UNIVERSITY OF PETROLEUM AND ENERGY STUDIES, DEHRADUN

Dissertation

Power Pricing in India with respect to Distribution Companies

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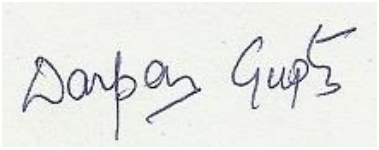
Student Declaration

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

()

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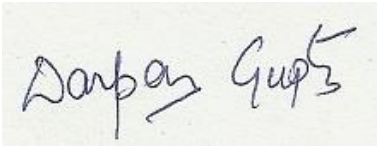
()

Darpan Gupta

Certificate

This is to certify that the dissertation report entitled "Reasons for Growing Popularity of Hedge Funds and their Implication on the Financial Market", submitted by Angkur Sarma to UPES for partial fulfillment of requirements for Masters of Business Administration (Energy Trading) is a bonafide record of the dissertation work carried out by him under my supervision and guidance. The content of the report, in full or parts have not been submitted to any other Institute or University for the award of any other degree or diploma.

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1. Introduction

Nearly 25% or 289 million people lack access to electricity in India. The power sector has been the core of energy policy in India, the aim of which centers around the three problems including energy access, energy security and climate change. As per IEA, by 2012, the country had recorded fifth largest installed capacity for power generation which multiplied three times from 289 TWh to 899 TWh within a span of 20 years. However, the per-capita electricity consumption is seen at 0.2% of the world average and about 7% of Organization of Economic Co-operation and Development (OECD) countries' level. This to an extent signals towards the absolute challenges faced by the power sector in such a vast country.

Year	Per Capita Consumption (kWh)
	(Gross Gen.+Net import)/Mid year Population
2005-06	631.4
2006-07	671.9
2007-08	717.1
2008-09	733.5
2009-10	778.6
2010-11	818.8
2011-12	879.2

Table 1: All India annual per capita consumption of Electricity

At present, India's power sector agonizes from the precise problems that it has been trying to report which are non-viability of projects owing to financial conditions coupled with inadequate investments in the sector. Another issue that the recently come up is the severe shortage of fuel. India's power sector had observed a highly rigid system that was closely dominated and regulated by state utilities, which were vertically-integrated until the start of 1991 economic reforms. The state electricity boards, (SEBs) were the controller and manager across the electricity supply chain including generation, transmission and distribution within a given state. However, ever increasing T&C losses coupled with a distorted tariff structure stemmed a situation near bankruptcy of these boards. Further result was an insufficient and unreliable supply of electricity.

AT&C losses were 27% in FY 2010-11 across nation and are estimated to be equivalent to 1.5% of India's GDP (CEA,2010) or approximately USD 17 billion in terms of 2010 GDP. Compared to the most efficient countries including Japan (5%) and south Korea (4%) and other emerging economies including China (5%), Indonesia (10%) and Brazil (17%), in 2009 (WDI, 2012). The losses in India are extremely high. The losses are closely attached to the private investment, that is, it is observed that state having low private share in power capacity icur or experience heavy losses.

There are two perspectives for calculation of Power pricing i.e. from generators perspective (supply side) and from consumers' perspective (demand side). Consumers' perspective is the one which is more of quality based analysis rather than quantitative based. Consumers' perspective will be more influenced by the presence of government authority. In generators' perspective, there can be two kind of transactions i.e. Bilateral and Exchange based.

In this study, we will be analyzing the pricing mechanism which should be used to determine the power prices for better negotiation. In the bilateral transaction, there are many factors which affect the price i.e. supply and demand scenarios, transmission costs, power purchase cost, fuel costs etc. In exchange based transactions, we will be analyzing the pricing mechanism of trading exchanges i.e. Indian Energy Exchange (IEX) and Power Exchange of India Ltd. (PXIL). These trading exchanges publish their prices time to time depending upon the transaction or product types available at the exchanges.

We will be analyzing the pricing mechanism in case of bilateral transaction with respect to other countries i.e. The US, Nordic countries and European countries. We will try to visualize that whether models of other countries can be implemented to our country. We will be comparing the pricing mechanism and products offered of electricity exchanges i.e. IEX and PXIL with other countries exchanges i.e. NordPool, European Energy Exchange and Amsterdam Energy Exchange etc.

1.1. Power Scenario in India

India is facing several challenges in respect of power sector. It has been seen that India has significant growth in generation over the years, but still it is suffering shortage and supply constraints. According to an article in Business Standard, it has been reported that India have energy shortage of 2.1% and peak load shortage of 2.6 % in 2015-16. It was previously reported that energy shortages were 7.8% and peak load shortage was 13% in 2000-01. India have the lowest per capita power consumption among the world.

According to Central Electricity Authority, India's per capita electricity consumption is 1010 Kilowatt-hour (kWh) in 2014-15 which was 914.41 kWh in 2012-13. Comparatively, China has per capita consumption of 4000 kWh while developed nations are averaged around 15,000 kWh per capita. It is being seen that GDP has direct link to the power consumption. As the GDP growth increase, shortage of power becomes more severe.

There are many factors which are relating to the current power situation in India. These factors can be categorized as high Aggregate Transmission and Distribution Losses, energy shortage and peak load demand, demand in excess of supply, low Plant load factor, low availability of fuel, weak financial position of the Electricity Boards. The ministry of Power is continuously making efforts for the reduction of the transmission and distribution losses. The ministry is also making efforts in form of the regulation to attract more investment in developing the generation and transmission facilities.

Ministry of Power is also promoting the development of viable renewable energy technologies with the help of Ministry of Non-Conventional Energy Sources. The viable renewable energy technologies include biomass power, wind, small hydro, demand side management and energy conservation etc.

Central Electricity Authority (CEA) has projected shortfall of 1,50,000 MW in last 15 years while target of increasing the generation capacity of 10,000 MW per year was set. This target seems to be not fulfilling so CEA has modified it to 8.500 MW per year. In original, the capacity addition is on average 3,000 MW per year. This generation capacity addition is mostly done by the state i.e. 49% while 46% of the capacity addition is done by the central plants Out of these additions private sector has contributed very less i.e. 4%.

There are various kind of transactions in power sector i.e. Short Term, Medium Term, Long Term, Contingency transactions. According to the recent statistics, Total electricity generation in India leaving renewable and captive power plants beyond the scope in January, 2016 was 91671.33 MUs. Out of this generation, 10.05% i.e. 9215.24 MUs was transacted through STOA.

Type of Short Term Transaction	Volume (MUs)	%age out of total electricity generation
Bilateral (through traders, TAM in PXs & directly between Distribution Companies)	4699.94	5.13%
Collective Transactions in DAM (through IEX & PXIL)	2863.63	3.12%
Through DSM	1651.67	1.80%
TOTAL	**9215.24**	**10.05%**

Table 2: Short Term Transaction data of India in January, 2016

These transactions can be further distributed. Out of bilateral transactions which is 51% of the short term transactions, 36.53% are transacted through traders and term-ahead contracts on power exchanges while remaining 14.47% are transacted directly between distribution companies.

1.2. Basic Introduction of Power Market

In this section, we will discuss about the basic technical things which should be known by anybody who want to understand the power market. We will give short introduction of the general regulations which are related to Power Market.

What is Electricity? Electricity is not yet been defined by any sources but generally the flow of electrons is known as electricity. Conductor is used to provide path to the electrical charges to flow which we know generally as electric wires.

Is there any difference between Power and Energy? and on what basis billing is done? Power is the rate of doing work and generally expressed in terms of Joule/sec or Watt. Energy is the practical commercial unit of electrical energy or work performed. For example, If any device of power rating 1 kW is connected to electrical supply for 10 Hours then it will consume 10 kWh. Here power is 1 kW while 10 kWh is the energy consumed. Billing will be done on the energy consumed.

What is Power Factor and Plant load factor? Power factor is ratio between real power and apparent power in any circuit. Plant Load factor is the actual energy produced in a given period of time in MWh in respect of the maximum possible energy in MWh which can be produced if plant has operated to its full capacity. In simple words, Power factor is effectiveness measured in terms of consumption while Plant load factor is the measurement of effectiveness in terms of generation.

How the demand is projected and calculated for the purpose of procurement and billing? Demand is the active power required in MW over any designated period of time. Demand forecasting and procurement is done on the basis of three type of demand i.e. Sanctioned Demand, Maximum Demand and Contract Demand. Sanctioned Demand means the load in kW/kVA which the licensee has agreed to supply from time to time subject to the governing terms and conditions in the absence of agreement between the licensee and the consumer. Maximum Demand is the maximum load measured in kVA/kW at the point of supply of a consumer during a particular time block. Its unit is also expressed in kW/kVA or MW/MVA. Consumer's contract demand means the maximum demand in kW/kVA agreed to be supplied by the licensee and indicated in the agreement between the licensee and the consumer. In other words, Contract demand is the demand (load in terms of kW/MW/kVA/MVA) based on the customer requirement with power supplier as per the supply agreement.

What is Electricity Duty? Why it is charged to consumers? Electricity Duty is the charge levied for, and paid to, the State Government for the energy consumed by a consumer or by a person other than a plant generating energy for his own use or consumption. This duty is computed at such rate a may be fixed by the State Government from time to time by notification in the Official Gazette of respective States.

What is Fuel Adjustment Cost? The Fuel adjustment cost (FAC) is the cost that permits jurisdictional utilities to regularly adjust the price of electricity to reflect fluctuation in the cost of fuel used to generate electricity. Fuel Adjustment Cost is decided after approval from CERC for Central Sector Generating Stations and respective SERCs for State sector Generating Stations. FSA is the additional fuel cost that was not collected from consumers by DISCOMs in the previous years. The monthly electricity bills of consumers for previous years did not cover the actual cost of fuel that distribution companies paid to generator to buy power. So, to make up for the loss that DISCOMs suffered, SERC has allowed the DISCOMs to collect this money.

Fuel costs are the major part of the cost for generating electricity. Fuel prices i.e. cost of coal, oil etc fluctuate widely over relatively short periods of time. The FAC allows utilities to adjust those fluctuations in their electric tariff.

1.3. Grid Connectivity in India and Mechanism of Power Flow

Grid management and Transmission are essential functions when we want to make the generated power to transmit from the generating stations to the consumers or to the load centers.

National rid in India is operated by Power Grid Corporation of India Limited which owns and operates about 1,00,619 circuit kms of transmission lines at 800/765 kV, 400 kV, 220 kV & 132 kV EHVAC & +500 kV HVDC levels and 168 sub-stations.

There are five regional grids in India namely Eastern Region (ER), Northern Region (NR), North-Eastern Region (NER), Western Region (WR) and Southern Region (SR). The first four regional rids are synchronously inter-connected whereas the southern region is asynchronously connected since the operating frequency of that region is low due to its low generation than the rest other four regions.

The National Load Dispatch Centre (NLDC) is the highest authority of the country who monitor the grid operation. Regional Load Despatch Centre (RLDC) prepares the schedule for its respective regions and sends the schedule to respective State Loa Despatch Centre (SLDC) of different states of that region who incorporates the schedule sent by RLDC into it own schedule.

The power flows through the Central Tranmission Utility (CTU) network responsible for inter-state transmission and State Transmission Utilities (STU) network responsible for intra-state transmission depending on the location where the seller injects (point of injection) the power or the buyer withdraw the power (point of withdrawal) by the method of displacement.

The RLDCs in India are presently owned, managed and operated by POSOCO (Power System Operation Corporation Limited) while the SLDCs in the state are owned operated and managed by the respective State Transmission Utility (STU) as the case may be. The EA 2003 has a provision for a National Load Despatch centre (NLDC) for optimum scheduling and dispatch of electricity across various regions and also coordinating cross border energy exchange in real time. Presently, POWERGRID is operating & maintaining the National power system. It is also maintaining the National Power System Desk (NPSD) in New Delhi for information exchange and facilitating inter-regional transactions. The cross border exchanges are coordinated by the RLDC of the region wherein the inter-national inter-connection is situated.

1.4. Indian Energy Exchange (IEX)

On 6th February, 2007, the CERC issued guidelines for grant of permission to set up power exchanges in India. Financial Technologies (India) Ltd. Responded by proposing then tentatively named "Indian Power Exchange Ltd." And applied for permission to set it up and operate it within the parameters defined by CERC and other relevant authorities. Based on the oral hearing on July 10, the CERC accorded its approval vide its order dated 31st August, 2007. IEX thus movd from the conceptual level to firmer grounds. On 9th June, 2008, CERC accorded approval to IEX to commence its operations and 27th June, 2008 marked its presence in the history of Indian Power Sector as Indian Energy Exchange Ltd. (IEX), India's first-ever power exchange goes LIVE.

On 27th June, 2013, IEX completed 5 years of successful business in Indian Power market.

There are numerous benefits of IEX, out of which some are described here.

- **Transparency**
  IEX offers a transparent, national level platform for trading electricity in India leading to a vibrant power market.

- **Access a diversified portfolio**
  IEX offers a broader choice to generators and distribution licensees at the national-level so that they can trade in smaller quantities and smaller number of hours without additional overheads.

- **Payment Security**
  IEX stand in as the counter party for all trades, so participanys need not be concerned about the risk-profile of the other party.

- **Minimal transaction overheads/charges**
  All charges are displayed on the IEX trading terminals, so there is no room for negotiation. The cost of transactions through IEX is much less than any other mode of transaction.

- **Efficient portfolio management**
  IEX enables participants to precisely adjust their portfolio as a function of consumption or generation Participants, especially distribution licensees, are enabled to precisely manage their consumption and generation pattern.

- **Hedging UI risks**
  IEX provides a tool to hedge against adverse movement in electricity prices. Thus, price risk are minimized.

- **Market Development**
  IEX has plans to launch a range of products to facilitate development of power markets in India in such a way that investment in capacity enhancement is encouraged.

1.5. Power Exchange of India Limited (PXIL)

Power Exchange of India Limited (PXIL) is India's first institutionally promoted Power Exchange that provides innovative and credible solutions to transform the Indian Power Markets. A deep understanding of the local markets is matched by PXIL's non-partial, unbiased and often fearless functioning, at time even in the face of uncomfortable conclusions. There core values are – integrity, excellence, commitment and continued innovation. These are the bedrock on which the edifice of PXIL stands. PXIL's unique combination of local insights and global perspectives helps its stakeholders to make better informed business and investment decisions, improves the efficiency of the power markets, and helps shape policies and projects. PXIL is India's first and only Quality Management System "ISO 9001:2008" certified Power Exchange in the country. On 22nd October, 2013, PXIL completed 5 years of successful business in Indian Power market.

PXIL is promoted by two of India's biggest exchanges i.e. National Stock Exchange of India Limited (NSE) and National Commodity & Derivatives Exchange Limited (NCDEX).

PXIL has taken several business initiatives to improve the exchange driven power market.

A) **Removal of Regulatory hurdles:** PXIL has identified resolution of the following three Regulatory issues to create a level playing field for Market participants across Power Exchanges.

- **Exchange specific NOC:** Previously, some of the SLDCs provided Exchange specific No Objection Certificate (NOC) for the Open Access consumers during this period the Open Access consumer was unable to transact on other PX. The process of receiving second NOC was prohibitive, hence many participants were reluctant to apply for second NOC and would instead wait till the expiry of the first NOC before applying for a new NOC. PXIL raised the matter of 'Exchange specific NOC' with the hon'ble CERC. The Hon'ble CERC issued an amendment to short term Open Access Regulations on Sept 11, 2013 providing for 'Exchange neutral NOCs' to be issued by all the SLDCs. With this new amendment, a market participant has a choice of transacting on any power exchange.

- **Allocation of Transmission Corridor:** Under the current principles of proportionate allocation of Transaction corridor the large applicant gets major share of transmission corridor and the smaller applicant gets a miniscule share. PXIL ha submitted a Petition to Hon'ble CERC proposing equal allocation to all the PXs, we expect CERC to initiate the proceeding and give a favorable order soon

- **NLDC Operating Charges:** The current structure of NLDC Operating charges creates an arbitrage that entices a participant to transact on an Exchange with large number of participants. PXIL has submitted a Petition to CERC pleading for uniform operating changes to be specified by the Commission. The hearing on the Petition are concluded, we expect CERC to issue the Order in early December that would help eliminate the anomaly and subsequent burden on PXIL

B) **Provision of NOC Automation software at SLDC:** NOC automation software was successfully installed at Punjab SLDC which automates the process of generating Exchange neutral NOC to be issued by SLDC to the applicant. In the next stagem this NOC software would be provided to other SLDCs that will ease the process of issuing Exchange neutral NOC.

C) **Focus on Retail Market:** The retail market (≥ 1 MW) has played a significant role in providing a stable base for Buy side participation on the Exchanges, this segment has the highest potential for growth across all the states in the country. Retail business being a primary driver of trades on Power Exchanges, we have taken initiatives through our 'Retail Wing' to supplement the efforts of Traders and advisory members by way of generating a lead to induce OA customers on PXIL platform. PXIL has currently focused its Retail Market in the state of Gujarat, Rajasthan, Punjab and Haryana followed by Himachal Pradesh, Odisha & Uttarakhand. It's also assessing the Open Access market in Andhra Pradesh and Tamil Nadu. They would make inroads in these markets to coincide with unified of NEW grid with SR grid.

2. Literature Review

A) "Forecasting Electricity Prices", Bunn, Derek W. and Karakatsani, Nektaria, London Business School, 2003.

This research paper is concentrated on the main issues and recent research on modeling and forecasting electricity prices. This research is derived from the application of models adapted from financial assets, for both spot and forward prices is reviewed. The conclusion and emphasis is placed on the virtue of computationally intensive structural modeling.

This paper is concluded by finding and detailing the issues and challenges faced in the electricity price forecasting. This research is inspired by the needs of risk management which is more concerned on capturing the distribution of prices over a period of time than actual levels of price at particular times.

B) "ARMA and GARCH-type Modeling Electricity Prices", Dong, Yan, Department of Mathematical Sciences, Chalmers University of Technology and Göteborg University, May, 2012.

This thesis paper is basically based on the Nord Pool market. In this paper, all the models related to electricity price forecasting i.e. ARMA, GARCH, Exponential GARCH, Extreme Value Theory are explain ed theoretically. There are different methods which are used data preparation and model selection i.e. Maximum Likelihood Estimation Model, Estimation of ARMA and GARCH model, AIC and analysis of residuals. All the models such as ARMA, ARMA-GARCH, ARMA-EGARCH and Extreme Value Distribution model are fitted and then simulated.

C) "Electricity Price Curve Modeling and Forecasting by Manifold Learning", Chen, Jie and Huo, Xiaoming, IEEE Transactions on Power Systems, Vol.23, No. 3, August 2008.

