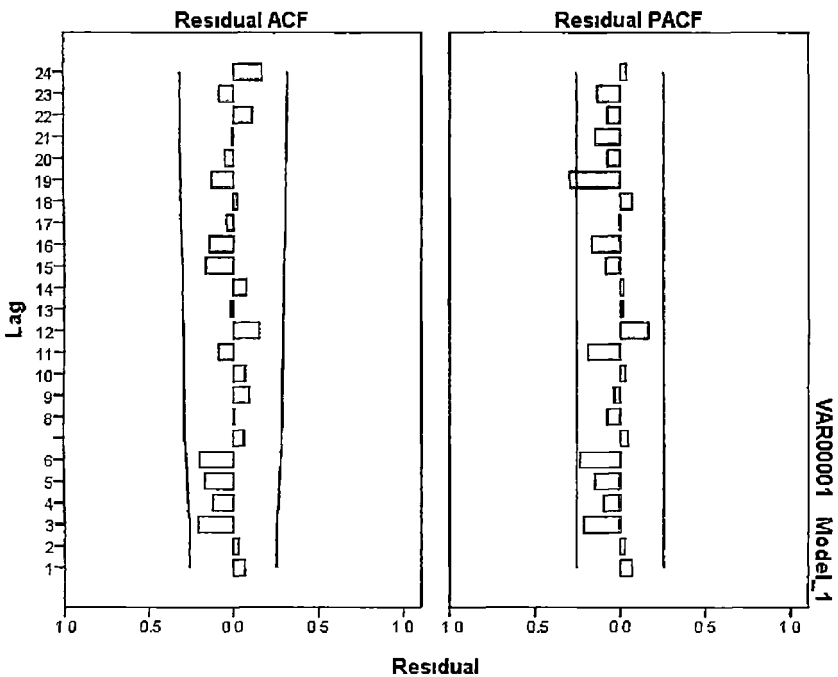
Thus the most suitable model ranked was ARIMA (0 2 4) for predicting the futures prices of rubber which is apparently parsimonious (meaning only a few number of regressors have been used) with MAPE 1 97 per cent which indicates that the forecasting inaccuracy is very low with a significantly high value of adjusted R^2 99 per cent and statistically significant regression estimates This is evident from the Fig 4 14 in which the actual and forecasted line graphs move without much variability From the Fig 4 15 (1) and Fig 4 15 (2) it is evident that the distribution of forecast errors follow N $(0\ \sigma^2)$ i e the residuals are white noise which assures independence of errors and is an essential requirement for any statistical testing procedure The model is given by

$$Y_t \quad 2Y_{t\,1} \quad Y_{t\,2} \quad 0\,705\,\varepsilon_{t+4}$$

Where Y_t denotes the close price of rubber in the month t and ε_t denotes the forecast error

Figure 4 15 (1)

Figure 4 15 (2)



4 7 Comparison of the forecasting performance of different forecasting models

The final objective of the study is to compare the forecasting performance of the univariate and multivariate models Hence a comparison of the performance of the forecasting models developed by multiple linear regression regression model using principal components and ARIMA (Autoregressive Integrated Moving Average) models are made and the results depicted in Table 4 16 Fig 4 16 and Fig 4 17 The R square and Adjusted R square are used to monitor the forecasting performance of each model

Table 4 16 Forecasting performance of MLR PCA and ARIMA

Type of Model	Mathematical form	R square	Adjusted R square
Multiple linear regression	$Y = 374\ 83 + 1\ 22\ X \quad 1\ 38\ X_2 + 1\ 19\ X_3 \quad 0\ 22\ X_4$	921	915
Regression using Principal components	$Y \quad 419\ 89 + 3\ 36\ P_1$	958	917
ARIMA	$Y \quad 2Y_{t\,1} \quad Y_{t\,2} \quad 0\ 705\ \varepsilon_{\,+4}$	990	989

As shown in Table 4 16 the R square and Adjusted R square for the univariate ARIMA model is higher than the other two models used Also the forecasting errors of this model were negligible indicating the forecasting efficiency of the ARIMA model to predict the futures prices of rubber

Fig 4 16 Trend in actual and predicted close prices of rubber futures using MLR PCA and ARIMA models

