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An Investigation on Time Varying Fluctuation of Petrol Price in India

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Abstract

Application of Statistical physics and stochastic processes in macro economic studies is an emergent area of research. Investigation and analysis of economic time series are now a day being done applying the paradigms of econophysics. An attempt is taken to understand the behaviour of the volatility of oil price from the aspect of statistical physics. The variation in price over a period of time has been explained by the probability distribution of various state space and finally uncertainty in the series is quantified by measuring entropy of various states.

Introduction

Petrol and petroleum products are very essential commodity in our daily life. The price of petrol directly or indirectly responsible for the price of other goods as the cost of transportation is associated with it. The volatility in the price makes it difficult to predict the trend as a result of which forecasting of petrol price is a problem faced by the researchers. It is generally believed that the price of petrol in the market may vary according to the price of crude oil in the international market however the price may change due to any political, social or economical issues of a country. It is also known that the change in price has a significant effect in country's GDP. A decrease in price contributes to increase in GDP[1]. Thus it has a strong impact in controlling the inflation for countries like India which imports petrol from other countries. The main purpose of this study is to investigate the trend of petrol price fluctuation and measuring the fluctuation in price with regard to uncertainty measure in order to have a better understanding of the trend. The past record of petrol price in India shows that the price used to change at irregular intervals. The price has started changing on a daily basis since 16th June, 2017. In the present work, two sets of data are taken under consideration, the price from 1st January,2001 to 15th June,2017 and from 16th June,2017 to 3rd January,2018 (henceforth referred as data set I and data set II).

Methodology

A number of research work has been conducted to investigate and forecast the economic time series in view of statistical physics or stochastic processes[2]–[6]. Volatility of time series can be captured by either stochastic modelling of series or by analysing the conditional time variances by GARCH model[7], [8]. The time series data has also been explained in view of time frequency analysis. In the present paper we have constructed the probability distribution of the price in order to see the most probable price . Further entropy is computed where the probability of each state of price is considered as follows[9]:

$$H = -\sum_{i=1}^{n} p_i \log p_i \qquad (1)$$

where, p_i refers to probability of each probable state. The time series is considered as deterministic if H=0 otherwise it is stochastic. A stochastic time series is more disordered or uncertain than a deterministic one. Entropy has a wide application in quantifying uncertainty[10]–[14].

Further, continuously compounded return has also been computed for both data sets as[15]

$$R_i = \log(\frac{P_{i+1}}{P_i}) \qquad (2)$$

where, P_i is the price of time instant $t_i$and quantile plots of return are constructed in order to see whether the distribution of return is normally distributed. MATLAB 2014 has been applied for the data analysis.

Data Analysis:

We have taken the data from
https://www.iocl.com/Product_PreviousPrice/PetrolPreviousPriceDynamic.aspx
The data are collected in two phases : from 1st January 2001 to 15th June 2017 and from 16th June to 3rd January 2018 in order to compare the daily fluctuation in price with earlier pattern of irregular fluctuation. The following plot of price for the above mentioned period indicates a non-stationary pattern with a upward trend of price for data set I (in Fig.1a) where as a stationary series with almost same statistical moments up to second order for data set II (in Fig.1b).

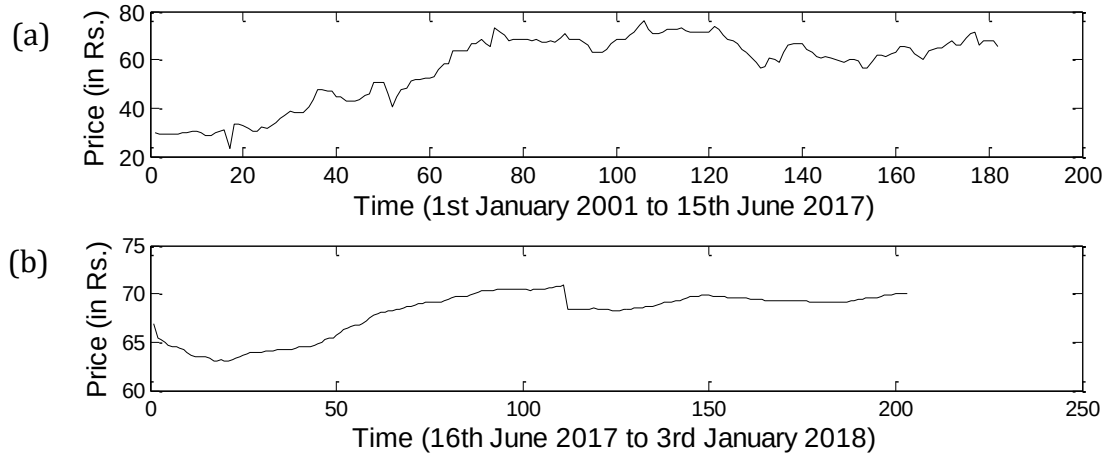

Fig 1: Comparison of petrol price fluctuation (a) data set I and (b) data set II
However the duration of both of the time series is different, the number of observation in the series of Fig.1b is more than the number of observation of time series in Fig.1a because of daily change in price. The statistical measure of the above two series is computed and listed in TABLE 1

TABLE 1

Duration	1st Jan 2001to 15th June2017	16th June 2017 to 3rd Jan 2018
Mean	56.7998	67.9752
Standard Deviation	14.2713	2.3336
CV	0.2513	0.0343
expected value*	57.0584	67.9388
Entropy	3.6892	1.7547

*the expected values are mean values computed using the respective probability distribution
It is evident from the above table that, the average petrol price in Delhi has been increased from 56.79 to 67.97 and the standard deviation has been reduced in the overall tenure of the present study. In the data set II, the price is changing on daily basis. This perhaps has lowered down the

standard deviation and consequently the measure of coefficient of variation. This indicates that set II is more consistent as compared to set I with regard to price. One can also see the difference in the observation period of the two sets. As the time period of the set I is longer, it has a wide variety of observational values (price) which makes the standard deviation more (14.2713). The change in the price is time varying, therefore the dynamics of petrol price can be expressed by its probability distribution. Thus the above two sets of data are considered for constructing probability distribution.