This research paper proposes a non- parametric approach for the modeling and analysis of the electricity price curve by the application of manifold learning methodology i.e. Locally linear embedding (LLE). The prediction method based on manifold learning and reconstruction is employed to make short term and medium term price forecasts. The method used in this paper is not only performs month-ahead prices over the other methods. The forecast accuracy of the fitted model is demonstrated by the numerical results using historical price data taken from the Eastern U.S. Electric power markets.

D) "Power Markets across the Globe and Indian Power Market", Mediratta, R.K., Pandya, Vishal and Khaparde, S.A., Fifteenth National Power Systems Conference, IIT Bombay, December 2008.

This research paper is based on the restructuring of power systems across the globe started with the redesigning of its power markets. The power market design determines the level of efficiency, transparency and flexibility offered to the market players. This paper discuss the operational aspects of some of the important power markets in North America, Europe and Australia. The power sector reforms in the Indian electricity market are also discussed along with the power exchange operations of Indian Energy Exchange (IEX) which is the first online electricity trading platform of India.

E) "Modeling and forecasting of day-ahead electricity price in Indian Energy exchange – evidence from MSARIMA-EGARCH model", Ghosh, Sajal and Kanjilal, Kakali, International Journal of Indian Culture and Business Management, Vol. 8, No. 3, 2014.

This research paper is totally based on the forecasting of the electricity prices of DAM market of Indian Energy Exchange (IEX). Electricity prices often exhibit extreme volatility due to its non-storable nature coupled with significant seasonal and diurnal variations of demand, supply constraints at peak hours and transmission bottlenecks. This study tries forecast the day-ahead hourly electricity price of Indian Eneryg Exchange (IEX) with an additional objective of modeling the volatility using MSARIMA and MSARIMA-EGARCH models. It has been found that MSARIMA-EGARCH model slightly outperform MSARIMA model in terms of in-sample forecasting performances. The study reveals that seasonality and time-varying volatility are present and past shocks to the variance are asymmetric with negative shocks give rise to higher volatility of price than positive shocks. The study also established that shocks to electricity prices volatility die out almost instantaneously. The above information can help to build up cost effective risk management plans for the participating companies in IEX.

The outcomes of this research paper are as follows. First, MSARIMA-EGARCH model confirms that past shocks to the variance are asymmetric with negative shocks give rise to higher volatility of price than positive shocks of an equal magnitude. The presence of asymmetry implies that the electricity prices might have experienced regime shift. Second, the shocks to electricity price volatility die out almost instantaneously and third, in-sample forecasting Performances reveal that incorporation of asymmetric time-varying volatility into an MSARIMA model improves the price forecasts in the day-ahead market.

3. Objectives

This report has been prepared after keeping following objectives in focus:

- Analyze the generation cost of electricity by different generators.
- Power purchase cost structure of different distribution companies.
- Fuel dependency analysis of power with respect of Distribution companies.
- Power pricing mechanism of different products in Power exchange.
- Analysis of risk associated with power prices in India
- Government policies available with respect of power pricing.
- Forecasting of Indian Energy Exchange Day Ahead Market Prices by the help of GARCH Modeling.

4. Research Methodology

3.1.Research Design

The research conducted will be descriptive in nature – that is, the data that will be collected through secondary media – and it will be thoroughly analyzed, and then, the industry would be explained so as to give answers to the research questions. For the modeling part, the information regarding different models will be collected and analyzed to see which model suits our research market or data. After carefully selecting the model, the model is being formed as per data available on IEX website from January, 2013 to September, 2015 and forecasting will be done for October – December, 2015. The forecasted data will be then compared with the actual data for the determination of the accuracy of model.

3.2.Hypothesis

The primary idea of the study is to identify current power market situation in India. Another reason behind the study is to forecast the price of electricity in terms of exchange for the exchange customers so that they can bid accurately and get power at best price available.

The central hypothesis of this report is based on how the Distribution companies price the power and what could be the other options apart from Distribution companies. In simple words, whether alternative of power procurement from distribution companies can be developed and if yes then what is the way and its impact?

3.3.Methods of Data Collection

The research will be conducted solely on secondary data. The data is mainly extracted from report provided by regulatory authorities, research papers and IEX website. The regulatory authorities consist of CERC, CEA, SERCs, SLDCs, RLDCs, and NLDC.

3.4.Analytical Tools

The analysis of the data collected will be primarily concerned with time series analysis. For GARCH modelings, NUMXL excel add-on was used.

3.5.Limitations of the Study

During the conduction of the research, the following limitations were faced –

- Indian power market is very vast and diversified. Due to this reason, the report consist of research on only four states i.e. Haryana, Maharashtra, Delhi, Uttarakhand.

- Previously, Uttar Pradesh was considered as the part of the research but due to regulatory hurdles and non-viability of Open Access transaction in the state, it has been excluded from research and Haryana is included.

- Indian Power market is fully government controlled. Due to this reason, the complete reliance of this report is on secondary data. Although the data is taken from authenticated government reports but there is no actual guarantee that the data is accurate.

4. Data Analysis and Interpretation

4.1. Generation Cost of different generators

In India, mostly coal-fired thermal power plants and hydro power plants are generalting the maximum electricity. The generation cost of different generators vary significantly depending upon the fuel used, location of the power plant, connectivity The Government of India introduced a partial privatization of the generation sector over 2006-2009, initiating a series of tenders for the construction, ownership and operation of large scale thermal power plants, including the 4 Gigawatt (GW) Ultra Mega Power projects (UMPP).

There is no document which is quoting the exact generation cost of power while the different power generation cost is quoted by different states and different generators while having the same technology. The price depends upon the age of that power plant and fuel consumed by it. In generalized way by the help of Power Purchase agreements, we tried to find the general generation cost pattern. The power purchase agreements underpinning the coal-fired UMPP were generally priced at Rs. 2-3/KWh for term of up to 25 years, with at best partial inflation indexation. Most of the huge power plants are facing problems in sourcing discounted domestic Indian market supplies of coal.

Wind, solar and hydro facilities can be built faster and at lower PPAs. In addition, the use of renewable energy incorporates a zero fuel cost, such that there is an inbuilt deflationary driver – zero indexation. Given the recent drive by the Reserve Bank of India (RBI) to prioritize the sustained reduction in inflation, renewable support a series of Government of India. Importing thermal coal achieves none of these goals, and more likely contradicts them.

According to Department of Atomic Energy, GoI, the cost of production of electricity through nuclear energy is comparable to those of the contemporary conventional base load power generating units (like coal based thermal power) located in the area/region.

S. No.	Type of Generating stations	Maximum Total Tariff (both fixed and energy charge)	Minimum Total Tariff (both fixed and energy charge)
1.	**Pit-head coal based station**	Rs. 3.19 per unit	Rs. 0.87 per unit
2.	**Non-pit-head based station**	Rs. 5.29 per unit	Rs. 3.32 per unit
3.	**Lignite based station**	Rs. 4.01 per unit	Rs. 2.79 per unit
4.	**Natural gas based station (APM**	Rs. 3.99 per unit	Rs. 2.66 per unit

	gas)		
5.	**Natural gas based station (NAPM gas)**	Rs. 4.52 per unit	Rs. 4.23 per unit
6.	**LNG gas based station**	Rs. 10.67 per unit	Rs. 8.41 per unit
7.	**Liquid based stations (Naphtha/HSD)**	Rs. 13.01 per unit	Rs. 7.67 per unit
8.	**Hydro based station**	Rs. 5.77 per unit	Rs. 0.86 per unit
9.	**Wind energy**	Rs. 6.00 per unit	Rs. 3.74 per unit
10.	**Solar PV (Photovoltaic)**	Rs. 7.72 per unit	-
11.	**Solar CSP (Concentrated Solar Power)**	Rs. 11.88 per unit	-
12.	**Nuclear Energy**	Rs. 3.41 per unit	Rs. 0.95 per unit

Table 3: Maximum and Minimum generation cost of different types of generators

4.2. Power Scenario of Delhi

In Delhi, Open access is permitted but the regulations are limiting its utilization. There is high viability of Open Access products whether it is Exchange products, Bilateral or Group captive but due to stringent rules which are limiting the accessibility of open access to the consumers. Some of the main issues which Open Access consumers or want to be customers are facing are as follows:

- The consumer shall schedule power from Open Access for complete 24 hours of the day.
- The schedule should be given beforehand.
- The schedule should be uniform for 24 hours.
- If the power is not scheduled for whole 24 hours then the NOC is cancelled after 2 days.
- Bank Guarantee has to be given based on the 'Quantum applied for Open Access'. It is equal to the 2 months combined charge of Cross Subsidy Surcharge, Wheeling Charges, Additional Surcharge for 24 hours for the applied quantum

Bank Guarantee = (Cross Subsidy Surcharge + Wheeling Charges + Additional Surcharge) for 2 months for applied quantum

Distribution for Open Access Charges in Delhi is as follows:

Wheeling Losses:

Voltage Levels	BRPL	BYPL	TPDDL
Above 66 KV (%)	0	0	0
33/66 KV (%)	1.37	0.9	1.25
11 KV (%)	2.25	2.00	3.96

Table 4: Wheeling losses of Delhi for various DISCOMs

Wheeling Charges:

Voltage Levels	BRPL	BYPL	TPDDL
Above 66 KV (Rs/KWh)	0	0	0.66
33/66 KV (Rs/KWh)	0.61	0.74	0.67
11 KV (Rs/KWh)	0.7	0.75	0.7

Table 5: Wheeling losses of Delhi for various DISCOMs

Cross Subsidy Surcharge:

DISCOMS	BRPL	BYPL	TPDDL
CSS	0.95	0.95	1.23

Additional Surcharge:

S. No.	Months	Time Slots (Hrs)	Rs/KWh	Average (Rs/KWh)
1	April – July	0-3	0.3	0.5
		3-9	1.3	
		9-12	0.3	
		12-18	0.3	
		18-24	0.3	
2	August – November	0-6	3	3
		6-12	3	
		12-18	3	
		18-24	3	

3	December – March	0-6	3	1.5
		6-12	1	
		12-18	1	
		18-24	1	

Table 6: Additional Surcharge of Delhi

These are the charges and losses occur during the power purchase. In Delhi, BRPL and BYPL shows good viability for the open access transaction while the consumers connected to TPDDL shows less savings in terms of open access power purchase.

The above stated financial restrictions are making it difficult for exchanges as well. Till now, only 12 open customers are present through power exchange.

4.3. Power Scenario of Uttarakhand

In Uttarakhand, Open Access shall be permissible to the consumers, located within the area of the distribution licensee of the state, having contracted load of 100 KVA and above. The consumer should be connected to the distribution system of licensee at 11 KV or above.

On November 19th, 2013, in line with the regulatory provisions (Terms and Conditions of Intra-State Open Access) 2010 of UERC, Uttarakhand State Load Dispatch Centre issued an Order informing open access consumers to prepare and submit daily schedule, showing separately the schedule of power from licensee and that from another supplier through Open Access for next day i.e. from 00:00 hrs to 24:00 hrs of the following day to SLDC along with copy to distribution licensee/UPCL. Also, if SLDC does not receive any schedule by 10:00 AM, then the power through open access will be considered zero and the consumer will be allowed to draw as per the schedule uploaded on SLDC website.

Key highlights of UERC (Terms & Conditions of Intra State Open Access) Regulations, 2015

1. Regulation 10 for the Conditions for Open Access:

"Open Access shall be permissible to the consumers, located within the area of the distribution licensee of the state having a contracted load of 100 KVA and above and connected to the distribution system of licensee at 11 KV or above, and are connected through an independent feeder emanating from a substation of licensee or industrial feeder.

Provided that when the consumer is connected to an industrial feeder, open access shall be only allowed if all the consumers on such industrial feeder opt for open access and are having simultaneous schedule of drawl under such open access.

Provided that the consumer who are not on independent feeder, shall be allowed open access subject to the condition that they agree to rostering restrictions imposed by utility on the feeders serving them.

Provided that, when two or more consumers connected to industrial/mixed feeder are availing continuous supply option then they need not have simultaneous schedule of drawal under open access"

Explanation: Consumers who are availing continuous supply option and are getting 24x7 hours supply; the unauthorized drawl during load restriction does not apply. In such cases, even if more than one such consumer is connected to the same industrial feeder then the condition of simultaneous schedule of drawl need not be imposed on such consumers.

2. **Regulation 19 Settlement of energy at drawl point in respect of Embedded OA consumers:**

"The Scheduled drawl (in MW) for any 15 minute time block shall be worked out on the basis of Approved Capacity (in MW) for that block after adjusting the transmission and distribution losses as determined by the Commission in the Tariff Order for the relevant year."

"The minimum of Actual Recorded Energy (in kVAh) and Scheduled Energy (in kVAh) calculated on the basis of Scheduled Drawl worked out in sub-regulation above shall be considered as the quantum of energy drawn under Open Access. Such quantum of energy drawn under open access shall be adjusted from the monthly consumption of energy recorded in the meter for each time of the day block for the billing purpose."

Explanation: According to UERC, since ABT complaint SEM meters record load (KVA) and energy (kWh/kVAh) and other parameters for every 15 minutes time block, therefore, a comparison between the recorded drawl and open access scheduled drawl can be made for every 15 minutes time block during the open access period, and accordingly, lower of the actual energy drawl and scheduled open access drawl derived as per the regulations, can be adjusted from the recorded energy for each 15 minute time block. Now this net energy will have to be segregated for each time of the day block and thereafter, appropriate ToD tariffs be applied for the billing purpose.

3. **Regulation 20 regarding Transmission & Wheeling Charges for Open Access Customer:**

A) "For use of Intra-State transmission system- Transmission charges payable to STU by an open access customer for usage of their system shall be determined as under:

Transmission Charges = ATC/(PLS_T x 365)(Rs/MW/day)

Where,

ATC = Annual Transmission Charges determined by the commission for the state transmission system for the relevant year

PLS_T = Peak load served by the State transmission system in the previous year.

Provided that transmission charges shall be payable on the basis of Approved Capacity.

Provided for Open Access, for part of the day, the transmission charges shall be levied as under:

(i) Upto 6 hours in a day: ½ of the transmission charges as determined in sub regulation (1) (b) above.

(ii) Above 6 hours in a day: Equal to the transmission charges determined in the sub regulation (1) (b) above.

Explanation: UERC has introduced a minimum level of transmission charges i.e. half of the overall transmission charges for all open access customers who schedule their power from 1 to 6 hours in a day and while for other category of open access customers who schedule for more than 6 hours in a day have been clubbed and will be required to pay full transmission charges for the day as approved by the Commission from time to time.

B) **Regarding Wheeling Charges:**

Wheeling charges payable to distribution licensee, by an open access customer for usage of its system shall be determined as under:

Wheeling Charges = (ARR – PPC – TC) / (PLS_D x 365) (Rs/MW/Day)

Where,

ARR = Annual Revenue Requirement of the distribution licensee for the relevant year

PPC = Total Power Purchase Cost of distribution licensee for the relevant year

TC = Total transmission chare paid by distribution licensee for State and Inter-State transmission system for the relevant year.

PLS_D= Total Peak loa serve by the concerned distribution system for the previous year

Provided Embedded open access consumer shall pay wheelin charge as determined by the Commission in the following manner:

$WC_{Embedded\ consumer}$ = WC – [(FC*0.85*12*1000)/365] (Rs/MW/day)

Where

$WC_{Embedded\ consumer}$ = Net wheeling charges for embedded consumers

WC = Wheeling charges as determined by the Commission in accordance with the methodology specified in Regulation 20(2) contained in Chapter 5 of this regulations.

FC = Fixed/demand charges in Rs/kVA/month as per rate schedule approved in the tariff order for the relevant year. For the purpose of conversion of kVA in kW power factor of 0.85 has been taken.

Explanation: Recovery of transmission/wheeling charges to be based on approved capacity in case of Open Access transactions.

4. **Regulation 22: Cross Subsidy Surcharge:**

"Embedded open access consumer, in addition to transmission and/or wheeling charges, shall pay cross subsidy surcharge determined by the Commission. Cross Subsidy Surcharge determined on Per Unit basis shall be payable, each month by such consumer based on the actual energy drawn during the month through open access. The amount of surcharge shall be paid to the distribution licensee."

"Provided that no cross subsidy surcharge would be levied on long term/medium term open access consumer and a person who has established a captive generation plant for carrying the electricity to the destination of his own use."

"Provided also that in case power supply position or the load of the consumers seeking open access changes substantially, then commission may review the Cross Subsidy Surcharge as and when required."

Explanation: No cross subsidy surcharge would be levied on power available with consumers through open access to the extent of restrictions/power cuts imposed by the distribution licenee.

5. Regulation 27 Metering:

"All open access customers, existing as well as new, including generating stations, irrespective of their capacity shall be provided with ABT compatible Special Energy Meters by the distribution licensee for and at the cost of the open access customers."

"The distribution licensee shall provide Check Meter, at the cost of the open access customers, of the same specifications as Main Meters at the point of injection and point of drawl."

"The distribution licensee to provide Check Meter of the same specification as Main Meter at its own cost: Provided that Main and Check ABT complaint meter can also be procured by open access customers from the suppliers notified by the distribution/transmission licensee as applicable. However, the cost of Check meter shall be adjusted in the open access charges bills of the customers."

6. Regulation 30 Imbalance Charge:

When Open Access customer is a consumer of distribution licensee:

(i) In case of under drawl 30 (2)(c)

In case of under-drawl is caused by non-availability of the distribution system and/or intra-state transmission system the open access customer shall be compensated by the distribution licensee at the average power purchase of the distribution licensee as projected in the Tariff Order of the relevant year.

When Open Access Customer is a generator

In case of under injection by generator due to reasons attributable to the generator.

(i) Imbalance charges payable by the generator to the distribution licensee shall be charged at average power purchase cost of the distribution licensee as projected in the tariff order for the relevant year.

(ii) In case of under injection by the generator due to non-availability of distribution/transmission network.

Imbalance charges payable by the distribution licensee to the generator shall be charged at average power purchase cost of the distribution licensee as projected in the tariff order for the relevant year.

(i) In case of over injection by the generator. Imbalance charges payable by the distribution licensee to the generator shall be charged at average power purchase cost of the distribution licensee as projected in the tariff order for the relevant year.

"Provided that in case of non-availability of distribution/transmission system due to force majeure events then distribution/transmission licensee shall not be liable to pay any imbalance charges to the open access customers."

4.4. Power Scenario of Haryana

As per latest amendments in HERC regulations dated 03.12.2013, the following has been implemented:

(a) Any consumer of a distribution licensee having a contract demand of 0.5 MVA or above and connected to the distribution system of the licensee or to the transmission system of STU or of a transmission licensee other than STU at 11 kV or above, shall be entitled for seeking open access provided he is connected through an independent feeder emanating from a grid sub-station.