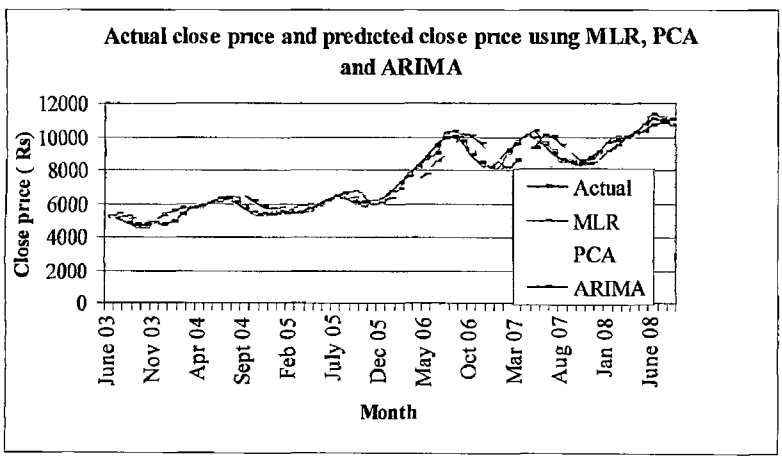


Fig 4 16 shows the efficiency of prediction by both univariate and multivariate models The actual close prices and the predicted close prices using ARIMA are almost moving in the same direction as compared with the predicted values by MLR model and PCA model

Fig 4 17 Prediction errors in MLR PCA and ARIMA

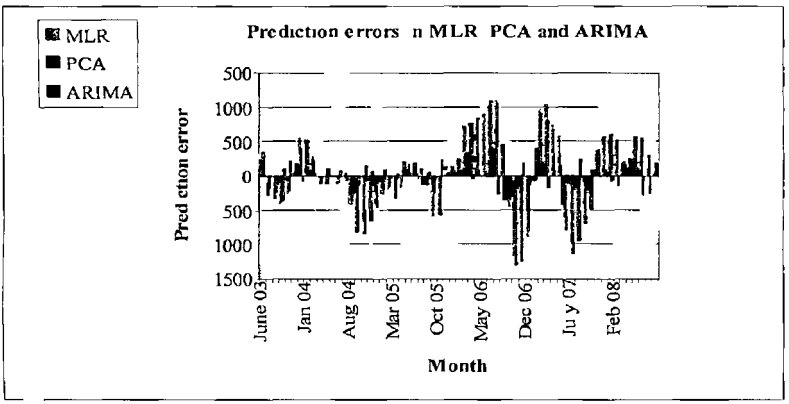


Fig 4 17 shows higher errors of prediction in the multiple linear regress on model and principal component model than in the ARIMA model wh ch proves the superiority of ARIMA modelling for predicting the futures prices of rubber with better accuracy The prediction errors of PCA compared to MLR is higher The errors in PCA s upto Rs 1500 for one tonne in both negative and positive direction which means that for one kilogram of rubber there is a difference of Rs 13 between the actual and the predicted price Similarly in the case of MLR the maximum deviation from the actual and predicted value is nearly Rs 1200 again implying that for one kilogram the difference between the predicted and the actual close prices of rubber futures is Rs 12 As compared to the errors of MLR and PCA the error in ARIMA is negligible The highest deviation in prediction by ARIMA is only Rs 411 for one tonne But it is to be noted here that MLR predicted the close price us ng the highly correlated independent variables viz open high low and volume traded while the PCA predicted the close price using the principal component generated by the single var able viz open price Even though PCA predicted the close price of rubber with the single variable the deviation from the actual close price follows a normal distribution

The prediction error of MLR when compared with that of PCA is lower which is due to the multicollinearity of the independent variables used in MLR Hence PCA can be considered as a good fit for prediction compared to MLR

Thus it can be concluded that the univariate time series model is a superior alternative for forecasting purposes since ARIMA models are superior to all other models in predicting the close price of rubber futures ARIMA is apparently parsimonious and hence superior to all other models ARIMA model fits the price series well and have correctly predicted the futures price trend within the sample period of study Thus the comparative performance of univariate and multivariate model proves that the univariate model is more accurate in predicting futures prices of rubber than the multivariate model

Summary and Conclusion

CHAPTER 5

SUMMARY OF FINDINGS AND CONCLUSION

A huge domestic market growing furiously because of the massive production of passenger and commercial vehicles ensures a better future for consumption of rubber products As 65 per cent of the rubber produced in India is utilized by the automobile industry the Indian rubber industry is set to grow at a fast pace India has a huge potential to become a commendable global player due to a strong technically trained manpower base and many supporting institutions for education training and testing As India is already ranked as the fourth largest consumer and producer of natural rubber and the tenth largest total rubber producer it is the preferred destination for some of the world s largest companies in the rubber industry through direct investment and technical tie ups (www indiarubberexpo in)

