

Predicting Shrimp Prices in India: A Forecast Using Random Walk Model

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ABSTRACT:

Shrimp continues to be one of the most traded food commodities in the world. Due to its taste and nutritional benefits, there has been a major growth in the demand of shrimps from the developed nations in the world. Changing demographic pattern of the world population has caused shrimps to be a preferred species in the developing country to fulfill their food requirement. With the marine resources continuously depleting, aquaculture emerges as an industry, capable to fulfill the rising demand of shrimps in the world. The aim of this paper is to study the pattern of the shrimp prices in India. Further an attempt has been made to predict the future movement of the shrimp prices in India using the random walk model.

Keywords: Shrimp, forecast, time series, trend analysis, random walk.

I. INTRODUCTION

The world has witnessed a rapid urbanization since 1950 and the rate of its development is forecasted to continue in the coming decades. There has also been a major shift in the proportion of the urban and rural population of the world, which has resulted in variations in the demographic profile and other characteristics of the world population. One of the impacts of such change leads to the change in the food consumption pattern.

The aging population has caused a shift in food consumption towards healthier food product, whereby a stable demand for meat protein, fish protein and a continuous decrease in consumption of starch-based foods has been observed. Increased life expectancy and average employment period of the population has affected GDP and the ability to purchase food. With the increase in education levels, there has been a more conscious choice of food that is consumed.

Agriculture has been a prominent contributor to the food ecosystem of humans, and still, it remains to be so. However, with the growing changes in the world civilization, seafood has emerged to be a major food component in the world. In recent years, shrimp has emerged as a highly preferred seafood species for human consumption.

According to Oxford dictionary shrimp is "A small free-swimming crustacean with an elongated body, typically marine and frequently of commercial importance as food". The origin of the term 'shrimp' dates back in around 14th

century with middle English 'shrimpe' and in middle low german 'schrempen' which means to contract or wrinkle.

Traditionally most of the demand for shrimps was fulfilled by capture fisheries wherein the stocks available in the open oceans were a major source of production. Due to overfishing and other unregulated fishing methods, the natural stock available experienced a constant pressure and eventually led to a decrease in the overall production of shrimps. With the introduction of shrimp aquaculture, the gap between the demand of shrimps and the supply from the capture fisheries has reduced which has moderated the prices of shrimps in the market.

'Shrimp' and 'prawn' are common English names used synonymously due to lack of systematic basis to mark a distinction.

According to the crustacean taxonomist Tin Yam Chan, "The terms shrimp and prawn have no definite reference to any known taxonomic groups. Although the term shrimp is sometimes applied to smaller species, while prawn is more often used for larger forms, there is no clear distinction between both terms and their usage is often confused or even reverses in different countries or regions."

According to Food and Agriculture Organization (FAO), shrimps refer to marine Penaeid while prawns refer to freshwater palaemonids. In general, shrimps refer to the smaller animals and prawns to the larger ones. Prawns are generally larger in size as compared to shrimp and have larger legs with claws on three pairs. Furthermore prawns have branching gills.

Hundreds of species of shrimp inhabit the brackish and marine waters of the globe. Most are rare, very small, or not suitable for human consumption. All farm-raised shrimp and most of the shrimp caught by fishermen belong to the Penaeid family of decapods crustaceans and are referred to as Penaeid". The genus name is Penaeus.

FISHERY SECTOR IN INDIA

In India, fisheries and aquaculture is an important sector of food production which provides nutritional security to the food basket in the country. It contributes to the agricultural exports and supports millions by providing direct and indirect employment in different activities. India enjoys diverse resources ranging from deep seas to lakes in the mountains. India has recorded a continuous and sustained growth in fish production since independence. India has accounted for nearly 6.3% of the global fish production while the fishery sector contributes to 1.1% of the GDP and 5.15% of the agricultural GDP. The total fish production amounted to 10.07 million metric tonnes where nearly 65% of the total contribution comes from the inland sector. In India, Fish and fishery

products have presently emerged as the largest group in agricultural exports, with 10.51 lakh tonnes in terms of quantity and Rs.33,442 crores in value, which accounts for around 10% of the total exports of the country and nearly 20% of the agricultural exports.

<Table: 1 Fishery Resources of India>

<Table: 2 Status of Fisheries in India>

This study is an attempt to study the trend in the shrimp prices in India and estimate its future movement. The study is based on secondary data of monthly shrimp prices for the period: June 1997 - June 2017.