(b) A group of two or more consumers of a distribution licensee having a combined contract demand of 0.5 MVA or above and connected to the distribution system of licensee at 11 kV or above through an independent feeder emanating from a grid sub-station, shall also be entitled for seeking open access if all such consumers collectively apply for open access through a group representative to be nominated by all such consumers on that feeder.

(c) The consumers of a distribution licensee with contract demand of 0.5 MVA or above who are not on independent feeders may be allowed open access subject to the condition that they agree to the system constraints as well as the power cut restrictions imposed by the distribution licensee serving them. In such cases, under drawl, if any, on account of power cut restrictions shall not be compensated.

(d) The grant of open access to the consumers of the distribution licensee covered under sub clauses (a), (c) and (d) above shall be subject to the condition that if power is scheduled to be procured through open access in any time slot of the day, it shall not be less than 250 kW for consumers with contract demand upto 1.5 MW, shall not be less than 500 kW for consumers with contract demand above 1.5 MW but up to 5 MW and shall not be less than 1 MW for consumers with contract demand above 5 MW. In case of a group as per regulation 8 (3) and 8 (4) above, these conditions shall apply to the group as a whole.

Currently another regulation has come where a single industry connected to mixed feeder (where other few industries are also connected) can opt for open access but he will face the problem scheduled power cut from the DISCOM even if his power is scheduled.

Industries can buy power as per their requirement, either on RTC Basis or only for those time blocks in which the need arises.

Industries having consumption for 10-12 hours are able to buy power through IEX/PXIL but they have to send a detailed slot-wise schedule report for 24 Hrs to concerned DISCOM and SLDC by Email before 10 am on the trading day.

The submitted schedule will be considered as confirmed schedule for working out the slot-wise admissible drawl of the consumer from the licensee with reference to his sanctioned contract demand (Contract demand – Schedule through O.A = Admissible drawl from Discom).

If a particular industry wants to draw power from 00 to 12 and 18 to 24, then their Bid format should be like this:

START	END	DRAWL VOLUME	PRICE/MWH
00	12	1.2	3500
12	18	1.2	500
18	24	1.2	3500

NOTE: The drawl volume can be different as well as price may differ and for those time slots in which there is no need of power bid should not be placed., Vary the quantum also.

There are various charges which are taken from Open Access Consumers. Electricity Duty and Municipal Tax will be charged on the total unit recorded on ABT meter. FSA will be charged on units consumed from EB. Consumer's bill also includes cross subsidy surcharge applicable only on open access units.

As per latest tariff order dated 29.05.2014 the following changes in data are in effect from 01.04.2014:

Wheeling Charges: From 70p/unit to 74paise/unit

Cross Subsidy Surcharge: From 53 paise/unit to Rs 2.02/unit for HT Industry, 84 paisa/unit for Non Domestic Supply(NDS).

STU charges- 17 paise/unit to 29 paise/unit

STU loss- 2.50% retained as was in 2013-14

Additional Surcharge (newly imposed)- 50 paise per unit on OA units. Earlier there was no additional surcharge for 2013-14

Tariff revised: Rs 5.30/kVAh to Rs 5.80/kVAh for HT Industries, Rs 5.85 Rs/kWh or Rs 5.26/kVAh to Rs 6.35 Rs/kWh or Rs 5.71 Rs/kVAh for NDS

The Billing settlement will be done after 1 Month from the trading Month.

UI refund has started for under-drawl for dedicated/independent feeder for consumers in Haryana. DHBVNL has started to refund for consumption effective from January 2012 to till date.(For any cases of fault or factors). For mixed feeder if there is a power cut then DHBN is not liable to refund. Refund is on the basis of the UI rate corresponding to the UI frequency of the time blocks during under drawl or IEX/PXIL prices of the corresponding time-blocks whichever is lower.

UHBVNL soon will start the UI refund for which we have filed an application for UI refund.

As per HERC latest notification, the commission has decided UI refund in case of under-drawl by the open access consumers in case of the following conditions:

(i) Under drawl by an open access consumer due to reasons attributable to him and within his control shall be compensated only to the extent of 10% of the entitled drawl in a time slot or upto 5% of the entitled drawl on aggregate basis for all the 96 time slots in a day and no compensation shall be payable by the distribution licensee for under drawl beyond these limits.

(ii) If the under drawl is on account of any force majeure conditions such as earth quake, flood, war or any other act of God i.e. conditions beyond the control of the consumer, which simultaneously do not disable the licensee from supplying power, the consumer will be compensated for the entire under drawl.

(iii) If the under drawl is on account of non availability of transmission/distribution system of licensee or on account of unscheduled load shedding, the consumer will be compensated for the entire under drawl.

As per latest tariff order dated 29.05.2014 It has also been decided by HERC to levy Peak Load Exemption charge (PLEC) on energy drawn through open access during peak load hours as per the following conditions:

(i) PLEC not to be levied on energy drawn upto 20% of CD.

(ii) Energy drawn beyond that covered in (i) above and up to energy consumption during peak load hours in a month worked out corresponding to 50% of contract demand- Rs. 0.95 / kWh

(iii) Balance Energy drawn if any, beyond that covered in (i) and (ii) above i.e. beyond energy consumption during peak load hours in a month worked out corresponding to 50% of contract demand- Rs. 1.50 / kWh.

It has also been provided in the amendments that during peak load hour restrictions, the embedded open access consumer shall be entitled to bring open access power upto his contract demand without the requirement of any approval of special dispensation from the licensee provided that his total drawl i.e. drawl through open access plus the drawl from the licensee does not exceed his contract demand and further he shall restrict his drawl from the distribution licensee to peak load exemption limit/ special dispensation allowed by the licensee.

4.5. Tariff components with respect to Distribution Companies

Distribution companies procure power from different sources i.e. Thermal, Hydro, solar etc. Mainly distribution companies either buy power directly from Thermal and Hydro power generators or they procure power from power exchange to fulfill their short term power requirement. There are types of power purchase i.e. one when distribution companies buy power from different generators and other is when customers procure power from the distribution companies.

When Distribution companies procure power from different generators i.e. Thermal & Hydro Power generators

- Capacity Charge (for recovery of Annual Fixed cost) + Energy Charge
- Capacity Charge
    - Return on Equity (RoE)
    - Depreciation
    - Interest on Loan Capital
    - Interest on Working Capital
- Energy Charges
    - Landed Fuel Cost of primary fuel (excluding hydro)
    - Cost of secondary fuel eg. Oil, diesel.

These all tariff components are disclosed by the Commission every year in their tariff structure as ARR (Annual Revenue Requirement). Capacity charge remains the same throughout the year as disclosed while the generators have the flexibility to change the energy charges according to the fluctuation in the price of the fuel and other technology requirement.

When customers procure power from the distribution companies' then tariff is charged in different manner. In that case tariff components are as follows:

- Energy Charges
- Fixed Monthly Charges
- Electricity Duty
- Fuel Cost Adjustment
- Municipal Tax
- Peak Load Exemption charge (if applicable)

All of these tariff components are charged by the Distribution companies from customers. These components vary from state to state. All state charge Energy Charge, Fixed Monthly Charge on compulsory basis, while other are optional.

4.6. Tariff components with respect to Open Access

Open Access is the provision given under Open Access Regulation, 2008 with amendments. Open Access is that provision under which if the consumer fulfills the minimum eligibility criteria defined under the Open Access Regulation then it can purchase from any source. The source can be different i.e. directly from generators (through bilateral transactions) or from power exchange.

There are some specific charges which are to be recovered by the distribution companies and other authorities in respect to the procurement of the power. These charges are specified as the tariff components with respect to Open Access. The tariff components are as follows:

- Energy Charges
- Point of Connection (POC) injection loss (in terms of money)
- Point of Connection (POC) withdrawal loss (in terms of money)
- Point of Connection (POC) injection charge
- Point of Connection (POC) withdrawal charge
- State Transmission Utility (STU) loss
- State Transmission Utility (STU) charge
- Wheeling loss
- Wheeling charge
- NLDC Application Charge
- RLDC Application Charge
- SLDC Application Charge
- RLDC Scheduling & Operating Charge
- SLDC Scheduling & Operating Charge
- Power Exchange transaction fees
- Trading Margin
- Additional Surcharge

- Cross Subsidy Surcharge (CSS)
- Renewable Purchase Obligation (RPO)

These charges are applicable on the open access customers depending upon the transaction type. In case of bilateral transactions, power exchange transaction fees is not applicable. Trading margin is charged only when the trader is involved. The transmission losses are recovered in terms of power volume adjustment.

Out of all these tariff components, Additional Surcharge and CSS are charged by the distribution companies.

Energy Charges are the cost of the electricity which is charged by the generators at its generating bus bar. POC loss, STU loss and wheeling loss are the transmission and distribution loss which are adjusted in terms of the power. POC charge, STU charge and wheeling charges are the charges which are charged by the utilities in respect of using their infrastructure. NLDC, RLDC and SLDC charge application, scheduling and operating fees for maintaining the balance and scheduling the power through the infrastructure. As power transmission and distribution infrastructure in India is very limited and the consumers are too much. For this purpose, respective load dispatch centers schedule power according to the requirement and charge fees for doing so.

Power exchange transaction fees is the fees which is charged by the power exchanges to the consumers for utilizing their platform for the purpose of trading. Trading Margin is the margin charged by the trader is consumer is trading through trader for providing their services. Additional Surcharge is the charge charged by the distribution companies in respect of fluctuation in the prices of providing the distribution services. Cross Subsidy Surcharge is the surcharge charged by the distribution companies in order to recover the subsidy given to the subsidized consumers such as agriculture, hospitals, government service providers etc. Renewable Purchase Obligation (RPO) is the obligation stated by the government in its regulation which states that if power is purchased through conventional generator then some of the power percentage should be procure which is generated through renewable sources. These percentages vary from state to state. This regulation is made for the protection of the environment and minimizing the damage done to the environment from power generated through conventional sources.

4.7.Tariff Breakup with respect to Distribution Companies & Open Access

Every state recovers different charges depending upon their power procurement process. The basic charges are defined by the help of the Central regulation but these can be varied by state according to their requirement. Distribution tariff is the tariff recovered by the distribution companies while Cross Subsidy surcharge and additional surcharge are the part of Open Access bill along with the Open Access charges as stated above.

Distribution charges which are recovered by the different distribution companies of the under research states i.e. Maharashtra, Haryana, Uttarakhand and Delhi are as follows:

Maharashtra:

Distribution Tariff Category wise (Rs./KWh)	11 KV		22 KV		33 KV		132 KV	
	Express Feeder	**Non-Express Feeder**	**Express Feeder**	**Non-Express Feeder**	**Express Feeder**	**Non-Express Feeder**	**Express Feeder**	**Non-Express Feeder**
Commercial	11.15	10.62	11.15	10.62	11.15	10.62	11.15	10.62
Industrial	7.21	6.71	7.21	6.71	7.21	6.71	7.21	6.71

Table 7: Electricity tariff of different consumers in Maharashtra

Time of Day (ToD) tariffs which are charged in variation of base tariffs

ToD Tariffs (in addition to above base tariffs) (in Rs./KWh)	
0600 – 0900	0
0900 – 1200	0.8
1200 – 1800	0
1800 – 2200	1.1
2200 – 0600	-1.5

Table 8: Time of Day (ToD) tariff of Maharashtra

Voltage Levels	Feeder Type	Cross Subsidy Surcharge	Additional Surcharge
11/22 KV	Express	1.49	Not Available
	Non-Express	1.09	
33 KV	Express	1.49	
	Non-Express	1.09	
66 KV and above	Express	1.49	
	Non-Express	1.09	

Table 9: Cross Subsidy Surcharge (CSS) and Additional Surcharge of Maharashtra

Haryana:

Distribution Tariff Category wise	Commercial (Rs./KWh)	Industrial (Rs./KWh)
11 KV	6.3	6.15
33 KV	6.3	6.05
66/132 KV	6.3	5.95
220 KV	6.3	5.85
400 KV	6.3	5.75
Arc Furnace/ Steel Rolling Mills	Not Applicable	6.45 if supply at 11 KV and other tariff applicable for supply above 33 KV and above

Table 10: Electricity tariff for different consumers in Haryana

Cross Subsidy Surcharge – Rs. 0.93/KWh

Additional Surcharge – Rs. 0.5/KWh

Uttarakhand:

Commercial Consumers –

Upto 25KW =4.05/unit

Above 25KW =3.65/unit

Upto 4KW and consumption Upto 50 units per month =4.20/unit & 4.85/unit

Above 25KW 4.75/unit

Single point bulk supply =4.65/KVAh

Advertisement hoardings =4.90/unit

Industrial Consumers –

Industrial consumers are charged based on load factor and Normal or Peak hours.

Load Factor	Energy Charges	
	Normal Hours	Peak hours
Upto 40%	Rs. 3.40/KVAh	Rs. 5.63/KVAh
Above 40%	Rs. 3.75/ KVAh	Rs. 5.63/ KVAh

Cross Subsidy Surcharge – Rs. 0.42/unit

Additional Surcharge – Not Applicable

Delhi:

DISCOM tariff Category wise	Commercial	Industrial
11 KV	Rs. 8.4/KVAh	Rs. 7.4/KVAh
33/66 KV	Rs. 8.4/KVAh	2.5% rebate on above
220 KV	Rs. 8.4/KVAh	4% rebate on above

Table 11: Electricity tariff for different consumers in Delhi

Time of Day (ToD) Tariff is applicable only during May – September.

Duration	**Surcharge/Rebate**
Peak Hours (1300 – 1700 Hrs & 2100 – 2400 Hrs)	20% Surcharge on Energy Charges
Off Peak Hours (0300 – 0900 Hours)	20% Rebate on Energy Charges

Table 12: Time of Day (ToD) tariff of Delhi

DISCOM	Connectivity	Cross Subsidy Surcharge	
		Industrial (Paise/KWh)	**Commercial (Paise/KWh)**
TPDDL	11 KV	58.7	249.7
	33 & 66 KV	79.01	270.01
	Above 66 KV	Not Applicable	Not Applicable
BRPL	11 KV	107.63	243.63
	33 & 66 KV	114.44	250.44
	Above 66 KV	Not Applicable	Not Applicable
BYPL	11 KV	136.5	252.5
	33 & 66 KV	144.38	260.38
	Above 66 KV	Not Applicable	Not Applicable

Additional surcharge as applicable:	
April-July	
Time Slots	Ps/Unit
0-3	30
3-9	130
9-12	30
12-18	30
18-24	30
August-November	
Time Slots	Ps/Unit
0-6	300
6-12	300
12-18	300
18-24	300
December-March	
Time Slots	Ps/Unit
0-6	300
6-12	100
12-18	100
18-24	100

Table 13: Cross Subsidy Surcharge (CSS) and Additional Surcharge of Delhi

4.8.Data Preparation

During data preparation, data is first collected in form of MCP (Market Clearing Price) data from IEX website for the period of 1st January, 2013 to 31st December, 2015.

Once sample data is collected, the data is formulated in most common time series layout in excel as dates and values in adjacent columns in the same spreadsheet. In this time series layout, date is included just to identify the value at different dates while dates are not needed for the analysis.

A time-series data sample will generally consist of data which are at equal time interval. In our case, the data is equally spaced as daily data. There is no sample missing as the trading and delivery is done on regular basis without any gap.

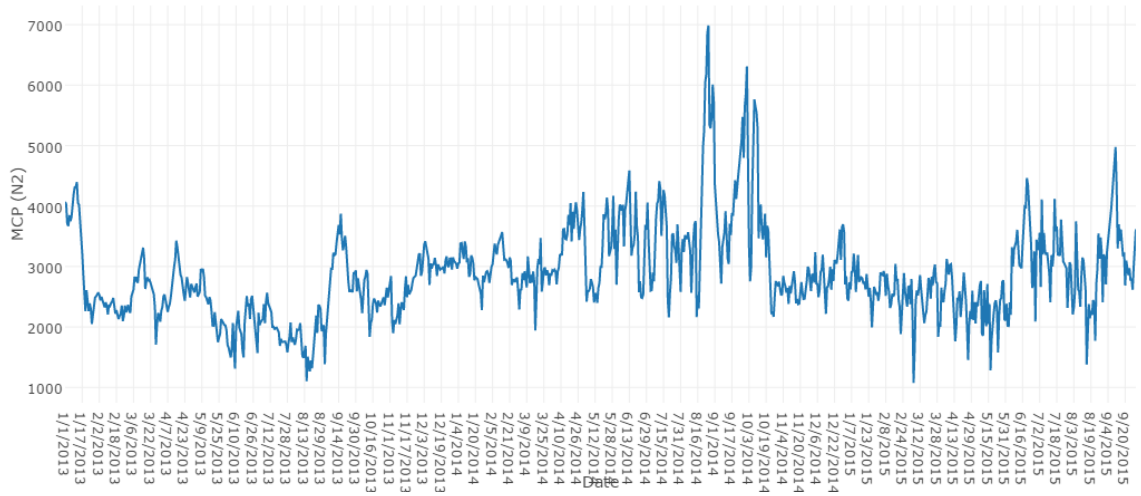

Figure 1: Graphical Representation of Sample Price Data

Now when our data is nearly prepared, then we have to test it whether we can apply any model to it or the data needs modification. Testing of data consist of testing stationarity, homogeneity, concentration of values.

The main question should be why should we care about these tests when we have the actual data? There are several reasons behind it. First reason is that the time series model never considers any limitation on values which any series can take. It means the model can consider the data set which may yield poor model fitting. Second reason could be that if any data set is affecting the floor or ceiling values of the entire data set then it will affect the symmetry of the values around the mean. This will make it difficult for any model to capture the time series.

4.9.Statistical Data Analysis

In this section, we will conduct few calculations in order to summarize the statistical distribution of the sample to understand the unknown population distribution.

The descriptive Statistics computed are as follows:

Descriptive Statistics	
AVERAGE:	2853.97
STD DEV:	739.2688
SKEW:	1.33
EXCESS-KURTOSIS:	3.92
MEDIAN:	2745.502
MIN:	1074.863
MAX:	6987.774
Q 1:	2403.05
Q 3:	3186.948

Significance Test at 5.00%

Significance Test		**5.00%**
Target	**P-Value**	**SIG?**
0.000	0.00%	TRUE
0.000	0.00%	TRUE
0.000	0.00%	TRUE

Test	**p-value**	**SIG?**
White-noise	0.00%	FALSE
Normal Distributed?	0.00%	FALSE
ARCH Effect?	0.00%	TRUE

Table 14: Descriptive Stastical Analysis of Sample Data

From above, we can conclude that underlying distribution has following properties –

- Mean is significantly different from zero.
- Density (mass) distribution is significantly positively skewed.
- Density distribution has fat tails.
- Half of the observation values fall between 2403.05 and 3186.9.

Here, median is smaller than average, the distribution is positively skewed, to showing that the distribution has right fat tails.