Domestic prices of natural rubber had witnessed considerable fluctuations The price of natural rubber could have stayed at the extraordinary high levels that reached about a few months ago in the peak season since there had been noticeable increase in demand from some sections of rubber based industry This demand was reflected in the price of natural rubber as rubber is an industrial raw material Many growers have the opinion that the futures trading in rubber is the only future for rubber The advantages of futures trading over conventional trading are competitive price discovery risk covering and price stabilization The potential benefits could be realized only if it functions efficiently under stringent regulations to protect the genuine interests of different stakeholders The present study was an attempt to analyse and predict the price movements of rubber futures since the prediction of futures prices is useful to the investors in futures trading like farmers and traders The study was undertaken with the following specific objectives

i) to examine the price movements of rubber futures through NMCE
ii) to predict the futures prices of rubber and
iii) to compare the forecasting pe formance of univariate and multivariate models

The study was based on secondary data Major sources of secondary information were the commodity exchanges of India and the publications of Rubber Board Daily futures prices of open low high close and spot prices and volume traded of rubber were collected for the period April 2003 to August 2008 from National Multi Commodity Exchange (www nmce com)

Data regarding the global scenario of rubber was made available from the website (www rubbberstudy com) of International Rubber Study Group Singapore Data on rubber producing countries rubber consuming countries major importers and exporters of rubber were collected from the Rubber Statistical News published by Statistics and Planning Department Rubber Board Kottayam The price movements of rubber futures have been examined using ordinary line graph correlation candlestick chart CAGR and ANOVA Prediction of futures prices of rubber has been done using the multivariate and univariate tools of Multiple linear regression Principal component analysis and Autoregressive integrated moving average after which their forecasting performance has been compared

5 1 The major findings

The major findings of the study are summarized and presented in the subsequent order

5 1 1 Rubber economy an outline

5 1 2 Concept of commodity futures

5 1 3 Commodity futures markets in India

5 1 4 Prediction techniques

5 1 5 Price movements of rubber futures through NMCE

5 1 6 Prediction of futures prices of rubber

5 1 7 Comparison of the forecasting performance of univariate and multivariate models

5 1 1 Rubber economy an outline

Rubber is an important plant not only for world economic strategies but also for the daily use of human beings Natural rubber is one of the most important agro based industrial raw materials in the world Nearly 60 per cent of the natural rubber is consumed by the transport sector

5 1 1 1 Global rubber scenario

Natural rubber normally accounts for nearly 40 per cent of the global demand while synthetic rubber a petroleum product accounts for the rest Tokyo Commodity Exchange Singapore Commodity Exchange and Osaka Mercantile Exchange are the major exchanges undertaking futures trading of rubber Kuala Lumpur London and New York are the major physical markets

i) Global production of natural rubber

Out of the world rubber production 93 per cent is the contribution by the developing countries The key contributors towards the production of natural rubber are Thailand Indonesia Malaysia and India India is the fourth largest producer of natural rubber and India s contribution towards the total world s production has slightly increased in 2008 compared to the previous year with a share of 8 85 per cent

ii) *Global consumption of natural rubber*

China is the largest consumer of natural rubber with more than one fourth of the total India has come to third position in consumption in the year 2008 More than half of the global consumption is shared by China USA Japan and India Whereas India can meet most of her consumption out of her own production China USA and Japan have to import most of the natural rubber that they consume

5 1 1 2 Indian scenario of rubber

India is the fourth largest producer and third largest consumer of natural rubber in the world Nearly 1 09 million small farmers are engaged in rubber

cultivation in India At present small holdings account for 89 per cent of the area and 93 per cent of the production in the country

i) *Area under cultivation production and productivity of natural rubber*

The rubber plantation industry in India has achieved the highest growth rate among the major crops in the country in terms of area production and productivity The fall in production of NR in the country during the year 2007 2008 was mainly due to vector borne diseases affecting tappers in the major rubber growing areas in Kerala unfavourable weather conditions and abnormal leaf fall RSS account for 72 per cent and block rubber 10 per cent of the rubber production of India