II. LITERATURE REVIEW

CIBA conducted a conference on “New vistas in Indian aquaculture” where in matters like improvement of technology in aquaculture, intensified aquaculture systems for better environmental and social concerns, diversification of species in aquaculture, effects of pollution, diseases, availability of quality feeds on aquaculture productivity, development of linkage between farms and markets and other issues were discussed.

“Research needs to sustain Asia Pacific aquaculture to year 2025 and beyond” which was funded by the international development research cooperation, Canada (IRDC) (2007) focused on the factors affecting the aquaculture industry and the innovation required for a sustainable growth up to the year 2025 in the Asia Pacific region. Climate Change, Bio diversity in aquaculture, issues in health hazards, integrated fish farming, feed management, effective utilization of land and other resources, socio economic issues, etc.

A paper entitled “Economics of Shrimp Farming: A Comparative Study of Traditional Vs. Scientific Shrimp Farming in West Bengal” by Poulomi Bhattacharya (The Institute for Social and Economic Change, Bangalore) attempted to analyse the economic viability of the alternative shrimp farming systems from a long term perspective in the context of household level shrimp farming in West Bengal, by incorporating the costs incurred due to generation of negative externality and the risks associated with shrimp farming.

“Fisheries co-management and transaction costs” a study by Nik Mustapha, Raja Abdullah, K Kuperan Viswanathan and Robert S Pomeroy emphasized the need of co management in the fisheries sector as a solution to the problems of overcoming conflicts and overexploitation of resources. The paper also discusses the importance of determining transaction costs of fisheries management system, in order to develop a feasible fisheries.

III. RESEARCH METHODOLOGY

A OBJECTIVE OF THE STUDY

- To study the pattern of shrimp prices in India and estimate its future movement.

B SCOPE OF THE STUDY

- The study considers the shrimp prices in India on the basis of rupees per pound.
- The period of study is from June 1997 to June 2017
- The study focuses on the estimation of trend for average annual shrimp prices

C DATA SOURCE:

- The study is based on secondary data.

D METHODS USED FOR THE STUDY:

- Time series analysis techniques
- Random walk with drift model for forecasting.

E LIMITATIONS OF THE STUDY

- The study is based on the shrimp prices collected from secondary sources, actual prices may vary.

The study has been based on the Random walk model to forecast the future values, applying other models may give different outputs.

IV. DATA AND EMPIRICAL RESULTS

<Table: 3 – monthly shrimp prices>

Broadly the shrimp prices in last 20 years exhibited a three-phased movement. In the initial phase, the shrimp prices which began with an upward bias from June'97 continued to rise but suddenly experiencing a sharp drop in its prices. The second phase witnessed the movement of shrimp prices in a constant range for a considerable period of time. The third phase experienced a sharp rise in the shrimp prices where the prices had reached to highest levels, however the third phase is also characterized by a high volatility and correction in the shrimp prices due to the internal and external factors which has caused a negative price pressure on the shrimp markets.

<Figure: 1 – chart for monthly shrimp prices>

From the monthly data collected for the shrimp prices from a period to June 1997 to June 2017, the mean shrimp prices during this period were calculated to 608.50 with a standard error of 11.35. Median of 558.55 and mode of 582.21 was calculated. The standard deviation in shrimp prices is 176.27. The range for shrimp prices was 721.54 with minimum prices during the period being 369.71 and maximum prices being 1091.25.

<Table: 4 – Descriptive statistics for shrimp prices>

<Figure: 2 – shrimp prices movement from mean>

Shrimp prices experienced a wide movement from its period mean. The prices which began at an above average level in the initial months saw a downtrend and continued to be on the lower side for a significant period of time. March 2013 witnessed a trend reversal when the prices began to rise sharply above the period average in before experiencing a drop in July 2015. Since then the shrimp prices have exhibited an upward movement.

Fig. 3 shows the monthly changes in the shrimp prices relative to its previous month, thereby creating a chart for the percentage change experienced by the shrimp prices in that month. The chart highlights the highly volatile behavior of shrimp prices, thereby showing wide movements on either side of the equilibrium

<Figure: 3 - % monthly changes in shrimp prices>

<Table: 5 – average annual shrimp prices >

<Table: 6 - Summary Statistics for Shrimp Prices>

The above table shows summary statistics for average annual shrimp prices. It includes measures of central tendency, measures of variability, and measures of shape. Of particular interest here are the standardized skewness and standardized kurtosis, which can be used to determine whether the sample comes from a normal distribution. Values of these statistics outside the range of -2 to +2 indicate significant departures from normality, which would tend to invalidate any statistical test regarding the standard deviation.