The quartile (Q1, Q3) inscribe 50% of the value in the sample. This is used to distribute and categorized the data when there is chance that extremities can skew the data.

We had plotted the histogram of the sample data which is as follows:

Histogram Table	**24**	**2853.97**		**739.2688**		
Bin	**LL**	**UL**	**Center**	**Freq**	**Cum. Freq**	**Normal**
1	1074.863	1321.234	1198.049	0.5%	0.5%	1.1%
2	1321.234	1567.606	1444.42	1.0%	1.6%	2.2%
3	1567.606	1813.977	1690.791	3.0%	4.6%	3.9%
4	1813.977	2060.348	1937.163	5.3%	9.9%	6.2%
5	2060.348	2306.72	2183.534	9.2%	19.1%	8.8%
6	2306.72	2553.091	2429.905	15.4%	34.5%	11.2%
7	2553.091	2799.462	2676.277	19.0%	53.5%	12.9%
8	2799.462	3045.834	2922.648	15.6%	69.1%	13.2%
9	3045.834	3292.205	3169.019	10.0%	79.2%	12.1%
10	3292.205	3538.576	3415.39	6.7%	85.8%	9.9%
11	3538.576	3784.947	3661.762	5.0%	90.9%	7.3%
12	3784.947	4031.319	3908.133	3.1%	94.0%	4.8%
13	4031.319	4277.69	4154.504	2.0%	96.0%	2.9%
14	4277.69	4524.061	4400.876	1.4%	97.4%	1.5%
15	4524.061	4770.433	4647.247	0.5%	97.8%	0.7%
16	4770.433	5016.804	4893.618	0.4%	98.2%	0.3%
17	5016.804	5263.175	5139.99	0.3%	98.4%	0.1%
18	5263.175	5509.547	5386.361	0.5%	98.9%	0.0%
19	5509.547	5755.918	5632.732	0.4%	99.3%	0.0%

20	5755.918	6002.289	5879.104	0.2%	99.5%	0.0%
21	6002.289	6248.66	6125.475	0.3%	99.7%	0.0%
22	6248.66	6495.032	6371.846	0.1%	99.8%	0.0%
23	6495.032	6741.403	6618.217	0.0%	99.8%	0.0%
24	6741.403	6987.774	6864.589	0.2%	100.0%	0.0%

Table 15: Histogram data of Sample data

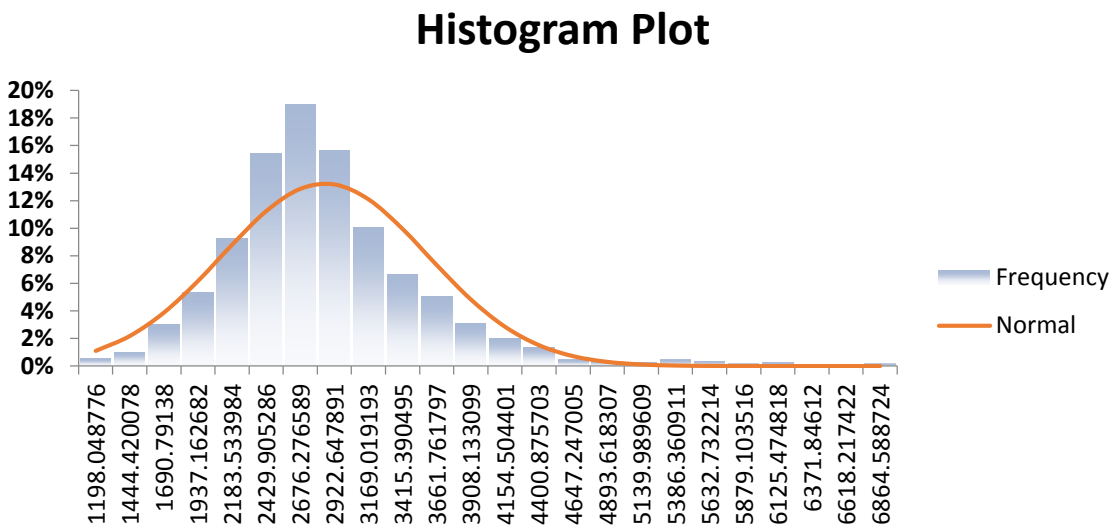

Figure 2: Histogram Plot of sample data

Here we can clearly see that the data has right fat tail and as stated in the test result that data is not normally distributed, it can be visually analyzed through histogram plot.

4.10. Data Smoothening

In this section, we will check whether the data needs any modification or it is ready to be fed in the model. In order to check it we had plotted QQ plot and checked Kernel Density Estimation and Empirical Distribution Function. We had also done stationarity test i.e. Augmented Dickey Fuller Test. Several other test are also conducted.

	Mean	STDEV
QQ-Plot	2853.97	739.2688
Q	**Normal**	**Empirical**
9.1%	-1.3	-1.1
18.2%	-0.9	-0.8
27.3%	-0.6	-0.6
36.4%	-0.3	-0.4
45.5%	-0.1	-0.2
54.5%	0.1	-0.1
63.6%	0.3	0.1
72.7%	0.6	0.4
81.8%	0.9	0.7
90.9%	1.3	1.3

Table 16: QQ Plot data of sample data

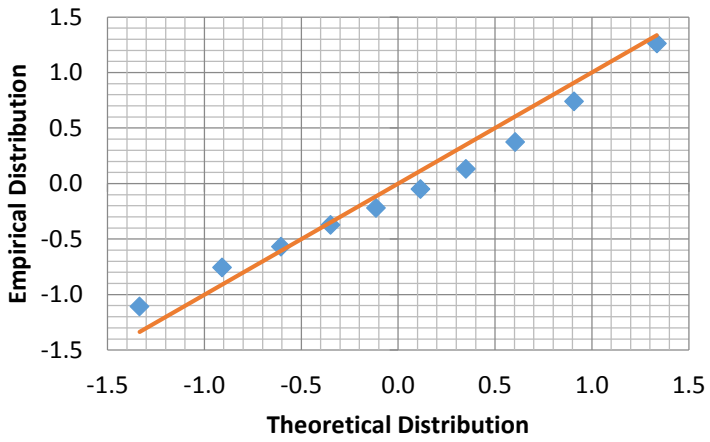

Figure 3: QQ Plot of Sample Data

Here from QQ Plot we can see that the data is distributed around the trend line. There is no data which is showing significant deviation from the trend line.

Kernel Density Estimation is the test where we test the distribution of data in form of density or frequency and then it is compared with the Normal Distribution.

Min	Range	Mean	STDEV
1074.863	5912.911	2853.97	739.2688
Kernel Density Estimation (KDE)			
X(1)	**KDE**	**Gaussian**	**Size**
1074.863	0.00%	0.00%	**5**
2257.445	0.05%	0.04%	
3440.028	0.03%	0.04%	
4622.61	0.00%	0.00%	
5805.192	0.00%	0.00%	

Table 17: Sample Kernel Density Estimation data

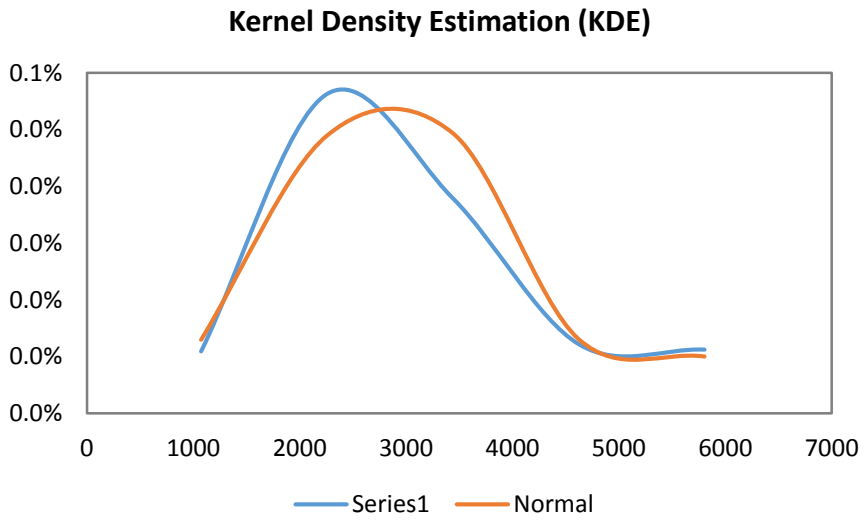

Figure 4: Sample Kernel Density Estimation Plot

Here this test is also confirming the results related to normality presented in the Descriptive Statistic analysis.

Empirical Distribution Function (EDF) is which jumps by 1/N at the occurrence of each observation:

$$\text{EDF (x)} = \frac{1}{N}\sum_{i=1}^{N} I\{x \leq x_i\}$$

EDF is defined as the computation of the cumulative distribution of the underlying random number. If the sample size is large, then it is important to estimate the true underlying cumulative

density function of the point present in the sample. This function virtually guaranteed to converge with the true distribution.

Empirical Distribution Function (EDF) data set can be found in Appendix A.

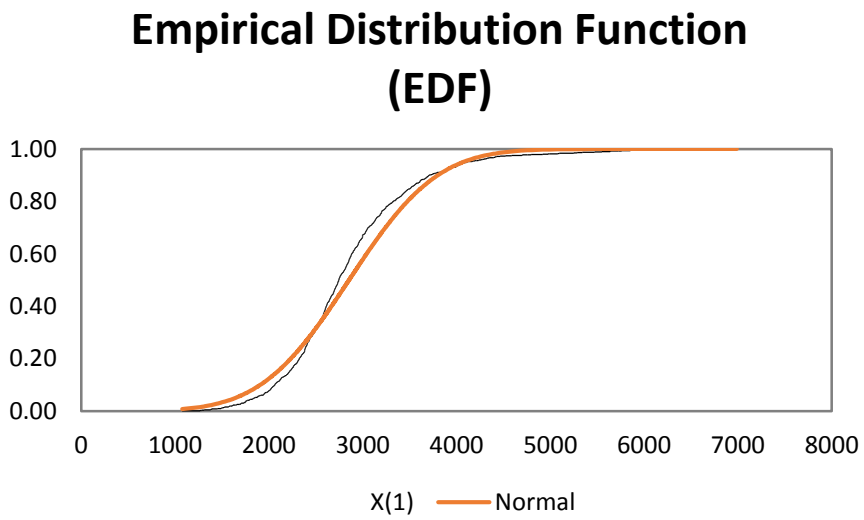

Figure 5: Empirical Distribution Function of Sample Data

Augmented Dickey Fuller unit root test is also done for the presence of unit root in the presence of drift and trend.

$$(1 - L)y_t = \nabla y_t = \alpha + \gamma y_{t-1} + \beta\, t + \cdots$$

The basic null hypothesis of this test is as follows:

$H_0 : \gamma = 0$

The test results are as follows:

Stationary Test

Test	Stat	P-Value	C.V.	Stationary?	5.0%
ADF					
No Const	-1.4	15.5%	-1.9	FALSE	
Const-Only	-5.2	0.1%	-2.9	TRUE	
Const + Trend	-5.3	0.0%	-1.6	TRUE	
Const+Trend+Trend^2	-6.0	0.0%	-1.6	TRUE	

Table 18: Stationary Test results of Sample Data

In this test existence of unit root is confirmed in three formats while rejected in only one formulation. This states that the data shows no stationarity in case of no constant

($\nabla y_t = \gamma y_{t-1} + \varepsilon_t$) while shows stationarity with constant only ($\nabla y_t = \alpha + \gamma y_{t-1} + \varepsilon_t$) and constant with trend ($\nabla y_t = \alpha + \gamma y_{t-1} + \beta t + \varepsilon_t$).

Serial correlation of any time-series can be checked by the statistical test which is done for White noise. It is also commonly known as Ljung-Box Test.

The hypothesis for this test are as follows:

$H_0 : \rho_1 = \rho_2 = \ldots = \rho_m = 0$

$H_1 : \Sigma \rho_k \neq 0$

Where ρ_i is the autocorrelation function for the i-th lag. The selection of m (max. lag) is arbitrary. It has been found from different research works of the scholar that m should be ideally taken as the LN(Sample Size). In our case it is coming to be 6.99, so we had taken lag = 7. Test result are as follows:

White-noise Test

Lag	Score	C.V.	P-Value	Pass?	5.0%
1	881.27	3.84	0.0%	FALSE	
2	1608.05	5.99	0.0%	FALSE	
3	2198.88	7.81	0.0%	FALSE	
4	2697.51	9.49	0.0%	FALSE	
5	3149.73	11.07	0.0%	FALSE	
6	3559.57	12.59	0.0%	FALSE	
7	3956.10	14.07	0.0%	FALSE	

Table 19: White Noise Test Result

It shows that Ljung-Box test is failed in all the scenarios which concur that this sample data set has no presence of serial correlation.

4.11. Time Series Modeling

As we had seen in the previous section, the sample doesn't exhibit significant serial correlation but they possess ARCH effect. According to these test results, ARCH/GARCH model is best suited to fit the data.

We are considering GARCH (1,1) model for this time as the data is showing not much variation and also showing stationarity.

$$y_t = \mu + a_t$$
$$a_t = \sigma_t \varepsilon_t$$
$$\varepsilon_t \sim \varphi\ (0,1)$$
$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i\, a_{t-i}^2 + \sum_{j=1}^{q} \beta_j\ \beta_1 \sigma_{t-j}^2$$
$$\sigma_t^2 = \alpha_0 + \alpha_1 a_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

Where

x_t is the time series value at time t

μ is mean of GARCH model

a_t is the model's residual at time t

σ_t is the conditional standard deviation (i.e. volatility) at time t.

p is the order of the ARCH component model

$\alpha_0, \alpha_1, \alpha_2, \ldots$ are the parameters of the ARCH component model.

q is the order of the GARCH component model

$\beta_1, \beta_2, \beta_3 \ldots$ are the parameters of the GARCH component model

The GARCH (1,1) model is as follows:

GARCH(1,1)

Param	Value
μ	2853.97
α_0	863394.50
α_1	0.45
β_1	0.45

Table 20: Uncalibrated GARCH (1,1) model

These are model parameters which are needed to formulate the model. Goodness of Fit is needed to be checked for the viability of the model.

Goodness of Fit test results is as follows:

Goodness-of-fit		
LLF	AIC	CHECK
-9033.46	18072.92	1

Table 21: Goodness of Fit result of Uncalibrated GARCH model

The model can be tested for further calibration in order to maximize the Log-Likelihood Function. The parameters are so adjusted that the Log-Likelihood is maximized while keeping the Check status equal to 1.

The calibrated GARCH model is as follows:

GARCH(1,1)	
Param	Value
μ	2697.17
α_0	36111.64
α_1	0.66
β_1	0.28

Table 22: Calibrated GARCH (1,1) model

And the Goodness of Fit report of the calibrate model is as follows:

Goodness-of-fit		
LLF	AIC	CHECK
-8347.94	16701.89	1

It can be seen from the calibrated goodness of fit report that the LLF is maximized.

Residual Analysis report of the calibrated model is as follows:

	Residuals (standardized) Analysis						
	AVG	**STDEV**	**SKEW**	**KURTOSIS**	**Noise?**	**Normal?**	**ARCH?**
	0.09	1.00	-0.28	0.56	FALSE	FALSE	FALSE
Target	0.00	1.00	0.00	0.00			
SIG?	TRUE	FALSE	TRUE	TRUE			

Table 23: Residual Analysis report of Calibrated GARCH model

There are certain properties which are needed to be tested to check the viability of the model. The properties are as follows:

- No Serial Correlation
- No Conditional Heteroskedasticity
- No Non-linear dependence
- No ARCH effect present
- Jarque-Bera static test should be more than 6.

All these properties are checked.

Here, as the residual analysis report shows that White noise test report is showing FALSE which means that the model is not showing any kind of serial correlation.

The residual analysis repot of the calibrated model is showing that there is no ARCH effect is present which is also confirming that it has no Conditional Heteroskedasticity.

4.12. Simulation and Forecasting

In this section, we will simulate the data according to the calibrated model. Monte Carlo Simulation is used for the simulation in case of the GARCH model. Simulation is done for the next some days according to the latest observations present. Forecasting of calibrated model is projected by the way of mean, standard error and confidence interval.

Simulation results for next 10 days (Jan 1, 2016 – Jan 10, 2016) are as follows:

Step	S[1]
1	2140.288
2	2384.928
3	2655.894
4	3047.114
5	3151.173
6	2468.19
7	2366.622
8	1950.72
9	2450.756
10	1952.999

Table 24: Simulation results for next 10 days

The simulation results are compared with the actual price of IEX which is out of sample data. Here, we found that the deviation from the actual price is in range of Rs.145.7 to 732.15 per MWh. This deviation can be neglected if the simulated result is lying between the results of the forecast.

Here in this section, we will forecast the conditional mean and conditional standard deviation (Volatility):

$$y_{T+k} = \mu_{T+k} + a_{T+k}$$
$$\mu_{T+k} = E_T[yT_k]$$
$$a_{T+k} = \sigma_{T+k} \times \epsilon_{T+k}$$
$$\epsilon_{T+k} \sim \varphi(0,1)$$

Where

- μ_{T+k} is the conditional mean forecast at T+k.
- σ_{T+k} is the conditional volatility forecast at T+k.

For 95% confidence interval, the forecast is expressed as follows:

$$\mu_{T+k} - 1.96 \times \sigma_{T+k} \leq y_{T+k} \leq \mu_{T+k} + 1.96 \times \sigma_{T+k}$$

For GARCH models, the conditional mean is constant, so the forecast procedure is primarily focused on a volatility forecast.

$$\mu - 1.96 \times \sigma_{T+k} \leq y_{T+k} \leq \mu + 1.96 \times \sigma_{T+k}$$

For a stable time series model, the conditional mean and variance forecast converge to their long-run (historical or unconditional) values. The long-run values are implies (i.e. calculated) from the model's parameter values.

For GARCH(1,1), the long run conditional volatility is expressed as follows:

$$\sigma_{T+\infty} = V_L = \frac{\alpha_0}{1-\sum_{i=1}^{\max(p,q)}(\alpha_{i+\beta_i})}$$

Using GARCH model, we can forecast by this formula

$$\sigma^2_{T\to T+N} = \frac{\sigma^2_{T+1} + \sigma^2_{T+2} + \cdots + \sigma^2_{T+N}}{N} \times 365$$

Where N is the no of days for which forecast is required.

For further and better forecasting and calculations, the volatility value forecasted by this calibrated model can be plugged into the any pricing equation such as Black-Scholes to generate forecast for N days.