ii) *Consumption of natural rubber*

The tyre industry consumes almost 58 per cent of the rubber produced in the country Due to increased production in various categories of tyres and the growth in exports the auto tyre industry registered a considerable growth in the consumption of natural rubber

iii) *Production and consumption of synthetic rubber*

Synthetic Rubber (SR) production in the country registered a growth of 1 8 per cent in the year 2008 compared to the previous year which was mainly in the poly butadiene rubber The import of SR by the rubber goods manufacturing industry also increased by 13 78 per cent during the same period

iv) *Import and export of natural rubber*

Ribbed Smoked Sheets account for 45 per cent and block rubber 40 per cent of the imports during 2008 Ninety eight per cent of the import was through advance license Tyre is the major form in which rubber is exported from India The increase in the international prices of rubber led to increase in exports and decrease in imports Import and export of natural rubber from India is shaped by the gap between global and Indian prices If global prices are ruling higher compared to the domestic prices

imports will be less while the opposite would take place in the case of domestic price staying higher compared with global prices

v) *Domestic and international prices of natural rubber*

The price of NR both in domestic and international markets has remained volatile since April 2007 The increase in domestic rubber price could be attributed to various factors including increased economic activity shortage in NR production unfavourable climatic conditions government policies increase in international NR prices and increase in crude oil prices

vi) *Rubber futures in India*

Futures trading in Rubber flagged off on 15 h March 2003 for the very first time in India through NMCE The main spot markets for rubber in the country are Kottayam Cochin and Kozhikode in Kerala The most commonly used grade in the futures market is the RSS 4 grade and the minimum lot size for one trade is 100 kg

5 1 1 2 Rubber Scenario in Kerala

Kerala is the leading rubber plantation state in India accounting for nearly 90 per cent of India s rubber production This plant which was brought to India during the British rule has spread all over Kerala and to other parts of India and provides daily income to the growers as well as the workers The Indian Rubber Board was established on the 19 April 1947 to look after the rubber plantation industry in the country

5 1 2 Concept of commodity future

A futures contract is a legally binding agreement made between two parties to buy or sell a commodity or financial instrument at an agreed price on a specified date in the future Commodity markets across the world are experiencing an exponential growth in recent years Commodity futures trading is one of the very few ways to make good profits in a shorter time with low investment Commodity futures market

is expected to help the market participants through two vital economic functions viz price discovery and price risk management

5 1 3 Commodity futures markets in India

In India futures trading started in an organized manner in 1875 at Mumbai for cotton by the Bombay Cotton Trade Association Certain mill owners unhappy with the working of their association began a new association in 1893 called the Bombay Cotton Exchange Limited It conducted futures trading for cotton In due time futures markets were started for pepper turmeric potato sugar and jaggery Because of the apprehensions of the Indian Government that speculators were manipulating the market to the detriment of the farmers futures trading was banned in the 1960s except for a few commodities As the country embarked on economic liberalization policies and signed the Uruguay Round General Agreement on Tariffs and Trade (GATT) in the early nineties the Government realized the need for futures trading to strengthen the competitiveness of Indian agriculture and the commodity trade and industry At present futures markets is permitted for about 146 commodities through 22 exchanges

5 1 3 1 Structure and regulation of commodity futures market in India

The FCRA 1952 provides for three tier regulatory system for commodity futures trading in India the Ministry of Consumer Affairs the Forward Markets Commission and an association i e commodity exchanges recognized by the Government of India on the recommendation of Forward Market Commission

5 1 3 2 Leading commodity exchanges of India

The Government of India has allowed national commodity exchanges These exchanges are expected to offer a nation wide anonymous order driven screen based trading system for trading The Forward Markets Commission (FMC) regulates these exchanges Consequently three national commodity exchanges and 19 regional exchanges have been approved to commence business in this regard

5 1 3 3 National Multi Commodity Exchange of India Ltd (NMCE)

NMCE is the first demutualised electronic multi commodity exchange of India which was granted the national status on a permanent basis by the Government of India and became operational since 26th November 2002 with headquarters in Ahmedabad NMCE was promoted by commodity relevant public institutions It is the only Commodity Exchange in the world to have received ISO 9001 2000 certification from British Standard Institutions (BSI) NMCE has been the pioneer in many aspects it was the first Exchange to take up the issue of differential treatment of speculative loss to enroll participation of high net worth corporate securities brokers in commodity derivatives market to introduce warehouse receipt system within existing legal and regulatory framework and to complete the contractual groundwork for dematerialization of the warehouse receipts