In this case, the standardized skewness value is within the range expected for data from a normal distribution. The standardized kurtosis value is within the range expected for data from a normal distribution. The table indicates a mean of 612.83 with a standard deviation of 166.87. The annual average is in a range of 593.343 where the low point is 417.154 and high point being 1010.5

FORECASTING - PRICES

Data variable: prices Number of observations = 21 Time indices: year

Length of seasonality = 2

FORECAST SUMMARY

Seasonal adjustment: Multiplicative

Forecast model selected: Random walk with drift = 9.67137

Number of forecasts generated: 5

Number of periods withheld for validation: 0

<Table: 7 Forecast estimation>

<Figure: 4 – Time sequence Plot for prices>

Following is a calculation for the forecast of future values of prices. The data cover 21 time periods. Above a random walk with a drift, the model has been applied. Here the model assumes that the best forecast for future data is given by the last available data value plus a constant drift up or down. Each value of prices has been adjusted in the following way before the model was fit:

(1) A multiplicative seasonal adjustment was applied.

The table summarizes the performance of the model in fitting the historical data. It displays:

- (1) The root mean squared error (RMSE)
- (2) The mean absolute error (MAE)
- (3) The mean absolute percentage error (MAPE)
- (4) The mean error (ME)
- (5) The mean percentage error (MPE)

Each of the statistics is based on the one-ahead forecast errors, which are the differences between the data value at time t and the forecast of that value made at time t-1. The first three statistics measure the magnitude of the errors.

FORECAST TABLE FOR PRICES

Model: Random walk with drift = 9.67137

Seasonal adjustment: Multiplicative

<Table: 8 Forecast table for prices>

<Table: 9 forecast with 95% confidence level>

The above table shows the forecasted values for prices. During the period where actual data is available, it also displays the predicted values from the fitted model

and the residuals (data-forecast). For time periods beyond the end of the series, it shows 95.0% prediction limits for the forecasts. These limits show where the true data value at a selected future time is likely to be with 95.0% confidence, assuming the fitted model is appropriate for the data. The five-year forecast of shrimp prices indicates an increase in the existing prices and estimates an annual average price of 779 for the year 2018 and 817 for the year 2022.

Conclusion

Shrimp prices in India have been under constant pressure, both from within and outside the industry, as a result of which there has been a growing concern about the sustainable development of the fishing industry in future. Shrimp has been a major component of the fishing industry in India which accounts for a major percentage of the total production as well as the overall exports. A shrimp is also considered to be a preferred species for human consumption due to its nutritional benefits and taste. The demand for shrimp has experienced a constant rise among the people within India and across the world.

Rising demand has always been a characteristic of shrimps as a market commodity. The random walk model applied here estimates an upward trend in the shrimp prices in India, for next five years. This increase in prices is backed by a growing demand, which shows signs of sustainable growth for the shrimp market in the future. However, the prices of shrimps are affected by a number of factors external to the industry which may impact the prices in a negative way. Yet the general outlook for shrimp market looks optimistic in the coming years.

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Table: 1 Fishery Resources of India

Coastline	8129 km
Exclusive Economic Zone	2.02 million sq. km
Continental Shelf	0.506 million sq. km
Rivers and Canals	1,91,024 km
Reservoirs	3.15 million ha
Ponds and Tanks	2.35 million ha
Oxbow lakes and derelict waters	1.3 million ha
Brackishwater	1.24 million ha
Estuaries	0.29 million ha

(Source: The National Fisheries Development Board (NFDB))

Table: 2 Status of Fisheries in India

Global position	3rd in Fisheries 2nd in Aquaculture
Contribution of Fisheries to GDP (%)	1.07
Contribution to Agril. GDP (%)	5.15
Per capita fish availability (Kg.)	9.0
Annual Export earnings (Rs. In Crore)	33,441.61
Employment in sector (million)	14.0
Present fish Production	6.4 mmt
Inland	3.4 mmt
Marine	3.0 mmt
Potential fish production	8.4 mmt
Fish seed production	21,000 million fry
Hatcheries	1,070
FFDA	422
BFDA	39

(Source: The National Fisheries Development Board (NFDB))