Forecasting result for next 20 days by the help of calibrated model is as follows:

Step	Mean	STD	TS	UL	LL
1	2697.166	537.4739	537.4739	3750.596	1643.737
2	2697.166	556.1705	546.9021	3787.24	1607.092
3	2697.166	573.2925	555.8381	3820.799	1573.534
4	2697.166	589.0283	564.3187	3851.641	1542.692
5	2697.166	603.5334	572.3766	3880.07	1514.263
6	2697.166	616.9383	580.0413	3906.343	1487.99
7	2697.166	629.3536	587.3395	3930.677	1463.656
8	2697.166	640.8745	594.2952	3953.257	1441.075
9	2697.166	651.5833	600.9303	3974.246	1420.087
10	2697.166	661.5519	607.2648	3993.784	1400.549
11	2697.166	670.8436	613.3171	4011.996	1382.337
12	2697.166	679.5147	619.104	4028.991	1365.342
13	2697.166	687.6149	624.6409	4044.867	1349.466
14	2697.166	695.1891	629.9421	4059.712	1334.621
15	2697.166	702.2774	635.0209	4073.605	1320.728
16	2697.166	708.9162	639.8894	4086.617	1307.716
17	2697.166	715.1382	644.559	4098.812	1295.521
18	2697.166	720.9735	649.0403	4110.248	1284.084
19	2697.166	726.4492	653.3432	4120.981	1273.352
20	2697.166	731.5903	657.4767	4131.057	1263.276

Table 25: Forecasted results for next 20 days

The above forecasted data consist of Mean and Standard Deviation of the forecasted data. Upper limit and Lower limit is forecasted to determine the value at specific day. These upper and lower limits are compared with the actual price on IEX on specified dates (Jan 1,2016 to Jan 20,2016).

Step	Mean	STD	TS	UL	LL	Actual	Pass (UL)?	Pass (LL)?
1	2697.166	537.4739	537.4739	3750.596	1643.737	2352.09	Pass	Pass
2	2697.166	556.1705	546.9021	3787.24	1607.092	2542	Pass	Pass
3	2697.166	573.2925	555.8381	3820.799	1573.534	2154.86	Pass	Pass
4	2697.166	589.0283	564.3187	3851.641	1542.692	2309.55	Pass	Pass
5	2697.166	603.5334	572.3766	3880.07	1514.263	2511.79	Pass	Pass
6	2697.166	616.9383	580.0413	3906.343	1487.99	2288.74	Pass	Pass
7	2697.166	629.3536	587.3395	3930.677	1463.656	2512.32	Pass	Pass
8	2697.166	640.8745	594.2952	3953.257	1441.075	2682.87	Pass	Pass
9	2697.166	651.5833	600.9303	3974.246	1420.087	2696.81	Pass	Pass
10	2697.166	661.5519	607.2648	3993.784	1400.549	2458.45	Pass	Pass
11	2697.166	670.8436	613.3171	4011.996	1382.337	2699.93	Pass	Pass
12	2697.166	679.5147	619.104	4028.991	1365.342	2427.67	Pass	Pass
13	2697.166	687.6149	624.6409	4044.867	1349.466	2168.27	Pass	Pass
14	2697.166	695.1891	629.9421	4059.712	1334.621	2566.55	Pass	Pass
15	2697.166	702.2774	635.0209	4073.605	1320.728	2727.57	Pass	Pass
16	2697.166	708.9162	639.8894	4086.617	1307.716	4175.65	Fail	Pass
17	2697.166	715.1382	644.559	4098.812	1295.521	3832.61	Pass	Pass
18	2697.166	720.9735	649.0403	4110.248	1284.084	3735.17	Pass	Pass
19	2697.166	726.4492	653.3432	4120.981	1273.352	3784.51	Pass	Pass
20	2697.166	731.5903	657.4767	4131.057	1263.276	3921.98	Pass	Pass

Table 26: Comparative Analysis of Forecasted data with actual data

It has been seen that the model is perfectly predicting the range which include the actual price.

The simulated data is tested by different stastical test and results are as follows:

Descriptive Statistics	
AVERAGE:	2708.319
STD DEV:	814.9563
SKEW:	-0.42
EXCESS-KURTOSIS:	0.15
MEDIAN:	2831.691
MIN:	490.9408
MAX:	4349.546
Q 1:	2275.403
Q 3:	3183.326

The Normality test results are as follows:

Normality Test	Score	C.V.	P-Value	Pass?	5.0%
Jarque-Bera	2.89	5.99	23.6%	TRUE	
Shapiro-Wilk	0.98	#N/A	18.9%	TRUE	
Doornick Chi-Square	3.10	5.99	21.2%	TRUE	

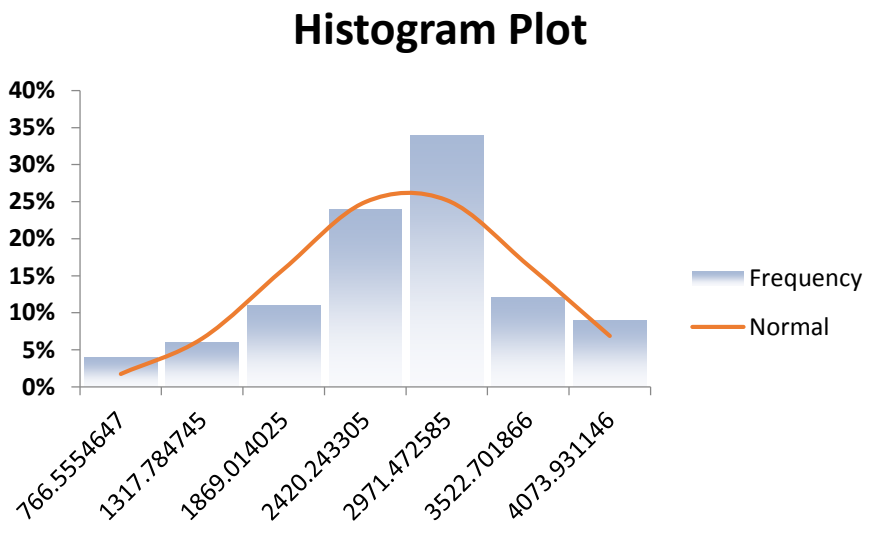

Figure 6: Histogram Plot of Forecasted data

The test results show that it is showing normality which is desired.

5. Conclusion and Recommendations

The power pricing in India is very complicated. It has been seen that the power prices are not only dependent on one factor while they are dependent on various factors. The power price are mostly controlled by the regulation made by different state commissions under the guidance of the Central Commission. The prices are decided and can vary anytime according to the government authorities and distribution companies. Central commission has given this power to every state commission that it can decide its own regulation as well tariff breakups.

As compared to the other energy market, the power prices are not only depending on the generation cost as the cost of generation from the different generators with the same technology can vary. There are various state regulations and the financial obligations depending upon the states and the path followed. Unlike other energy markets, the power prices can also vary depending upon the transaction type as the financial fees related to different transactions are different.

Transmission and distribution network is the vital part of the power pricing. In India, the transmission and distribution network is limited, so it is not always possible that you will et the corridor for the flow of power. In order to avoid the position of corridor unavailability, distribution companies schedule their power beforehand and to recover the additional cost occurring due to this distribution companies vary their wheeling charges.

So, the power pricing of any state can vary according to the available distribution companies and their power procurement practices. Demand Supply is not playing any major role until average demand is maintained.

Other part of this report is related to the forecasting of the power prices on IEX. The forecasting is done by the help of Last 3 years power prices of the N2 bid area i.e. January, 2013 to December, 2015. The model which is used is General Autocorrelation Heteroskedasticity, GARCH (1,1). The forecasting results of the GARCH (1,1) model are showing positive results.

It is recommended to work on the combined GARCH model with the ARIMA model in order to increase the accuracy of the forecast and develop the ability to forecast the exact price rather that range of price. Volatility calculated by the GARCH (1,1) model is correctly defined and can be used in the combined model to forecast further.

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7. APPENDICES

Appendix A: Basic Day Ahead Market Daily MCP data set of N2 Region

Date	MCP (N2 Region)
1/1/2013	4069.482396
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12/26/2015	2400.66
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Appendix B: Empirical Distribution Function (EDF) Data set

		Mean	**STEDEV**	
		2853.97	**739.2688**	
Empirical Distribution Function (EDF)				
X(1)	EDF	X-Bar	Y-Bar	Normal
1074.863	0.00	28.80083		0.01
1103.664	0.00	161.7182	0.00	0.01
1265.382	0.00	18.34698	0.00	0.02
1283.729	0.00	24.84875	0.00	0.02
1308.578	0.00	8.384479	0.00	0.02

1316.962	0.01	60.64021	0.00	0.02
1377.603	0.01	3.815312	0.00	0.02
1381.418	0.01	10.16792	0.00	0.02
1391.586	0.01	54.76885	0.00	0.02
1446.355	0.01	4.791042	0.00	0.03
1451.146	0.01	37.62802	0.00	0.03
1488.774	0.01	6.063438	0.00	0.03
1494.837	0.01	1.881146	0.00	0.03
1496.718	0.01	11.58021	0.00	0.03
1508.299	0.01	13.83937	0.00	0.03
1522.138	0.01	4.5775	0.00	0.04
1526.715	0.02	41.91552	0.00	0.04
1568.631	0.02	2.289063	0.00	0.04
1570.92	0.02	6.2875	0.00	0.04
1577.208	0.02	2.261354	0.00	0.04
1579.469	0.02	12.7874	0.00	0.04
1592.256	0.02	18.30385	0.00	0.04
1610.56	0.02	2.675313	0.00	0.05
1613.235	0.02	3.574375	0.00	0.05
1616.81	0.02	27.87021	0.00	0.05
1644.68	0.02	8.026667	0.00	0.05
1652.707	0.02	5.053229	0.00	0.05
1657.76	0.03	29.46865	0.00	0.05
1687.229	0.03	0.865104	0.00	0.06
1688.094	0.03	14.59687	0.00	0.06
1702.691	0.03	0.475417	0.00	0.06
1703.166	0.03	0.516771	0.00	0.06
1703.683	0.03	2.798333	0.00	0.06
1706.481	0.03	25.72708	0.00	0.06
1732.208	0.03	3.677813	0.00	0.06
1735.886	0.03	12.52865	0.00	0.07
1748.415	0.03	0.423438	0.00	0.07
1748.838	0.03	1.97875	0.00	0.07
1750.817	0.04	0.121458	0.00	0.07
1750.938	0.04	0.159479	0.00	0.07
1751.098	0.04	7.121146	0.00	0.07
1758.219	0.04	2.278125	0.00	0.07
1760.497	0.04	1.541771	0.00	0.07
1762.039	0.04	8.385833	0.00	0.07
1770.425	0.04	2.314792	0.00	0.07
1772.739	0.04	15.50104	0.00	0.07
1788.24	0.04	8.413854	0.00	0.07
1796.654	0.04	4.794271	0.00	0.08

1801.449	0.04	5.570521	0.00	0.08
1807.019	0.05	16.03187	0.00	0.08
1823.051	0.05	4.982813	0.00	0.08
1828.034	0.05	6.343958	0.00	0.08
1834.378	0.05	1.564479	0.00	0.08
1835.942	0.05	1.100521	0.00	0.08
1837.043	0.05	10.21448	0.00	0.08
1847.257	0.05	7.084063	0.00	0.09
1854.341	0.05	22.15635	0.00	0.09
1876.498	0.05	1.168229	0.00	0.09
1877.666	0.05	2.734792	0.00	0.09
1880.401	0.05	0.469375	0.00	0.09
1880.87	0.06	1.437917	0.00	0.09
1882.308	0.06	2.33125	0.00	0.09
1884.639	0.06	10.48115	0.00	0.09
1895.12	0.06	7.128438	0.00	0.10
1902.249	0.06	7.06125	0.00	0.10
1909.31	0.06	6.858437	0.00	0.10
1916.168	0.06	25.35573	0.00	0.10
1941.524	0.06	2.222917	0.00	0.11
1943.747	0.06	3.120625	0.00	0.11
1946.868	0.06	0.785313	0.00	0.11
1947.653	0.06	0.052188	0.00	0.11
1947.705	0.07	1.372083	0.00	0.11
1949.077	0.07	0.268229	0.00	0.11
1949.346	0.07	7.679375	0.00	0.11
1957.025	0.07	0.472292	0.00	0.11
1957.497	0.07	1.033229	0.00	0.11
1958.53	0.07	9.445313	0.00	0.11
1967.976	0.07	7.812292	0.00	0.12
1975.788	0.07	8.100521	0.00	0.12
1983.889	0.07	3.947917	0.00	0.12
1987.836	0.07	0.917396	0.00	0.12
1988.754	0.07	2.342917	0.00	0.12
1991.097	0.08	0.095104	0.00	0.12
1991.192	0.08	11.24385	0.00	0.12
2002.436	0.08	0.93375	0.00	0.12
2003.369	0.08	1.516146	0.00	0.12
2004.886	0.08	2.380938	0.00	0.13
2007.267	0.08	3.883646	0.00	0.13
2011.15	0.08	5.540208	0.00	0.13
2016.69	0.08	1.289583	0.00	0.13
2017.98	0.08	1.985833	0.00	0.13

2019.966	0.08	0.435625	0.00	0.13
2020.401	0.08	0.083021	0.00	0.13
2020.484	0.09	1.648333	0.00	0.13
2022.133	0.09	2.933646	0.00	0.13
2025.066	0.09	4.216979	0.00	0.13
2029.283	0.09	1.379583	0.00	0.13
2030.663	0.09	2.071042	0.00	0.13
2032.734	0.09	0.479896	0.00	0.13
2033.214	0.09	7.136042	0.00	0.13
2040.35	0.09	1.54625	0.00	0.14
2041.896	0.09	2.684479	0.00	0.14
2044.581	0.09	1.693542	0.00	0.14
2046.274	0.09	2.204062	0.00	0.14
2048.478	0.10	0.704062	0.00	0.14
2049.182	0.10	8.744271	0.00	0.14
2057.927	0.10	2.077917	0.00	0.14
2060.005	0.10	3.403125	0.00	0.14
2063.408	0.10	0.120729	0.00	0.14
2063.528	0.10	0.254792	0.00	0.14
2063.783	0.10	0.081042	0.00	0.14
2063.864	0.10	0.177396	0.00	0.14
2064.042	0.10	5.191979	0.00	0.14
2069.234	0.10	0.145417	0.00	0.14
2069.379	0.11	4.928229	0.00	0.14
2074.307	0.11	3.191146	0.00	0.15
2077.498	0.11	1.65125	0.00	0.15
2079.15	0.11	0.765729	0.00	0.15
2079.915	0.11	0.477812	0.00	0.15
2080.393	0.11	6.580104	0.00	0.15
2086.973	0.11	0.869792	0.00	0.15
2087.843	0.11	6.344688	0.00	0.15
2094.188	0.11	2.205417	0.00	0.15
2096.393	0.11	9.208542	0.00	0.15
2105.602	0.11	6.157708	0.00	0.16
2111.759	0.12	1.643229	0.00	0.16
2113.403	0.12	0.995937	0.00	0.16
2114.399	0.12	0.789375	0.00	0.16
2115.188	0.12	1.101979	0.00	0.16
2116.29	0.12	1.726146	0.00	0.16
2118.016	0.12	2.58	0.00	0.16
2120.596	0.12	2.106979	0.00	0.16
2122.703	0.12	5.222083	0.00	0.16
2127.925	0.12	1.436354	0.00	0.16

2129.362	0.12	0.915521	0.00	0.16
2130.277	0.12	0.485104	0.00	0.16
2130.762	0.13	0.254583	0.00	0.16
2131.017	0.13	1.534479	0.00	0.16
2132.551	0.13	0.940833	0.00	0.16
2133.492	0.13	1.557917	0.00	0.16
2135.05	0.13	8.379479	0.00	0.17
2143.429	0.13	4.640521	0.00	0.17
2148.07	0.13	12.40917	0.00	0.17
2160.479	0.13	2.729687	0.00	0.17
2163.209	0.13	0.390521	0.00	0.18
2163.599	0.13	4.172917	0.00	0.18
2167.772	0.13	4.175729	0.00	0.18
2171.948	0.14	11.15083	0.00	0.18
2183.099	0.14	0.480104	0.00	0.18
2183.579	0.14	0.781146	0.00	0.18
2184.36	0.14	4.890625	0.00	0.18
2189.251	0.14	1.14625	0.00	0.18
2190.397	0.14	4.320521	0.00	0.18
2194.718	0.14	3.749167	0.00	0.19
2198.467	0.14	0.419063	0.00	0.19
2198.886	0.14	0.358438	0.00	0.19
2199.244	0.14	5.113125	0.00	0.19
2204.357	0.14	0.852708	0.00	0.19
2205.21	0.15	0.341458	0.00	0.19
2205.551	0.15	0.808646	0.00	0.19
2206.36	0.15	5.433125	0.00	0.19
2211.793	0.15	0.336875	0.00	0.19
2212.13	0.15	4.459271	0.00	0.19
2216.589	0.15	1.570729	0.00	0.19
2218.16	0.15	0.834479	0.00	0.19
2218.995	0.15	0.557812	0.00	0.20
2219.552	0.15	1.329375	0.00	0.20
2220.882	0.15	1.308229	0.00	0.20
2222.19	0.15	5.864896	0.00	0.20
2228.055	0.16	2.36	0.00	0.20
2230.415	0.16	3.478438	0.00	0.20
2233.893	0.16	0.824167	0.00	0.20
2234.718	0.16	3.989687	0.00	0.20
2238.707	0.16	2.013542	0.00	0.20
2240.721	0.16	1.816042	0.00	0.20
2242.537	0.16	0.121042	0.00	0.20
2242.658	0.16	0.882187	0.00	0.20

2243.54	0.16	2.590417	0.00	0.20
2246.13	0.16	0.324063	0.00	0.21
2246.454	0.16	2.736667	0.00	0.21
2249.191	0.17	2.522292	0.00	0.21
2251.713	0.17	4.287292	0.00	0.21
2256.001	0.17	3.947604	0.00	0.21
2259.948	0.17	0.608542	0.00	0.21
2260.557	0.17	0.500104	0.00	0.21
2261.057	0.17	0.413542	0.00	0.21
2261.471	0.17	0.633021	0.00	0.21
2262.104	0.17	0.487083	0.00	0.21
2262.591	0.17	3.052917	0.00	0.21
2265.644	0.17	2.024167	0.00	0.21
2267.668	0.17	0.715625	0.00	0.21
2268.383	0.18	0.010208	0.00	0.21
2268.394	0.18	6.956458	0.00	0.21
2275.35	0.18	1.694375	0.00	0.22
2277.044	0.18	0.684375	0.00	0.22
2277.729	0.18	2.098125	0.00	0.22
2279.827	0.18	8.520417	0.00	0.22
2288.347	0.18	6.022083	0.00	0.22
2294.369	0.18	2.256563	0.00	0.22
2296.626	0.18	3.136458	0.00	0.23
2299.762	0.18	0.277604	0.00	0.23
2300.04	0.18	0.19	0.00	0.23
2300.23	0.19	0.500937	0.00	0.23
2300.731	0.19	2.099062	0.00	0.23
2302.83	0.19	2.425	0.00	0.23
2305.255	0.19	0.445	0.00	0.23
2305.7	0.19	0.64	0.00	0.23
2306.34	0.19	0.089792	0.00	0.23
2306.43	0.19	1.612292	0.00	0.23
2308.042	0.19	4.799479	0.00	0.23
2312.842	0.19	0.125313	0.00	0.23
2312.967	0.19	1.335104	0.00	0.23
2314.302	0.19	0.545521	0.00	0.23
2314.848	0.20	5.6125	0.00	0.23
2320.46	0.20	1.497083	0.00	0.24
2321.957	0.20	0.352917	0.00	0.24
2322.31	0.20	0.84625	0.00	0.24
2323.156	0.20	0.126667	0.00	0.24
2323.283	0.20	0.596875	0.00	0.24
2323.88	0.20	1.590208	0.00	0.24