5 1 3 4 Multi Commodity Exchange (MCX)

MCX is a demutualised nationwide electronic multi commodity futures exchange set up by the Financial Technologies of India Limited having permanent recognition from the Government of India for facilitating online trading clearing and settlement operations for futures market across the country in November 2003 Presently MCX offers futures trading in 59 commodities

5 1 3 5 National Commodity and Derivatives Exchange Ltd (NCDEX)

NCDEX is a professionally managed on line multi commodity exchange It is the only commodity exchange in the country promoted by national level institutions It commenced its operations on December 15 2003 NCDEX is a nation level technology driven de mutualised on line commodity exchange with an independent Board of Directors and professional management NCDEX currently facilitates trading of 57 commodities

5 1 3 6 National Board of Trade Ltd (NBOT)

NBOT was incorporated on July 30 1999 to offer integrated transparent and efficient trading platform to various market intermediaries in the commodity futures trade It trades only in three commodities namely soya oil mustard and crude palm

oil It is a catalyst for the development of the Indian oilseeds growers trade and industry by providing the cost effective and efficient services

5 1 3 7 *Trends in futures trading of agricultural commodities*

India s volatile political climate requires the Government to engage in measures regardless of the economic rationale

i) Soaring prices of agricultural commodities

Prices of agricultural commodities especially edible oils chana and rubber rose sharply from the last quarter of 2007 Soy oil prices gained by about 35 per cent within a short span of five months from October 2007 to February 2008 and touched Rs 740 per quintal in domestic markets Domestic prices moved up sharply tracking global prices especially Chicago Board of Trade (CBOT) and Malaysian Derivatives Exchange (MDEX) Chana prices also gained by more than 30 per cent due to lower output concerns Rubber prices gained by 23 per cent in the domestic markets Increasing demand for rubber in global markets and strong crude oil prices led to sharp rise in prices

ii) *Government measures to contain prices of agricultural commodities*

Government took various measures to control the rising prices of food commodities It reduced import duty on refined edible oil from 40 45 per cent to zero per cent to control the rising prices of edible oils India imports about 50 per cent of the total domestic requirement of edible oil and is price taker in global markets Price movements especially in Malaysia and US has direct impact on the Indian domestic markets Apart from reducing import duties on edible oils Government also directed the state governments to strictly impose the stock limits on foodgrains and pulses Government of India banned the export of wheat lentils and most rice varieties built up grain reserves imposed export restrictions on steel and cement placed price caps on selected commodities and raised the country s cash reserve ratio in an attempt to reduce liquidity in the system

iv) Ban on futures trading in agricultural commodities

In spite of taking measures by the Government inflation remained high and touched 42 month high of 7 61 per cent in April 2008 With key state and general elections coming closer the ruling Congress Party was under heavy pressure to bring the country s inflation rate down to a comfortable level of about four percent

Government of India had already de listed four major commodities like wheat rice urad and tur during January February 2007 Although umpteen number of reports concluded that there is no relation between inflation and futures market trading in chana potato soy oil and rubber were suspended mainly due to the pressure from the then Left party which blamed futures trading for price rise Inflation remained above seven per cent for four consecutive weeks from March 2008 onwards Finally the Indian Government placed a ban on futures trading in soybean oil rubber chickpeas and potatoes on May 8 ^{h} in its latest attempt to rein in the country s fast growing inflation which reached 7 57 per cent in late April Government of India commissioned an Expert Committee in March 2007 under the chairmanship of Abhijit Sen to study the impact of futures trade on agriculture commodity prices and whether futures trading actually drove up spot prices The Committee submitted its report on 29th April 2008 in which no direct link between commodities futures trading and rising spot prices was established It found no evidence of futures trade affecting the spot prices of agriculture commodities The ban lapsed on November 30 and these four commodities resumed trading on December 4 ^{h} with the easing of inflation to eight per cent level for the week ended November 29 ^{h} 2008 The ban on four items not only affected the business on exchanges but also killed investors confidence

v) *Impact of ban on futures trading in rubber*

Rubber not being an essential commodity has no direct impact on Wholesale Price Index (WPI) Because of the ban on rubber futures 750 traders suffered losses Around 4 300 outstanding positions existed in the rubber contract when the

trading was banned Of this nearly 1 200 were for the May contract and 1 800 for the June contract while the rest were spread between the July and August contracts Since rubber prices did not come down even after the ban on futures trading it was reiterated that futures trading was not responsible for the rise of rubber prices Rubber prices in spot market reached an all time high of Rs 120 in Kottayam and Kochi though futures trading was banned a week ago Rise in the price and supply of crude oil and other fundamentals were responsible for the firming up in rubber price