Table: 3 – monthly shrimp prices

Month	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98
Price	590.51	603.58	596.37	567.71	585.47	612.65	648.33	650.58	643.23
Month	Mar-98	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Sep-98	Oct-98	Nov-98
Price	653	655.49	667.35	708.07	691.64	678.28	641.22	599.18	607.26
Month	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99
Price	609.8	602.76	599.26	598.78	608.42	636.43	646.63	648.86	654.09
Month	Sep-99	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00
Price	632.17	627.48	645.76	647.05	648.05	648.96	654.26	658.95	663.95
Month	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01
Price	674.83	676.15	689.95	689.71	705.04	721.85	727.44	742.31	758.72
Month	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01
Price	770.64	773.37	775.54	777	779.25	727.16	654.66	630.03	582.21
Month	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02
Price	558.23	571.33	563.36	558.55	474.52	484.12	485.69	483.74	482.02
Month	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03
Price	480.54	495.79	521.16	530.48	533.46	579.04	566.93	553.37	549.93
Month	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04
Price	545.7	540.02	521.37	505.27	500.2	501.63	499.22	490.85	488.93
Month	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04
Price	499.66	493.81	508.52	451.52	436.49	439.33	442.08	439.07	432.63
month	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05
price	431.45	438.88	453.37	457.43	457.97	455.36	456.34	455.84	455.45
month	Sep-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06	Apr-06	May-06
price	435.65	449.57	476.47	478.04	464.85	464.15	465.66	470.62	475.43
month	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07
price	482.2	486.4	487.26	482.89	432.4	430.18	424.47	434.97	438.09
month	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07
price	435.85	422.78	409.14	408.84	405.38	409.4	404.61	396.32	416.49
month	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08
price	423.98	429.56	439.01	449.17	445.54	468.86	471.02	471.2	442.27
month	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09
price	462.02	493.23	496.89	493.23	482.54	477.46	497.32	485.69	470.78
month	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10

price	463.4	470.53	468.69	469.86	437.78	401.89	370.24	369.71	388.21
month	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10
price	381.27	384.92	469.15	477.29	480.44	477.31	471.88	523.68	556.48
month	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11
price	562.81	565.49	566.37	560.57	553.05	559.39	556.16	546.31	554.21
month	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12
price	544.58	542.62	548.98	562.73	547.62	514.74	526.88	513.89	527.07
month	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13
price	543.49	538.61	538.93	529.22	519.52	560.88	582.21	589.84	615.9
month	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13
price	623.28	623.15	703.88	803.77	896.09	989.22	1,022.21	991.65	1,043.47
month	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14
price	1,058.69	1,061.89	1,064.44	1,048.63	1,091.25	1,046.81	1,059.90	1,059.53	1,074.19
month	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15
price	966.22	987.09	836.34	829.67	972.42	970.74	977.34	982.09	998.63
month	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16
price	1,013.47	1,010.06	1,032.70	876.02	624.07	669.75	675.28	741.57	752.04
month	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16
price	738.98	688.62	715.01	719.24	718.55	715.56	713.47	824.45	819.11
month	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17		
price	748.25	826.15	813.96	799.55	782.55	781.39	781.61		

(Source: indexmundi.com)

Table: 4 – Descriptive statistics for shrimp prices

Shrimp Price (Indian Rupee per Pound)	
Mean	608.4845228
Standard Error	11.35467095
Median	558.55
Mode	582.21
Standard Deviation	176.2718955
Sample Variance	31071.78113
Kurtosis	0.5726297
Skewness	1.136961365
Range	721.54
Minimum	369.71
Maximum	1091.25
Sum	146644.77
Count	241
Confidence Level (95.0%)	22.36753884

Table: 5 – Average Annual Shrimp Prices

Year	Avg. Shrimp Price (Rupee / £)	Year	Avg. Shrimp Price (Rupee / £)	Year	Avg. Shrimp Price (Rupee / £)
1997	600.66	2004	462.86167	2011	555.03833
1998	650.425	2005	455.86417	2012	536.92167
1999	628.97417	2006	463.87583	2013	830.09583
2000	679.92833	2007	417.15417	2014	1010.4967
2001	710.76	2008	463.5	2015	900.21417
2002	510.94167	2009	458.015	2016	741.2375
2003	533.01167	2010	461.92917	2017	797.535

Table: 6 - Summary Statistics for Shrimp Prices

Count	21
Average	612.83
Standard deviation	166.876
Coeff. of variation	27.2303%
Minimum	417.154
Maximum	1010.5
Range	593.343
Stand. skewness	1.68821
Stand. kurtosis	0.0143824

Table: 7 Forecast estimation

	Estimation
Statistic	Period
RMSE	109.779
MAE	75.1243
MAPE	11.5185
ME	-0.0192824
MPE	-1.39295