2325.47	0.20	1.114583	0.00	0.24
2326.585	0.20	1.545833	0.00	0.24
2328.13	0.20	4.516042	0.00	0.24
2332.646	0.20	0.554375	0.00	0.24
2333.201	0.21	2.069688	0.00	0.24
2335.271	0.21	1.066771	0.00	0.24
2336.337	0.21	3.108542	0.00	0.24
2339.446	0.21	0.496458	0.00	0.24
2339.942	0.21	2.963854	0.00	0.24
2342.906	0.21	2.068229	0.00	0.24
2344.974	0.21	2.769375	0.00	0.25
2347.744	0.21	0.1225	0.00	0.25
2347.866	0.21	0.130313	0.00	0.25
2347.997	0.21	3.280104	0.00	0.25
2351.277	0.21	1.493333	0.00	0.25
2352.77	0.22	1.263854	0.00	0.25
2354.034	0.22	0.528646	0.00	0.25
2354.563	0.22	4.59875	0.00	0.25
2359.161	0.22	4.634062	0.00	0.25
2363.795	0.22	0.642917	0.00	0.25
2364.438	0.22	0.065417	0.00	0.25
2364.504	0.22	7.359792	0.00	0.25
2371.863	0.22	0.066875	0.00	0.26
2371.93	0.22	3.226458	0.00	0.26
2375.157	0.22	0.145417	0.00	0.26
2375.302	0.22	2.160417	0.00	0.26
2377.463	0.23	0.038229	0.00	0.26
2377.501	0.23	1.448438	0.00	0.26
2378.949	0.23	0.740104	0.00	0.26
2379.689	0.23	0.86	0.00	0.26
2380.549	0.23	0.079062	0.00	0.26
2380.628	0.23	0.271563	0.00	0.26
2380.9	0.23	0.259063	0.00	0.26
2381.159	0.23	0.319479	0.00	0.26
2381.479	0.23	0.621458	0.00	0.26
2382.1	0.23	1.045833	0.00	0.26
2383.146	0.23	1.175	0.00	0.26
2384.321	0.24	0.203854	0.00	0.26
2384.525	0.24	1.135313	0.00	0.26
2385.66	0.24	0.4	0.00	0.26
2386.06	0.24	0.303333	0.00	0.26
2386.363	0.24	0.071667	0.00	0.26
2386.435	0.24	2.280833	0.00	0.26

2388.716	0.24	0.260833	0.00	0.26
2388.977	0.24	1.732708	0.00	0.26
2390.709	0.24	0.335938	0.00	0.27
2391.045	0.24	0.7575	0.00	0.27
2391.803	0.24	0.617187	0.00	0.27
2392.42	0.25	1.904688	0.00	0.27
2394.325	0.25	3.503646	0.00	0.27
2397.828	0.25	0.134583	0.00	0.27
2397.963	0.25	2.697083	0.00	0.27
2400.66	0.25	1.49	0.00	0.27
2402.15	0.25	1.800938	0.00	0.27
2403.951	0.25	0.046458	0.00	0.27
2403.997	0.25	0.794896	0.00	0.27
2404.792	0.25	1.518854	0.00	0.27
2406.311	0.25	0.182396	0.00	0.27
2406.494	0.25	0.776667	0.00	0.27
2407.27	0.26	0.029583	0.00	0.27
2407.3	0.26	0.909062	0.00	0.27
2408.209	0.26	0.407187	0.00	0.27
2408.616	0.26	1.646979	0.00	0.27
2410.263	0.26	0.666354	0.00	0.27
2410.929	0.26	0.936979	0.00	0.27
2411.866	0.26	2.358958	0.00	0.27
2414.225	0.26	0.854375	0.00	0.28
2415.08	0.26	1.347604	0.00	0.28
2416.427	0.26	3.376458	0.00	0.28
2419.804	0.26	0.895104	0.00	0.28
2420.699	0.27	5.021146	0.00	0.28
2425.72	0.27	1.998021	0.00	0.28
2427.718	0.27	0.160417	0.00	0.28
2427.878	0.27	0.350417	0.00	0.28
2428.229	0.27	1.541146	0.00	0.28
2429.77	0.27	0.094479	0.00	0.28
2429.864	0.27	2.834479	0.00	0.28
2432.699	0.27	0.266979	0.00	0.28
2432.966	0.27	0.548854	0.00	0.28
2433.515	0.27	0.967396	0.00	0.28
2434.482	0.27	0.474688	0.00	0.29
2434.957	0.28	1.875313	0.00	0.29
2436.832	0.28	0.057708	0.00	0.29
2436.89	0.28	1.451771	0.00	0.29
2438.342	0.28	1.705833	0.00	0.29
2440.048	0.28	0.748646	0.00	0.29

2440.796	0.28	0.434167	0.00	0.29
2441.23	0.28	3.115313	0.00	0.29
2444.346	0.28	2.175938	0.00	0.29
2446.522	0.28	1.354896	0.00	0.29
2447.876	0.28	2.067604	0.00	0.29
2449.944	0.28	0.189896	0.00	0.29
2450.134	0.29	11.23646	0.00	0.29
2461.37	0.29	1.742083	0.00	0.30
2463.113	0.29	0.354479	0.00	0.30
2463.467	0.29	0.463021	0.00	0.30
2463.93	0.29	2.169688	0.00	0.30
2466.1	0.29	0.413854	0.00	0.30
2466.514	0.29	1.566354	0.00	0.30
2468.08	0.29	0.99	0.00	0.30
2469.07	0.29	0.915313	0.00	0.30
2469.985	0.29	3.623021	0.00	0.30
2473.608	0.29	1.447188	0.00	0.30
2475.055	0.30	1.904583	0.00	0.30
2476.96	0.30	2.210312	0.00	0.31
2479.17	0.30	0.650833	0.00	0.31
2479.821	0.30	3.170313	0.00	0.31
2482.991	0.30	2.293125	0.00	0.31
2485.285	0.30	0.629583	0.00	0.31
2485.914	0.30	1.597292	0.00	0.31
2487.511	0.30	0.4425	0.00	0.31
2487.954	0.30	1.401146	0.00	0.31
2489.355	0.30	1.114792	0.00	0.31
2490.47	0.31	0.137604	0.00	0.31
2490.608	0.31	0.756562	0.00	0.31
2491.364	0.31	0.736875	0.00	0.31
2492.101	0.31	0.106563	0.00	0.31
2492.208	0.31	1.778021	0.00	0.31
2493.986	0.31	4.754479	0.00	0.31
2498.74	0.31	0.74	0.00	0.32
2499.48	0.31	0.162188	0.00	0.32
2499.642	0.31	1.117813	0.00	0.32
2500.76	0.31	1.431354	0.00	0.32
2502.191	0.31	0.265208	0.00	0.32
2502.457	0.32	0.373021	0.00	0.32
2502.83	0.32	0.073542	0.00	0.32
2502.903	0.32	0.002917	0.00	0.32
2502.906	0.32	0.644896	0.00	0.32
2503.551	0.32	1.277396	0.00	0.32

2504.828	0.32	1.561667	0.00	0.32
2506.39	0.32	3.197813	0.00	0.32
2509.588	0.32	2.592604	0.00	0.32
2512.18	0.32	1.424479	0.00	0.32
2513.605	0.32	0.452604	0.00	0.32
2514.058	0.32	1.014896	0.00	0.32
2515.072	0.33	2.677708	0.00	0.32
2517.75	0.33	3.198333	0.00	0.32
2520.948	0.33	0.45625	0.00	0.33
2521.405	0.33	0.595313	0.00	0.33
2522	0.33	2.759271	0.00	0.33
2524.759	0.33	1.584688	0.00	0.33
2526.344	0.33	0.460833	0.00	0.33
2526.805	0.33	1.915104	0.00	0.33
2528.72	0.33	2.580104	0.00	0.33
2531.3	0.33	4.046875	0.00	0.33
2535.347	0.33	1.115417	0.00	0.33
2536.462	0.34	2.298125	0.00	0.33
2538.76	0.34	0.185625	0.00	0.33
2538.946	0.34	0.729896	0.00	0.34
2539.676	0.34	1.612083	0.00	0.34
2541.288	0.34	0.942604	0.00	0.34
2542.231	0.34	1.019375	0.00	0.34
2543.25	0.34	0.023021	0.00	0.34
2543.273	0.34	2.963646	0.00	0.34
2546.237	0.34	2.105521	0.00	0.34
2548.342	0.34	4.2	0.00	0.34
2552.542	0.34	0.001875	0.00	0.34
2552.544	0.35	1.945937	0.00	0.34
2554.49	0.35	0.854167	0.00	0.34
2555.344	0.35	2.13	0.00	0.34
2557.474	0.35	1.613646	0.00	0.34
2559.088	0.35	0.752187	0.00	0.34
2559.84	0.35	0.945312	0.00	0.35
2560.785	0.35	1.094688	0.00	0.35
2561.88	0.35	2.366562	0.00	0.35
2564.247	0.35	0.229167	0.00	0.35
2564.476	0.35	0.210417	0.00	0.35
2564.686	0.35	0.026146	0.00	0.35
2564.712	0.36	0.17125	0.00	0.35
2564.884	0.36	0.333125	0.00	0.35
2565.217	0.36	0.327917	0.00	0.35
2565.545	0.36	2.667604	0.00	0.35

2568.212	0.36	3.084687	0.00	0.35
2571.297	0.36	0.137083	0.00	0.35
2571.434	0.36	2.089167	0.00	0.35
2573.523	0.36	0.366979	0.00	0.35
2573.89	0.36	1.869896	0.00	0.35
2575.76	0.36	2.46	0.00	0.35
2578.22	0.36	0.025937	0.00	0.35
2578.246	0.37	0.502708	0.00	0.35
2578.749	0.37	1.187188	0.00	0.35
2579.936	0.37	2.264167	0.00	0.36
2582.2	0.37	0.16125	0.00	0.36
2582.361	0.37	0.806979	0.00	0.36
2583.168	0.37	0.009271	0.00	0.36
2583.178	0.37	0.495521	0.00	0.36
2583.673	0.37	1.161979	0.00	0.36
2584.835	0.37	0.319271	0.00	0.36
2585.154	0.37	0.594896	0.00	0.36
2585.749	0.37	2.840417	0.00	0.36
2588.59	0.38	0.281562	0.00	0.36
2588.871	0.38	1.31625	0.00	0.36
2590.187	0.38	0.217083	0.00	0.36
2590.404	0.38	0.196458	0.00	0.36
2590.601	0.38	0.667708	0.00	0.36
2591.269	0.38	1.182292	0.00	0.36
2592.451	0.38	1.13875	0.00	0.36
2593.59	0.38	0.237083	0.00	0.36
2593.827	0.38	0.344375	0.00	0.36
2594.171	0.38	2.108854	0.00	0.36
2596.28	0.38	1.822604	0.00	0.36
2598.103	0.39	0.324479	0.00	0.36
2598.427	0.39	1.212396	0.00	0.36
2599.639	0.39	0.269688	0.00	0.37
2599.909	0.39	1.010937	0.00	0.37
2600.92	0.39	0.151563	0.00	0.37
2601.072	0.39	0.264688	0.00	0.37
2601.336	0.39	0.099271	0.00	0.37
2601.436	0.39	0.232187	0.00	0.37
2601.668	0.39	0.44375	0.00	0.37
2602.112	0.39	3.256458	0.00	0.37
2605.368	0.39	2.196458	0.00	0.37
2607.564	0.40	0.755208	0.00	0.37
2608.32	0.40	0.086875	0.00	0.37
2608.407	0.40	0.702604	0.00	0.37

2609.109	0.40	0.983021	0.00	0.37
2610.092	0.40	0.325833	0.00	0.37
2610.418	0.40	2.181979	0.00	0.37
2612.6	0.40	0.89	0.00	0.37
2613.49	0.40	1.869375	0.00	0.37
2615.359	0.40	0.49375	0.00	0.37
2615.853	0.40	0.405938	0.00	0.37
2616.259	0.40	1.273646	0.00	0.37
2617.533	0.41	0.441979	0.00	0.37
2617.975	0.41	1.575312	0.00	0.37
2619.55	0.41	0.015104	0.00	0.38
2619.565	0.41	0.369479	0.00	0.38
2619.935	0.41	2.99625	0.00	0.38
2622.931	0.41	0.267917	0.00	0.38
2623.199	0.41	0.391771	0.00	0.38
2623.591	0.41	0.649479	0.00	0.38
2624.24	0.41	3.697813	0.00	0.38
2627.938	0.41	1.296354	0.00	0.38
2629.234	0.41	2.203333	0.00	0.38
2631.438	0.42	0.375417	0.00	0.38
2631.813	0.42	0.992083	0.00	0.38
2632.805	0.42	3.458646	0.00	0.38
2636.264	0.42	4.341875	0.00	0.38
2640.606	0.42	2.474479	0.00	0.39
2643.08	0.42	0.107708	0.00	0.39
2643.188	0.42	0.216875	0.00	0.39
2643.405	0.42	0.0025	0.00	0.39
2643.407	0.42	0.290417	0.00	0.39
2643.698	0.42	1.834688	0.00	0.39
2645.532	0.42	0.665	0.00	0.39
2646.197	0.43	1.728125	0.00	0.39
2647.925	0.43	1.999792	0.00	0.39
2649.925	0.43	0.097708	0.00	0.39
2650.023	0.43	1.067188	0.00	0.39
2651.09	0.43	0.18	0.00	0.39
2651.27	0.43	2.165521	0.00	0.39
2653.436	0.43	2.427813	0.00	0.39
2655.863	0.43	0.835521	0.00	0.39
2656.699	0.43	2.030833	0.00	0.39
2658.73	0.43	0.77125	0.00	0.40
2659.501	0.43	2.119062	0.00	0.40
2661.62	0.44	0.371146	0.00	0.40
2661.991	0.44	1.584271	0.00	0.40

2663.575	0.44	0.261563	0.00	0.40
2663.837	0.44	1.22875	0.00	0.40
2665.066	0.44	3.890208	0.00	0.40
2668.956	0.44	1.074063	0.00	0.40
2670.03	0.44	2.169896	0.00	0.40
2672.2	0.44	1.300104	0.00	0.40
2673.5	0.44	0.345521	0.00	0.40
2673.846	0.44	2.7575	0.00	0.40
2676.603	0.44	2.338229	0.00	0.41
2678.941	0.45	5.514792	0.00	0.41
2684.456	0.45	0.645729	0.00	0.41
2685.102	0.45	0.588229	0.00	0.41
2685.69	0.45	0.936146	0.00	0.41
2686.626	0.45	0.8825	0.00	0.41
2687.509	0.45	1.231354	0.00	0.41
2688.74	0.45	0.075208	0.00	0.41
2688.815	0.45	0.594479	0.00	0.41
2689.41	0.45	2.440312	0.00	0.41
2691.85	0.45	0.183333	0.00	0.41
2692.033	0.45	1.271458	0.00	0.41
2693.305	0.46	0.121667	0.00	0.41
2693.426	0.46	0.235208	0.00	0.41
2693.662	0.46	0.35375	0.00	0.41
2694.015	0.46	1.538854	0.00	0.41
2695.554	0.46	1.005	0.00	0.42
2696.559	0.46	0.210729	0.00	0.42
2696.77	0.46	1.41	0.00	0.42
2698.18	0.46	2.725	0.00	0.42
2700.905	0.46	0.490208	0.00	0.42
2701.395	0.46	0.492812	0.00	0.42
2701.888	0.46	1.274896	0.00	0.42
2703.163	0.47	1.381979	0.00	0.42
2704.545	0.47	0.538021	0.00	0.42
2705.083	0.47	1.617083	0.00	0.42
2706.7	0.47	0.010521	0.00	0.42
2706.711	0.47	2.610104	0.00	0.42
2709.321	0.47	2.395729	0.00	0.42
2711.716	0.47	0.072396	0.00	0.42
2711.789	0.47	0.078958	0.00	0.42
2711.868	0.47	1.030104	0.00	0.42
2712.898	0.47	1.861875	0.00	0.42
2714.76	0.47	0.402188	0.00	0.43
2715.162	0.48	3.431667	0.00	0.43

2718.594	0.48	0.44375	0.00	0.43
2719.037	0.48	0.808438	0.00	0.43
2719.846	0.48	3.545417	0.00	0.43
2723.391	0.48	1.201042	0.00	0.43
2724.592	0.48	1.24375	0.00	0.43
2725.836	0.48	1.132083	0.00	0.43
2726.968	0.48	0.986875	0.00	0.43
2727.955	0.48	0.860625	0.00	0.43
2728.816	0.48	1.714479	0.00	0.43
2730.53	0.48	0.071771	0.00	0.43
2730.602	0.49	0.488125	0.00	0.43
2731.09	0.49	1.230104	0.00	0.43
2732.32	0.49	0.766771	0.00	0.43
2733.087	0.49	0.067083	0.00	0.44
2733.154	0.49	0.823646	0.00	0.44
2733.978	0.49	0.055729	0.00	0.44
2734.033	0.49	1.897187	0.00	0.44
2735.93	0.49	0.006458	0.00	0.44
2735.937	0.49	0.361979	0.00	0.44
2736.299	0.49	5.459063	0.00	0.44
2741.758	0.49	0.894479	0.00	0.44
2742.652	0.50	1.136979	0.00	0.44
2743.789	0.50	0.143229	0.00	0.44
2743.933	0.50	0.244896	0.00	0.44
2744.178	0.50	0.318854	0.00	0.44
2744.496	0.50	1.005937	0.00	0.44
2745.502	0.50	0.370313	0.00	0.44
2745.873	0.50	1.318958	0.00	0.44
2747.192	0.50	1.028542	0.00	0.44
2748.22	0.50	0.2925	0.00	0.44
2748.513	0.50	0.849896	0.00	0.44
2749.363	0.51	0.589063	0.00	0.44
2749.952	0.51	0.278438	0.00	0.44
2750.23	0.51	0.000417	0.00	0.44
2750.23	0.51	2.948333	0.00	0.44
2753.179	0.51	0.541667	0.00	0.45
2753.72	0.51	0.725729	0.00	0.45
2754.446	0.51	1.690104	0.00	0.45
2756.136	0.51	0.472813	0.00	0.45
2756.609	0.51	1.819167	0.00	0.45
2758.428	0.51	1.258854	0.00	0.45
2759.687	0.51	0.540833	0.00	0.45
2760.228	0.52	0.460208	0.00	0.45