5 1 4 Prediction techniques

For predicting the value of commodity futures people use historical price data of that commodity Technical analysts use a variety of methods in their attempts to extract valuable information from time series Some of the methods uch as Box Jenkins methods or other linear regression approaches rely on their assumption of a linear relationship among the variables The econometric models commonly used for prediction include Autoregressive Integrated Moving Average (ARIMA) Multiple Linear Regression (MLR) Generalized autoregressive conditional heteroskedasticity (GARCH) Autoregressive conditional heteroskedasticity (ARCH) Vector autoregression (VAR) and Stochastic Volatility (SV)

5 1 5 Price movements of rubber futures through NMCE

The trend in rubber prices and the relation between rubber and crude oil prices have been discussed for analyzing the price movements of rubber Since prices and volume of transactions are closely related trend in volume traded of rubber futures were also analysed The price movements of rubber futures and spot prices traded through NMCE were also studied

5 1 5 1 Trend in monthly rubber prices

Trend in monthly domestic rubber prices examined using 25 years data from July 1984 to June 2009 revealed a fluctuating trend from1984 to 2003 Rubber prices started showing an increasing trend even before futures trading in rubber started in April 2003 From February 2002 onwards the prices were showing a bullish trend

and farmers started reaping positive returns from June 2002 Ban was introduced in May 2008 when the prices reached as high as Rs 139 on the ground that futures trading were leading to speculative prices The highest monthly price was recorded in June 2008 the next month after the ban at Rs 146 The prices showed a drastic decline only after October 2008 more than five months after the ban The prices did not shoot up even after resuming of futures trading in December 2008 Rubber price has a direct relation with crude price as it is an important ingredient for synthetic rubber Because of rise in synthetic rubber price the demand for natural rubber increased There was an increase in the international prices of rubber during 2007 08 resulting in increasing exports and declining imports of India Moreover rubber is an internationally traded commodity and domestic prices are influenced by the international prices Hence increase in rubber prices cannot be attributed to futures trading alone On the other hand the increase in domestic rubber price could be attributed to various factors including increased economic activity shortage in NR production unfavourable climatic conditions government policies increase in international NR prices and increase in oil prices (Fig 4 2)

5 1 5 2 *Trend in rubber and crude oil prices*

Analysis of the trend in monthly rubber and crude oil prices revealed that the there is strong association between the rubber prices and crude oil prices Since crude oil is an essential commodity for the production of synthetic rubber the increase in the prices of crude oil naturally increase the rubber prices Hence the demand and price for the natural rubber also increased Thus the increase in crude oil prices was one of the major reasons for the increase in the rubber prices implying that the futures trading was not responsible for the increase in the domestic rubber prices

5 1 5 3 Trend of futures and spot prices of rubber

The price movements of rubber futures examined in relation to the spot prices revealed an increasing trend in both futures and spot prices The spot price of rubber was always below the futures close price except for certain months and this provides an opportunity for hedging Both the futures and spot prices moved in the same

direction Since the trend lines are very closely moving it implies that the spot and futures prices are highly related and prediction of one using the other is possible

5 1 5 4 Trend in volume traded of rubber futures

The prices of rubber and its volume traded are related and hence the trend in volume traded of rubber futures was examined for analyzing the price movements The trend explained that the fluctuations in the prices and the volume traded are highly related In the initial months after the introduction of futures trading the volume traded was too low since the people were not that much aware about the futures trading in rubber and there were not enough trading terminals for the traders to trade their products The reduction in volume traded of rubber futures in futures were attributed to the fall in the production and productivity of natural rubber The steep decline in the volume traded of rubber was due to the ban imposed from 7th May 2008 to 30h November 2008 The business of NMCE in which rubber is traded was affected by 30 per cent Even after the ban on rubber futures was lifted and trading was resumed lower volumes were reported due to the loss of confidence of the participants towards futures trading and towards the Government