Table: 8 Forecast table for prices

Period	Data	Forecast	Residual
1997.0	600.66		
1998.0	650.425	589.122	61.3028
1999.0	628.974	683.875	-54.9012
2000.0	679.928	616.445	63.4835
2001.0	710.76	714.449	-3.68903
2002.0	510.942	695.366	-184.424
2003.0	533.012	539.33	-6.31786
2004.0	462.862	523.843	-60.9814
2005.0	455.864	489.505	-33.6408
2006.0	463.876	449.397	14.4787
2007.0	417.154	490.556	-73.4016
2008.0	463.5	412.043	51.4569
2009.0	458.015	490.166	-32.151
2010.0	461.929	451.473	10.456
2011.0	555.038	488.538	66.5
2012.0	536.922	545.098	-8.17599
2013.0	830.096	566.253	263.843
2014.0	1010.5	810.523	199.977
2015.0	900.214	1057.02	-156.805
2016.0	741.237	878.185	-136.948
2017.0	797.535	777.983	19.5518

Table: 9 forecast with 95% confidence level

		LOWER 95.0%	UPPER 95.0%
PERIOD	FORECAST	LIMIT	LIMIT
2018.0	779.102	559.384	998.82
2019.0	817.222	495.216	1139.23
2020.0	798.1	417.537	1178.66
2021.0	836.91	381.524	1292.3
2022.0	817.098	325.793	1308.4

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Figure: 1 – chart for monthly shrimp prices

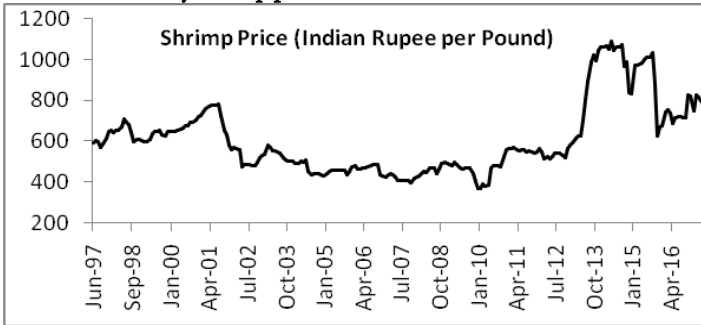


Figure: 2 – shrimp prices movement from mean

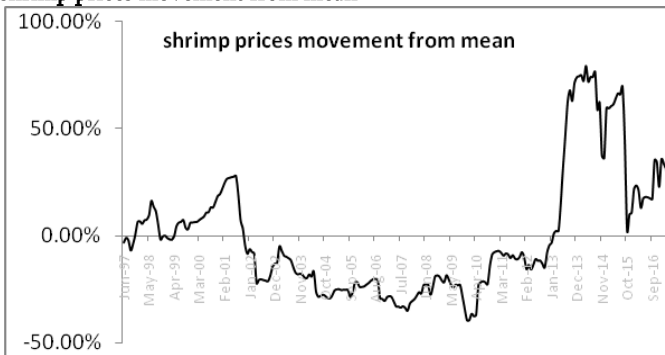


Figure: 3 - % monthly changes in shrimp prices

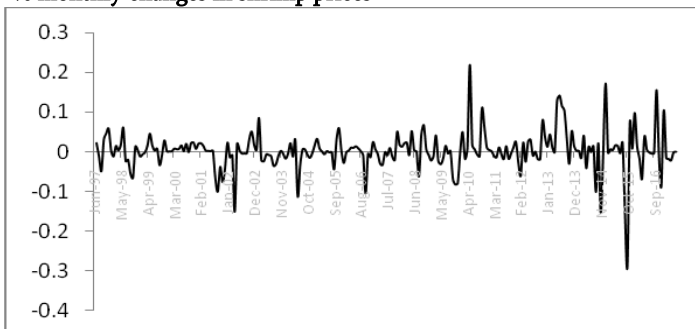
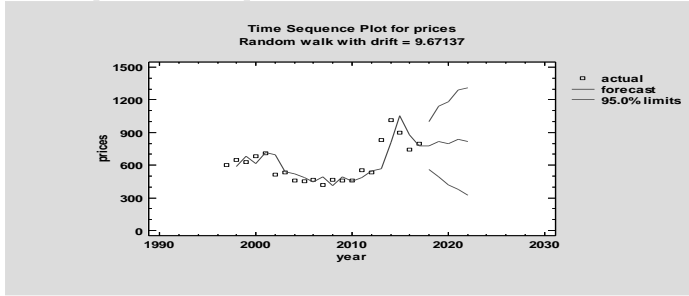


Figure: 4 – Time sequence Plot for prices



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