2760.688	0.52	1.752083	0.00	0.45
2762.44	0.52	0.46875	0.00	0.45
2762.909	0.52	4.056458	0.00	0.45
2766.965	0.52	0.851875	0.00	0.45
2767.817	0.52	3.365833	0.00	0.45
2771.183	0.52	0.916667	0.00	0.46
2772.1	0.52	1.172604	0.00	0.46
2773.272	0.52	0.387292	0.00	0.46
2773.66	0.52	2.394792	0.00	0.46
2776.054	0.52	1.965521	0.00	0.46
2778.02	0.53	0.322813	0.00	0.46
2778.343	0.53	2.957187	0.00	0.46
2781.3	0.53	8.889271	0.00	0.46
2790.189	0.53	0.379375	0.00	0.47
2790.569	0.53	1.112917	0.00	0.47
2791.682	0.53	0.795	0.00	0.47
2792.477	0.53	0.448125	0.00	0.47
2792.925	0.53	0.098854	0.00	0.47
2793.024	0.53	3.193646	0.00	0.47
2796.217	0.53	1.591979	0.00	0.47
2797.809	0.53	0.280833	0.00	0.47
2798.09	0.54	1.87375	0.00	0.47
2799.964	0.54	3.394271	0.00	0.47
2803.358	0.54	0.843438	0.00	0.47
2804.201	0.54	1.462917	0.00	0.47
2805.664	0.54	0.863229	0.00	0.47
2806.528	0.54	2.882396	0.00	0.47
2809.41	0.54	0.689896	0.00	0.48
2810.1	0.54	1.880104	0.00	0.48
2811.98	0.54	0.5925	0.00	0.48
2812.573	0.54	1.6175	0.00	0.48
2814.19	0.54	2.142188	0.00	0.48
2816.332	0.55	0.541354	0.00	0.48
2816.874	0.55	0.938542	0.00	0.48
2817.812	0.55	0.574479	0.00	0.48
2818.387	0.55	0.784583	0.00	0.48
2819.171	0.55	2.338854	0.00	0.48
2821.51	0.55	2.283542	0.00	0.48
2823.794	0.55	0.026563	0.00	0.48
2823.82	0.55	0.026562	0.00	0.48
2823.847	0.55	3.901458	0.00	0.48
2827.748	0.55	0.126979	0.00	0.49
2827.875	0.55	1.153437	0.00	0.49

2829.029	0.56	0.052813	0.00	0.49
2829.081	0.56	1.614896	0.00	0.49
2830.696	0.56	0.629063	0.00	0.49
2831.325	0.56	0.172604	0.00	0.49
2831.498	0.56	1.801875	0.00	0.49
2833.3	0.56	2.540625	0.00	0.49
2835.84	0.56	1.697708	0.00	0.49
2837.538	0.56	1.030833	0.00	0.49
2838.569	0.56	0.694479	0.00	0.49
2839.263	0.56	2.999792	0.00	0.49
2842.263	0.56	2.645625	0.00	0.49
2844.909	0.57	0.742708	0.00	0.50
2845.652	0.57	0.422813	0.00	0.50
2846.074	0.57	1.504062	0.00	0.50
2847.578	0.57	0.6225	0.00	0.50
2848.201	0.57	0.591458	0.00	0.50
2848.792	0.57	2.337292	0.00	0.50
2851.13	0.57	0.088438	0.00	0.50
2851.218	0.57	0.249792	0.00	0.50
2851.468	0.57	0.46	0.00	0.50
2851.928	0.57	0.832292	0.00	0.50
2852.76	0.57	0.618438	0.00	0.50
2853.379	0.58	0.441354	0.00	0.50
2853.82	0.58	0.778125	0.00	0.50
2854.598	0.58	1.651875	0.00	0.50
2856.25	0.58	1.131354	0.00	0.50
2857.381	0.58	0.015729	0.00	0.50
2857.397	0.58	1.271979	0.00	0.50
2858.669	0.58	0.210938	0.00	0.50
2858.88	0.58	3.184792	0.00	0.50
2862.065	0.58	1.872188	0.00	0.50
2863.937	0.58	1.692917	0.00	0.51
2865.63	0.58	0.086042	0.00	0.51
2865.716	0.59	0.374063	0.00	0.51
2866.09	0.59	0.615	0.00	0.51
2866.705	0.59	1.74875	0.00	0.51
2868.454	0.59	1.30625	0.00	0.51
2869.76	0.59	1.47	0.00	0.51
2871.23	0.59	2.736042	0.00	0.51
2873.966	0.59	0.298229	0.00	0.51
2874.264	0.59	0.134167	0.00	0.51
2874.398	0.59	0.151563	0.00	0.51
2874.55	0.59	0.616354	0.00	0.51

2875.166	0.59	1.447292	0.00	0.51
2876.614	0.60	1.588125	0.00	0.51
2878.202	0.60	0.113854	0.00	0.51
2878.316	0.60	2.008333	0.00	0.51
2880.324	0.60	2.144792	0.00	0.51
2882.469	0.60	0.175417	0.00	0.52
2882.644	0.60	0.939896	0.00	0.52
2883.584	0.60	1.288542	0.00	0.52
2884.873	0.60	3.28375	0.00	0.52
2888.156	0.60	1.576979	0.00	0.52
2889.733	0.60	0.692812	0.00	0.52
2890.426	0.60	3.688125	0.00	0.52
2894.114	0.61	4.880625	0.00	0.52
2898.995	0.61	0.195104	0.00	0.52
2899.19	0.61	0.436354	0.00	0.52
2899.626	0.61	0.303646	0.00	0.52
2899.93	0.61	0.364271	0.00	0.52
2900.294	0.61	0.691042	0.00	0.52
2900.985	0.61	5.312604	0.00	0.53
2906.298	0.61	1.000417	0.00	0.53
2907.298	0.61	1.297812	0.00	0.53
2908.596	0.61	1.239271	0.00	0.53
2909.835	0.61	2.002604	0.00	0.53
2911.838	0.62	1.369271	0.00	0.53
2913.207	0.62	0.872708	0.00	0.53
2914.08	0.62	0.566042	0.00	0.53
2914.646	0.62	2.199271	0.00	0.53
2916.845	0.62	2.626354	0.00	0.53
2919.472	0.62	0.266146	0.00	0.54
2919.738	0.62	0.627917	0.00	0.54
2920.366	0.62	2.571979	0.00	0.54
2922.938	0.62	0.076771	0.00	0.54
2923.014	0.62	4.092813	0.00	0.54
2927.107	0.62	7.156667	0.00	0.54
2934.264	0.63	2.145313	0.00	0.54
2936.409	0.63	1.320208	0.00	0.54
2937.729	0.63	1.029896	0.00	0.55
2938.759	0.63	0.131667	0.00	0.55
2938.891	0.63	5.005417	0.00	0.55
2943.896	0.63	1.523958	0.00	0.55
2945.42	0.63	0.607292	0.00	0.55
2946.028	0.63	0.188854	0.00	0.55
2946.217	0.63	1.451563	0.00	0.55

2947.668	0.63	1.337604	0.00	0.55
2949.006	0.63	1.021042	0.00	0.55
2950.027	0.64	2.607917	0.00	0.55
2952.635	0.64	0.046562	0.00	0.55
2952.681	0.64	0.396979	0.00	0.55
2953.078	0.64	1.521771	0.00	0.55
2954.6	0.64	0.219271	0.00	0.55
2954.819	0.64	0.304375	0.00	0.55
2955.124	0.64	2.460938	0.00	0.55
2957.585	0.64	0.201979	0.00	0.56
2957.787	0.64	0.789583	0.00	0.56
2958.576	0.64	0.663542	0.00	0.56
2959.24	0.64	5.075937	0.00	0.56
2964.316	0.65	1.199167	0.00	0.56
2965.515	0.65	0.154271	0.00	0.56
2965.669	0.65	0.256458	0.00	0.56
2965.926	0.65	1.318229	0.00	0.56
2967.244	0.65	3.736875	0.00	0.56
2970.981	0.65	0.865625	0.00	0.56
2971.846	0.65	0.355104	0.00	0.56
2972.201	0.65	3.718021	0.00	0.56
2975.919	0.65	2.03625	0.00	0.57
2977.956	0.65	2.608854	0.00	0.57
2980.564	0.65	2.559792	0.00	0.57
2983.124	0.66	1.505208	0.00	0.57
2984.629	0.66	1.381042	0.00	0.57
2986.011	0.66	5.646354	0.00	0.57
2991.657	0.66	0.389792	0.00	0.57
2992.047	0.66	3.007188	0.00	0.57
2995.054	0.66	0.186146	0.00	0.58
2995.24	0.66	0.373854	0.00	0.58
2995.614	0.66	0.696146	0.00	0.58
2996.31	0.66	0.930938	0.00	0.58
2997.241	0.66	0.199479	0.00	0.58
2997.44	0.66	0.459792	0.00	0.58
2997.9	0.67	0.731146	0.00	0.58
2998.631	0.67	0.048646	0.00	0.58
2998.68	0.67	0.031875	0.00	0.58
2998.712	0.67	0.739167	0.00	0.58
2999.451	0.67	0.454271	0.00	0.58
2999.905	0.67	0.014375	0.00	0.58
2999.92	0.67	0.055625	0.00	0.58
2999.975	0.67	1.964688	0.00	0.58

3001.94	0.67	4.926667	0.00	0.58
3006.867	0.67	5.436563	0.00	0.58
3012.303	0.67	6.286458	0.00	0.58
3018.59	0.68	0.124479	0.00	0.59
3018.714	0.68	3.048646	0.00	0.59
3021.763	0.68	3.346979	0.00	0.59
3025.11	0.68	1.530104	0.00	0.59
3026.64	0.68	2.017083	0.00	0.59
3028.657	0.68	0.462708	0.00	0.59
3029.12	0.68	1.457917	0.00	0.59
3030.578	0.68	0.150729	0.00	0.59
3030.728	0.68	2.581667	0.00	0.59
3033.31	0.68	0.668958	0.00	0.60
3033.979	0.68	0.030521	0.00	0.60
3034.009	0.69	0.694479	0.00	0.60
3034.704	0.69	2.612083	0.00	0.60
3037.316	0.69	1.23625	0.00	0.60
3038.552	0.69	0.745938	0.00	0.60
3039.298	0.69	2.045625	0.00	0.60
3041.344	0.69	2.785625	0.00	0.60
3044.129	0.69	1.746979	0.00	0.60
3045.876	0.69	1.406771	0.00	0.60
3047.283	0.69	0.330521	0.00	0.60
3047.614	0.69	0.418958	0.00	0.60
3048.033	0.69	1.880104	0.00	0.60
3049.913	0.70	1.356563	0.00	0.60
3051.269	0.70	0.690625	0.00	0.61
3051.96	0.70	0.467083	0.00	0.61
3052.427	0.70	0.392396	0.00	0.61
3052.819	0.70	7.465625	0.00	0.61
3060.285	0.70	2.773333	0.00	0.61
3063.058	0.70	6.041563	0.00	0.61
3069.1	0.70	0.154167	0.00	0.61
3069.254	0.70	0.558542	0.00	0.61
3069.813	0.70	1.045313	0.00	0.61
3070.858	0.71	5.361979	0.00	0.62
3076.22	0.71	1.771354	0.00	0.62
3077.991	0.71	6.223646	0.00	0.62
3084.215	0.71	1.635	0.00	0.62
3085.85	0.71	4.869896	0.00	0.62
3090.72	0.71	4.285729	0.00	0.63
3095.006	0.71	1.976354	0.00	0.63
3096.982	0.71	2.964375	0.00	0.63

3099.946	0.71	0.425208	0.00	0.63
3100.372	0.71	0.084063	0.00	0.63
3100.456	0.71	1.617396	0.00	0.63
3102.073	0.72	3.859896	0.00	0.63
3105.933	0.72	1.802708	0.00	0.63
3107.736	0.72	5.035417	0.00	0.63
3112.771	0.72	2.112604	0.00	0.64
3114.884	0.72	0.890417	0.00	0.64
3115.774	0.72	0.665937	0.00	0.64
3116.44	0.72	4.00125	0.00	0.64
3120.441	0.72	2.153958	0.00	0.64
3122.595	0.72	2.439479	0.00	0.64
3125.035	0.72	0.798958	0.00	0.64
3125.834	0.72	2.646562	0.00	0.64
3128.48	0.73	0.780833	0.00	0.64
3129.261	0.73	0.621667	0.00	0.65
3129.883	0.73	2.987812	0.00	0.65
3132.871	0.73	0.602396	0.00	0.65
3133.473	0.73	0.678229	0.00	0.65
3134.151	0.73	0.079167	0.00	0.65
3134.23	0.73	3.077396	0.00	0.65
3137.308	0.73	2.167292	0.00	0.65
3139.475	0.73	2.264271	0.00	0.65
3141.739	0.73	0.194896	0.00	0.65
3141.934	0.73	0.963958	0.00	0.65
3142.898	0.74	3.821562	0.00	0.65
3146.72	0.74	1.909896	0.00	0.65
3148.63	0.74	0.83125	0.00	0.65
3149.461	0.74	0.040625	0.00	0.66
3149.501	0.74	1.077188	0.00	0.66
3150.579	0.74	3.901354	0.00	0.66
3154.48	0.74	11.71427	0.00	0.66
3166.194	0.74	0.757708	0.00	0.66
3166.952	0.74	0.641354	0.00	0.66
3167.593	0.74	3.867708	0.00	0.66
3171.461	0.74	8.489271	0.00	0.67
3179.95	0.75	0.521042	0.00	0.67
3180.471	0.75	3.143437	0.00	0.67
3183.615	0.75	1.55875	0.00	0.67
3185.174	0.75	0.178854	0.00	0.67
3185.352	0.75	1.397083	0.00	0.67
3186.749	0.75	0.397188	0.00	0.67
3187.147	0.75	1.246146	0.00	0.67

3188.393	0.75	0.950729	0.00	0.67
3189.344	0.75	4.076354	0.00	0.67
3193.42	0.75	3.763542	0.00	0.68
3197.183	0.75	0.864062	0.00	0.68
3198.048	0.76	1.369479	0.00	0.68
3199.417	0.76	0.188333	0.00	0.68
3199.605	0.76	0.062917	0.00	0.68
3199.668	0.76	0.233646	0.00	0.68
3199.902	0.76	0.28875	0.00	0.68
3200.191	0.76	1.304375	0.00	0.68
3201.495	0.76	0.929063	0.00	0.68
3202.424	0.76	0.056979	0.00	0.68
3202.481	0.76	0.144896	0.00	0.68
3202.626	0.76	1.944792	0.00	0.68
3204.571	0.76	7.834896	0.00	0.68
3212.406	0.77	0.730729	0.00	0.69
3213.136	0.77	5.997604	0.00	0.69
3219.134	0.77	3.094271	0.00	0.69
3222.228	0.77	4.053958	0.00	0.69
3226.282	0.77	3.301146	0.00	0.69
3229.583	0.77	1.691875	0.00	0.69
3231.275	0.77	4.794271	0.00	0.70
3236.069	0.77	0.401458	0.00	0.70
3236.471	0.77	2.543646	0.00	0.70
3239.015	0.77	6.589271	0.00	0.70
3245.604	0.77	0.349896	0.00	0.70
3245.954	0.78	1.117604	0.00	0.70
3247.071	0.78	0.772083	0.00	0.70
3247.843	0.78	1.035104	0.00	0.70
3248.879	0.78	0.108333	0.00	0.70
3248.987	0.78	0.406458	0.00	0.70
3249.393	0.78	0.926667	0.00	0.70
3250.32	0.78	0.743854	0.00	0.70
3251.064	0.78	14.36615	0.00	0.70
3265.43	0.78	3.550938	0.00	0.71
3268.981	0.78	0.245	0.00	0.71
3269.226	0.78	0.630938	0.00	0.71
3269.857	0.79	5.948542	0.00	0.71
3275.805	0.79	1.085938	0.00	0.72
3276.891	0.79	1.495	0.00	0.72
3278.386	0.79	10.70615	0.00	0.72
3289.093	0.79	1.440208	0.00	0.72
3290.533	0.79	0.406875	0.00	0.72

3290.94	0.79	1.009896	0.00	0.72
3291.949	0.79	6.352188	0.00	0.72
3298.302	0.79	1.406771	0.00	0.73
3299.708	0.79	11.66323	0.00	0.73
3311.372	0.79	2.600417	0.00	0.73
3313.972	0.80	0.708125	0.00	0.73
3314.68	0.80	0.076458	0.00	0.73
3314.757	0.80	5.346979	0.00	0.73
3320.104	0.80	0.270417	0.00	0.74
3320.374	0.80	0.167812	0.00	0.74
3320.542	0.80	8.309583	0.00	0.74
3328.851	0.80	1.900521	0.00	0.74
3330.752	0.80	1.311667	0.00	0.74
3332.064	0.80	7.050104	0.00	0.74
3339.114	0.80	9.8525	0.00	0.74
3348.966	0.80	0.474375	0.00	0.75
3349.441	0.81	1.441979	0.00	0.75
3350.883	0.81	7.279687	0.00	0.75
3358.162	0.81	2.234896	0.00	0.75
3360.397	0.81	0.176354	0.00	0.75
3360.574	0.81	0.200208	0.00	0.75
3360.774	0.81	0.318229	0.00	0.75
3361.092	0.81	4.227604	0.00	0.75
3365.32	0.81	6.742812	0.00	0.76
3372.062	0.81	5.24	0.00	0.76
3377.302	0.81	4.184688	0.00	0.76
3381.487	0.81	6.556354	0.00	0.76
3388.043	0.82	4.040104	0.00	0.76
3392.084	0.82	7.069583	0.00	0.77
3399.153	0.82	3.09125	0.00	0.77
3402.244	0.82	0.090729	0.00	0.77
3402.335	0.82	4.966979	0.00	0.77
3407.302	0.82	3.687917	0.00	0.77
3410.99	0.82	4.013438	0.00	0.77
3415.003	0.82	0.67875	0.00	0.78
3415.682	0.82	0.765729	0.00	0.78
3416.448	0.82	0.260521	0.00	0.78
3416.708	0.82	1.236042	0.00	0.78
3417.944	0.83	3.525104	0.00	0.78
3421.47	0.83	5.385729	0.00	0.78
3426.855	0.83	0.688438	0.00	0.78
3427.544	0.83	1.565521	0.00	0.78
3429.109	0.83	2.504479	0.00	0.78