5 1 5 5 Price movements of rubber futures through Japanese candlestick chart

Candlestick chart revealed more number of green candlesticks during the study period implying that the close price was higher than the opening price in most of the months There was less number of upper shadows for the green candlesticks indicating that in most of the months the high price and close price were equal There are comparatively more number of lower shadows which means that the prices had gone beyond the open price on some days during that particular month Plus sign candlesticks (Doji) were also seen which means that the open and close prices of the respective months were same D uring the initial trading period the price has moved in the direction where the close price was higher than the open price then it started fluctuating from green to red candlesticks indicating that the close price was lower than the open price implying a bearish trend and indicating a selling pressure of rubber futures In general the candlestick chart revealed that the price movements of

rubber futures in NMCE was fluctuating since the red green and doji candlesticks were seen intermittently

5 1 5 6 Price movements of rubber through Compound growth rate

The CAGR of open high and low close spot prices and volume traded represented a lower annualized gain of prices over the time horizon It implies that even though in absolute terms the futures and spot prices of rubber increased the rate of growth over the study period was low indicating that there was no abnormal increase in the prices of rubber The low CAGR of rubber prices supports the inference that futures trading was not responsible for the steep increase in rubber prices The results of the analysis of variance of CAGR showed that the rate of growth was not significant over the different periods considered emphasising that the increase in rubber price was not caused by futures trading

5 1 6 Prediction of futures prices of rubber

The prediction of futures prices of rubber was done using the Multiple Linear Regression Model Principal component analysis and the univariate model of Box Jenkins Autoregressive Integrated Moving Average (ARIMA) Model

5 1 6 1 Multiple Linear Regression

For the regression analysis the daily data on open high low and close prices and the volume traded from April 2003 to August 2008 were considered The R square and Adjusted R square for the analysis were 92 1 per cent and 91 5per cent respectively Even though the value of R square was very high none of the regression coefficients were significant in the multiple linear regression model This might be due to the consequence of multicollinearity resulted in the multiple linear regression analysis involving the independent variables viz open high low and volume traded which are highly correlated Hence it could not be considered as a good fit for prediction of futures prices of rubber

Bibliography

5 1 6 2 Principal Component Analysis (PCA)

From the analysis of the principal component it was observed that the first component (open price) was a significant contributor towards the variation in the dependent variable (close price) Hence using the first component alone ie the first component generated using open price the prediction of close price of rubber futures could be done The first component itself could predict the variation in the close price with a high degree of accuracy The R square and Adjusted R square for the regression equation fitted using the Principal components as regressor were 91 7 per cent and 91 6 per cent respectively The first component generated using open price could predict 91 7 per cent of the variation in the close price of rubber futures

5 1 6 3 Autoregressive integrated moving average model (ARIMA)

The most suitable model ranked was ARIMA (0 2 4) for predicting the futures prices of rubber which is apparently parsimonious (meaning only a few number of regressors have been used) with MAPE 1 97 % which indicates that the forecasting inaccuracy is very low with a significantly high value of adjusted R^2 99% and statistically significant regression estimates The actual and forecasted line graphs of close price of rubber futures move without much variability

5 1 7 Comparison of the forecasting performance of different forecasting models

A comparison of the performance of the forecasting models developed by multiple linear regression regression model using principal components and ARIMA (Autoregressive Integrated Moving Average) models showed that ARIMA model was superior to all other models in predicting the close price of rubber futures MLR predicted the close price using the highly correlated independent variables viz open high low and volume traded while the PCA predicted the close price using the principal component generated by the single variable viz open price Even though PCA predicted the close price of rubber with the single variable the deviation from the actual close price follows a normal distribution The prediction error of MLR when compared with that of PCA is lower which is due to the multicollinearity of the

independent variables used in MLR Hence PCA can be considered as a good fit for prediction compared to MLR The R square and Adjusted R square for ARIMA model were higher than the other two models used Also the forecasting errors of this model were negligible indicating the forecasting efficiency of the ARIMA model The errors which mean the maximum deviation between the predicted and actual close prices were Rs 13 Rs 12 and Rs 4 for one kilogram of rubber for PCA MLR and ARIMA respectively Moreover being apparently parsimonious ARIMA is superior to the other two models used in the study

Conclusion

The study on ***Prediction of futures prices of rubber*** revealed an increasing trend in the prices of rubber which had started even before the commencement of futures trading in rubber in India Analysis of the trend in monthly rubber and crude oil prices revealed that the there is strong association between the rubber prices and crude oil prices The increase in domestic rubber prices could be attributed to various factors including increased economic activity shortage in NR production unfavourable climatic conditions government policies increase in international NR prices and increase in crude oil prices The increase in crude oil prices was one of the major reasons for the increase in the rubber prices There was no abnormal increase in rubber prices implying that futures trading was not responsible for the increase in the domestic rubber prices The close price and spot prices of rubber futures in NMCE moved almost in the same direction and hence the prediction of one using the other was possible ARIMA could predict the futures prices of rubber with high degree of accuracy Comparison of MLR PCA and ARIMA as forecasting models revealed that the univariate ARIMA model is superior to the other models in predicting futures prices of rubber

The reviewed studies exposed that forecasting accuracy of the models could be improved when time series and econometric forecasts were combined into a composite forecast The combined model could be an effective way to improve forecasting accuracy achieved by either of the models used separately Optimal forecasting produced by combined modelling scored better than application of the simple ARIMA model Hence the integration of different models could be an

effective method of improving upon their predictive performance especially when the models in the ensemble are quite different ARIMA models were integrated with Artificial Neural Network (ANN) and Fuzzy logic in order to overcome the linear and data limitations of ARIMA models thus obtaining more accurate results Empirical results of financial markets forecasting indicated that the hybrid models exhibited effectively improved forecasting accuracy This opens up scope for further research with composite forecasting models for improving the forecasting or prediction accuracy of rubber futures prices

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PREDICTION OF FUTURES PRICES OF RUBBER

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ABSTRACT OF THE THESIS

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ABSTRACT

The present study entitled *PREDICTION OF FUTURES PRICES OF RUBBER* was conducted with the following objectives

i) to examine the price movements of rubber futures through NMCE
ii) to predict the rubber futures prices and
iii) to compare the forecasting performance of univariate and multivariate models

Futures trading perform two important functions price discovery and hedging of price risk hence an effort to predict the futures prices of rubber a predominant crop of Kerala is of contemporary significance to the rubber growers and traders

The study was based on secondary data Futures prices of daily open low high close and spot and volume traded of rubber were collected for a period from April 2003 to August 2008 from National Multi Commodity Exchange The daily data were converted into monthly averages for the analysis The price movements of rubber futures have been examined using ordinary line graph correlation candlestick chart Compound Annual Growth Rate (CAGR) and ANOVA Correlation has been found inorder to measure the relation between the domestic rubber prices and the crude oil prices ANOVA was used to find the significance in the growth rate of rubber prices over different time periods Prediction of futures prices of rubber has been done using the Multiple Linear Regression Principal Component Analysis and ARIMA and the results of these models were compared to measure the forecasting performance of these models

The price movements of rubber futures using the line graph showed that both the spot and futures prices were highly related and hence prediction of one with the other is possible Rubber is an internationally traded commodity and the hike in the rubber prices globally influence the domestic the rubber pries Moreover the rise in the crude oil prices

influenced the natural rubber prices since the movements of domestic rubber prices and the crude oil prices showed a positive correlation The volumes traded were also fluctuating over the years The ban on futures trading in rubber drastically reduced the volume traded due to loss of investors confidence Candlestick chart showed that the prices were fluctuating with bullish bearish and neutral trend Even though the rubber prices increased the growth rate of rubber prices and volume traded over the years revealed a lower annualized gain making it clear that there was no abnormal hike in the rubber prices Hence the rise in rubber prices cannot be attributed to futures trading

The prediction of futures prices of rubber were done by different forecasting models viz ARIMA MLR and PCA MLR got R square and adjusted R square of 92 1 per cent and 91 5 per cent both values showing the significance of the model for predicting the futures prices Even though the value of R square is very high none of the regression coefficients were significant in the multiple linear regression model This might be due to the multicollinearity of the independent variables viz open high low and volume traded which are highly correlated Hence the principal component analysis was done The R square and Adjusted R square for the regression equation fitted using the Principal components as regressor are 91 7 per cent and 91 6 per cent respectively So with P_1 ie the first component generated using open price it was able to predict 91 7 per cent of the variation in the close price of rubber futures The ARIMA results got R square of 99 per cent wth MAPE 1 97 per cent indicating that the forecasting inaccuracy was very low and the Normalized Bayesian Criteria (BIC) of 10 478 indicated goodness of fit of the model and the accuracy of the prediction

While comparing the results of MLR PCA and ARIMA it was found ARIMA performed better in prediction Also the forecasting errors of ARIMA were negligible indicating the forecasting efficiency of the model Hence the study concluded that the univariate model outperforms the multivariate model with better accuracy in prediction