3431.614	0.83	2.950937	0.00	0.78
3434.565	0.83	3.414167	0.00	0.78
3437.979	0.83	3.895208	0.00	0.79
3441.874	0.83	3.932812	0.00	0.79
3445.807	0.83	0.699375	0.00	0.79
3446.506	0.83	1.986354	0.00	0.79
3448.493	0.84	5.729271	0.00	0.79
3454.222	0.84	1.015937	0.00	0.79
3455.238	0.84	3.956979	0.00	0.79
3459.195	0.84	0.962292	0.00	0.79
3460.157	0.84	0.699896	0.00	0.79
3460.857	0.84	5.4975	0.00	0.79
3466.354	0.84	3.094271	0.00	0.80
3469.449	0.84	3.420833	0.00	0.80
3472.87	0.84	0.465938	0.00	0.80
3473.336	0.84	4.256771	0.00	0.80
3477.592	0.84	3.707708	0.00	0.80
3481.3	0.85	0.048229	0.00	0.80
3481.348	0.85	4.198125	0.00	0.80
3485.546	0.85	14.32417	0.00	0.80
3499.871	0.85	6.510625	0.00	0.81
3506.381	0.85	1.225729	0.00	0.81
3507.607	0.85	1.203958	0.00	0.81
3508.811	0.85	4.062396	0.00	0.81
3512.873	0.85	2.502708	0.00	0.81
3515.376	0.85	1.881042	0.00	0.81
3517.257	0.85	1.182813	0.00	0.82
3518.44	0.85	2.765833	0.00	0.82
3521.206	0.86	2.999062	0.00	0.82
3524.205	0.86	5.465312	0.00	0.82
3529.67	0.86	7.079375	0.00	0.82
3536.749	0.86	4.443333	0.00	0.82
3541.193	0.86	3.221667	0.00	0.82
3544.414	0.86	2.206667	0.00	0.82
3546.621	0.86	1.063125	0.00	0.83
3547.684	0.86	5.409271	0.00	0.83
3553.093	0.86	3.229896	0.00	0.83
3556.323	0.86	1.369271	0.00	0.83
3557.693	0.86	6.616458	0.00	0.83
3564.309	0.87	2.839896	0.00	0.83
3567.149	0.87	0.369688	0.00	0.83
3567.519	0.87	0.521042	0.00	0.83
3568.04	0.87	1.760729	0.00	0.83

3569.8	0.87	11.21594	0.00	0.83
3581.016	0.87	16.2099	0.00	0.84
3597.226	0.87	2.617812	0.00	0.84
3599.844	0.87	2.128333	0.00	0.84
3601.972	0.87	5.600729	0.00	0.84
3607.573	0.87	2.106458	0.00	0.85
3609.68	0.87	0.736458	0.00	0.85
3610.416	0.88	1.8475	0.00	0.85
3612.264	0.88	0.309792	0.00	0.85
3612.573	0.88	0.455729	0.00	0.85
3613.029	0.88	4.533125	0.00	0.85
3617.562	0.88	2.784687	0.00	0.85
3620.347	0.88	0.062083	0.00	0.85
3620.409	0.88	2.576875	0.00	0.85
3622.986	0.88	10.0976	0.00	0.85
3633.083	0.88	0.763333	0.00	0.85
3633.847	0.88	17.84229	0.00	0.85
3651.689	0.88	10.01979	0.00	0.86
3661.709	0.89	0.322187	0.00	0.86
3662.031	0.89	1.965729	0.00	0.86
3663.997	0.89	6.335729	0.00	0.86
3670.333	0.89	0.400313	0.00	0.87
3670.733	0.89	3.731563	0.00	0.87
3674.464	0.89	6.664792	0.00	0.87
3681.129	0.89	1.289167	0.00	0.87
3682.418	0.89	3.793021	0.00	0.87
3686.211	0.89	1.552292	0.00	0.87
3687.764	0.89	0.86	0.00	0.87
3688.624	0.89	9.057083	0.00	0.87
3697.681	0.90	1.16125	0.00	0.87
3698.842	0.90	1.474688	0.00	0.87
3700.317	0.90	1.522187	0.00	0.87
3701.839	0.90	3.633438	0.00	0.87
3705.472	0.90	1.355937	0.00	0.88
3706.828	0.90	2.146042	0.00	0.88
3708.974	0.90	16.0075	0.00	0.88
3724.982	0.90	14.65292	0.00	0.88
3739.635	0.90	7.437396	0.00	0.88
3747.072	0.90	1.583958	0.00	0.89
3748.656	0.91	1.898854	0.00	0.89
3750.555	0.91	12.31833	0.00	0.89
3762.873	0.91	14.80437	0.00	0.89
3777.678	0.91	3.371042	0.00	0.89

3781.049	0.91	10.19802	0.00	0.90
3791.247	0.91	1.843333	0.00	0.90
3793.09	0.91	27.21875	0.00	0.90
3820.309	0.91	18.30542	0.00	0.90
3838.614	0.91	9.903021	0.00	0.91
3848.517	0.91	6.759167	0.00	0.91
3855.276	0.91	2.018125	0.00	0.91
3857.294	0.92	0.181875	0.00	0.91
3857.476	0.92	7.218438	0.00	0.91
3864.695	0.92	8.56875	0.00	0.91
3873.264	0.92	1.804688	0.00	0.92
3875.068	0.92	3.330208	0.00	0.92
3878.398	0.92	3.918021	0.00	0.92
3882.316	0.92	24.9775	0.00	0.92
3907.294	0.92	0.531562	0.00	0.92
3907.826	0.92	7.456146	0.00	0.92
3915.282	0.92	6.938854	0.00	0.92
3922.221	0.92	3.313333	0.00	0.93
3925.534	0.93	0.300104	0.00	0.93
3925.834	0.93	7.639479	0.00	0.93
3933.473	0.93	0.033958	0.00	0.93
3933.507	0.93	0.610729	0.00	0.93
3934.118	0.93	26.3324	0.00	0.93
3960.451	0.93	23.21562	0.00	0.93
3983.666	0.93	8.346771	0.00	0.94
3992.013	0.93	0.788125	0.00	0.94
3992.801	0.93	5.517187	0.00	0.94
3998.318	0.93	1.513021	0.00	0.94
3999.831	0.93	0.395937	0.00	0.94
4000.227	0.94	6.069063	0.00	0.94
4006.296	0.94	12.98677	0.00	0.94
4019.283	0.94	1.166771	0.00	0.94
4020.45	0.94	1.215	0.00	0.94
4021.665	0.94	7.468646	0.00	0.94
4029.133	0.94	8.331875	0.00	0.94
4037.465	0.94	2.046563	0.00	0.95
4039.512	0.94	9.939583	0.00	0.95
4049.451	0.94	1.485833	0.00	0.95
4050.937	0.94	6.441979	0.00	0.95
4057.379	0.94	4.340104	0.00	0.95
4061.719	0.95	7.763021	0.00	0.95
4069.482	0.95	9.325208	0.00	0.95
4078.808	0.95	9.265833	0.00	0.95

4088.073	0.95	18.52021	0.00	0.95
4106.594	0.95	0.496875	0.00	0.95
4107.091	0.95	7.225313	0.00	0.95
4114.316	0.95	2.377708	0.00	0.96
4116.694	0.95	23.14833	0.00	0.96
4139.842	0.95	30.16583	0.00	0.96
4170.008	0.95	7.124583	0.00	0.96
4177.132	0.95	21.79865	0.00	0.96
4198.931	0.96	13.75927	0.00	0.97
4212.69	0.96	21.80656	0.00	0.97
4234.497	0.96	6.104583	0.00	0.97
4240.601	0.96	25.29292	0.00	0.97
4265.894	0.96	7.880729	0.00	0.97
4273.775	0.96	5.486458	0.00	0.97
4279.261	0.96	12.3475	0.00	0.97
4291.609	0.96	19.06604	0.00	0.97
4310.675	0.96	4.30875	0.00	0.98
4314.984	0.96	11.74167	0.00	0.98
4326.725	0.96	2.820938	0.00	0.98
4329.546	0.97	20.23365	0.00	0.98
4349.78	0.97	0.317604	0.00	0.98
4350.098	0.97	46.36562	0.00	0.98
4396.463	0.97	13.6799	0.00	0.98
4410.143	0.97	2.882917	0.00	0.98
4413.026	0.97	13.48844	0.00	0.98
4426.514	0.97	0.687813	0.00	0.98
4427.202	0.97	36.77594	0.00	0.98
4463.978	0.97	59.87094	0.00	0.99
4523.849	0.97	2.289688	0.00	0.99
4526.139	0.97	63.44708	0.00	0.99
4589.586	0.98	107.3593	0.00	0.99
4696.945	0.98	6.125729	0.00	0.99
4703.071	0.98	54.21208	0.00	0.99
4757.283	0.98	39.40698	0.00	0.99
4796.69	0.98	121.8431	0.00	1.00
4918.533	0.98	57.22375	0.00	1.00
4975.757	0.98	17.50875	0.00	1.00
4993.266	0.98	87.53135	0.00	1.00
5080.797	0.98	16.71792	0.00	1.00
5097.515	0.98	151.7138	0.00	1.00
5249.229	0.98	35.9549	0.00	1.00
5285.184	0.99	3.917083	0.00	1.00
5289.101	0.99	53.34896	0.00	1.00

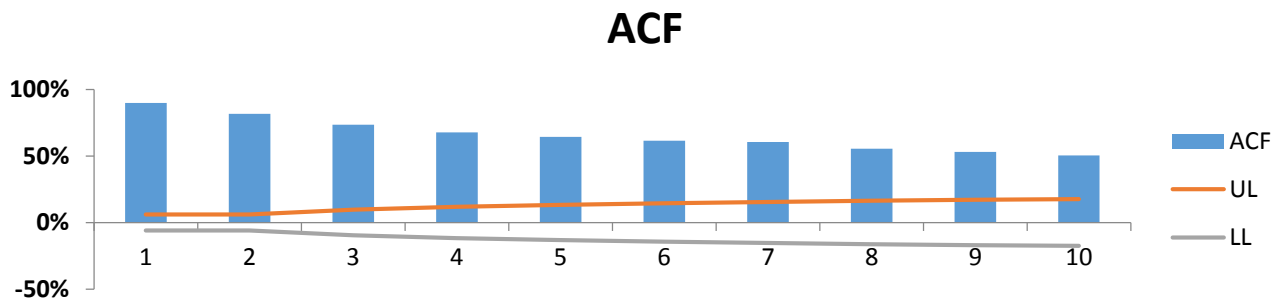
5342.45	0.99	129.1552	0.00	1.00
5471.605	0.99	2.908646	0.00	1.00
5474.513	0.99	75.16333	0.00	1.00
5549.677	0.99	88.30604	0.00	1.00
5637.983	0.99	5.709687	0.00	1.00
5643.693	0.99	82.70177	0.00	1.00
5726.394	0.99	37.4675	0.00	1.00
5763.862	0.99	90.94375	0.00	1.00
5854.806	0.99	156.1533	0.00	1.00
6010.959	1.00	33.03969	0.00	1.00
6043.999	1.00	138.4683	0.00	1.00
6182.467	1.00	126.4782	0.00	1.00
6308.945	1.00	551.7732	0.00	1.00
6860.718	1.00	127.056	0.00	1.00
6987.774	1.00		0.00	1.00

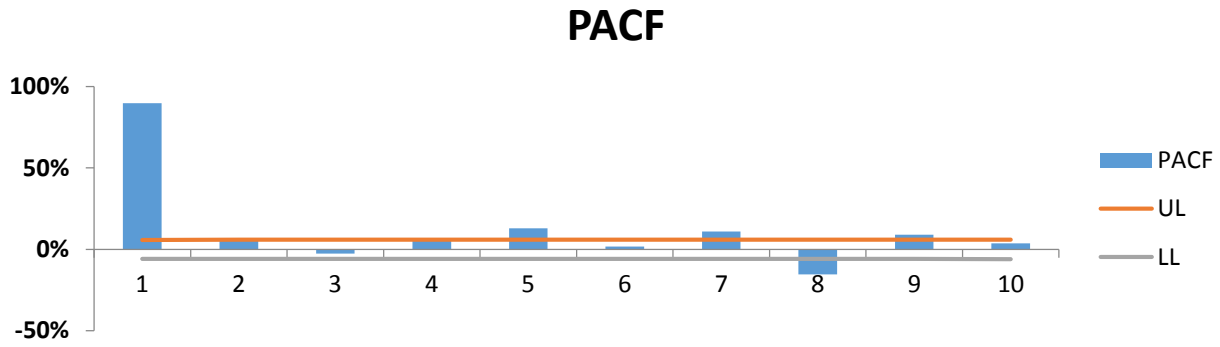
Appendix C: Correlogram Analysis

Correlogram Analysis

Lag	ACF	UL	LL	PACF	UL	LL
1	89.72%	5.93%	-5.93%	89.62%	5.93%	-5.93%
2	81.55%	5.93%	-5.93%	5.57%	5.93%	-5.93%
3	73.56%	9.57%	-9.57%	-2.55%	5.93%	-5.93%
4	67.60%	11.76%	-11.76%	6.16%	5.93%	-5.93%
5	64.44%	13.28%	-13.28%	12.91%	5.94%	-5.94%
6	61.37%	14.44%	-14.44%	1.73%	5.94%	-5.94%
7	60.39%	15.41%	-15.41%	10.88%	5.94%	-5.94%
8	55.54%	16.25%	-16.25%	-15.42%	5.94%	-5.94%

9	52.91%	17.02%	-17.02%	8.96%	5.95%	-5.95%
10	50.47%	17.65%	-17.65%	3.66%	5.95%	-5.95%





Appendix D: GARCH Model (Uncalibrated)

GARCH(1,1)

Param	Value
μ	2853.97
α_0	863394.50
α_1	0.45
β_1	0.45

Goodness-of-fit

LLF	AIC	CHECK
-9033.46	18072.92	1

	Residuals (standardized) Analysis						
	AVG	**STDEV**	**SKEW**	**KURTOSIS**	**Noise?**	**Normal?**	**ARCH?**
	-0.03	0.44	0.49	0.10	FALSE	FALSE	TRUE
Target	0.00	1.00	0.00	0.00			
SIG?	FALSE	TRUE	TRUE	FALSE			

Appendix E: GARCH (1,1) Model (Calibrated)

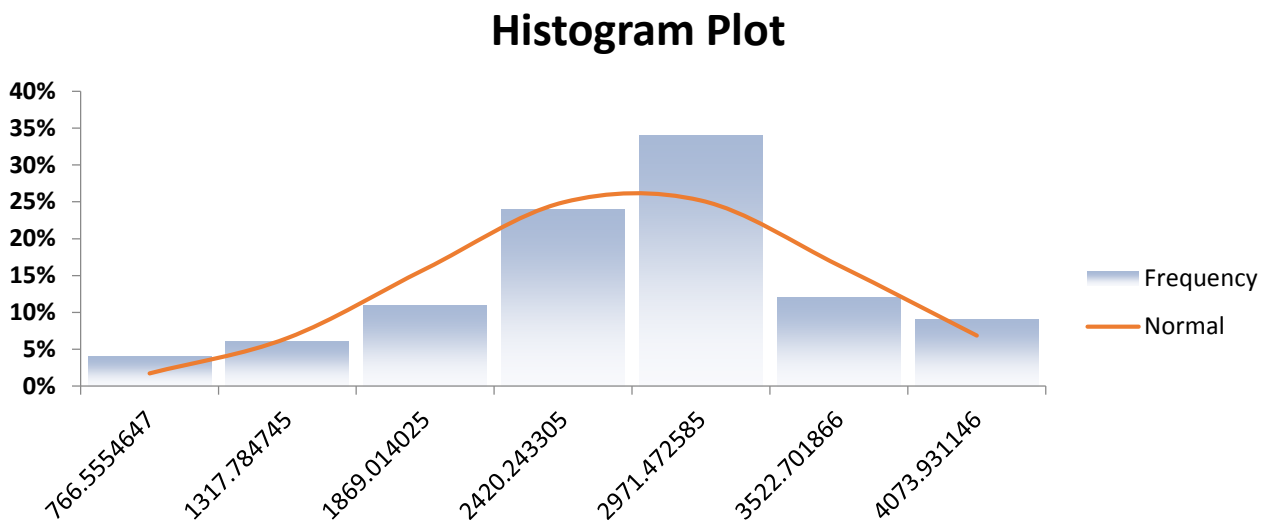
GARCH(1,1)	
Param	Value
μ	2697.17
α_0	36111.64
α_1	0.66
β_1	0.28

Goodness-of-fit		
LLF	AIC	CHECK
-8347.94	16701.89	1

	Residuals (standardized) Analysis						
	AVG	**STDEV**	**SKEW**	**KURTOSIS**	**Noise?**	**Normal?**	**ARCH?**
	0.09	1.00	-0.28	0.56	FALSE	FALSE	FALSE
Target	0.00	1.00	0.00	0.00			
SIG?	TRUE	FALSE	TRUE	TRUE			

Appendix F: Stastical Test Result of Calibrated GARCH (1,1) Model:

Histogram Table	**7**	**2708.319**		**814.9563**		
Bin	**LL**	**UL**	**Center**	**Freq**	**Cum. Freq**	**Normal**
1	490.9408	1042.17	766.5555	4.0%	4.0%	1.7%
2	1042.17	1593.399	1317.785	6.0%	10.0%	6.5%
3	1593.399	2144.629	1869.014	11.0%	21.0%	15.9%
4	2144.629	2695.858	2420.243	24.0%	45.0%	24.9%
5	2695.858	3247.087	2971.473	34.0%	79.0%	25.2%
6	3247.087	3798.317	3522.702	12.0%	91.0%	16.4%
7	3798.317	4349.546	4073.931	9.0%	100.0%	6.9%



Descriptive Statistics	
AVERAGE:	2708.319
STD DEV:	814.9563
SKEW:	-0.42
EXCESS-KURTOSIS:	0.15
MEDIAN:	2831.691
MIN:	490.9408
MAX:	4349.546
Q 1:	2275.403
Q 3:	3183.326

Significance Test		5.00%
Target	**P-Value**	**SIG?**
0.000	0.00%	TRUE
0.000	4.78%	FALSE
0.000	48.29%	FALSE

Normality Test	Score	C.V.	P-Value	Pass?	5.0%
Jarque-Bera	2.89	5.99	23.6%	TRUE	

Shapiro-Wilk	0.98	#N/A	18.9%	TRUE
Doornick Chi-Square	3.10	5.99	21.2%	TRUE