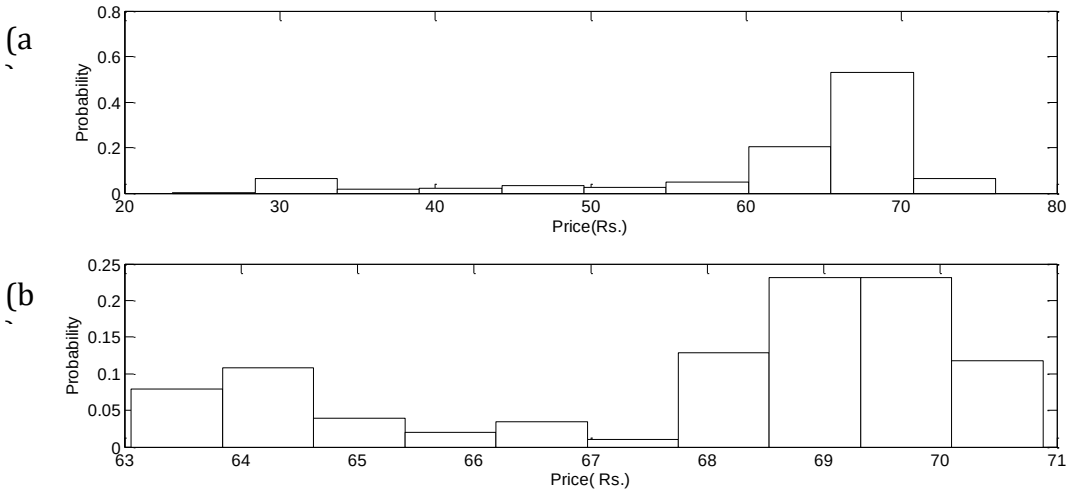

Fig. 2: Probability distribution of petrol price (a) set I (b) set II

The probability distribution shows the probability of occurrence of all possible states of price. Here the distribution of the data set I is left skewed (Fig.2a) . Almost entire probability mass is shifted towards right indicating the most probable price of petrol for this duration. On contrary, the distribution for set II is bimodal representing two most occurring prices for the duration. In this case the total probability mass is distributed at two different prices, a lower price with lower probability and a higher price with higher probability. The entropy has been computed using (Eqn.1) from the above two distribution and listed in TABLE 1.It can be seen that the entropy of data set I is more than the entropy of set II indicating the fact that set I is more uncertain than the set II.

Further, continuously compounded returns are computed in both cases of data sets I and II and the quantile plots of return exhibit that the return does not follow standard normal distribution (Fig. 3). Specifically, the return distribution follows leptokurtic distribution which is more peaked than normal distribution.

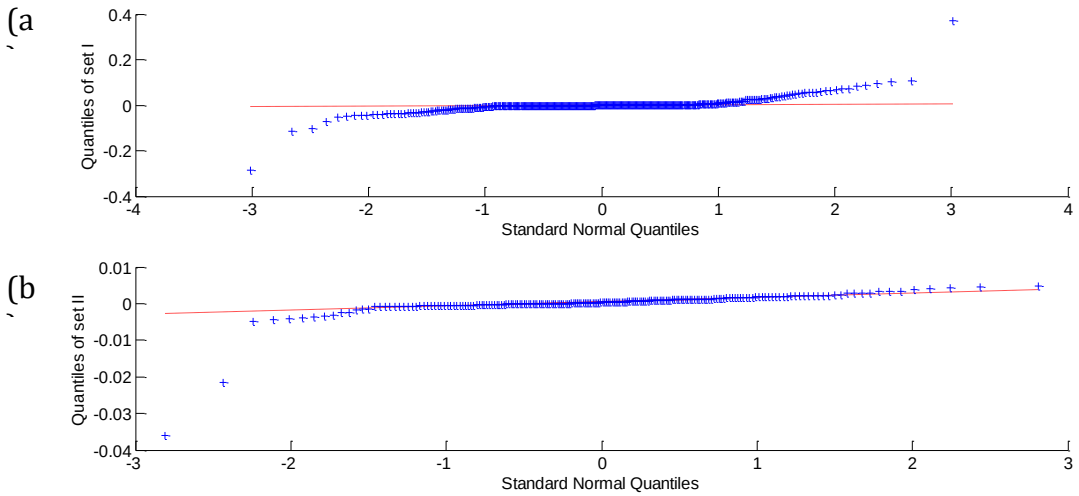

Fig. 3: Quantile plots compounded return for (a) set I and (b) set II

Conclusion

A study on daily change of petrol price is conducted as compared to earlier pattern of change of price. The observations for two different time periods are plotted against time to see how the price is changing with respect to time. Later on the time varying change of price is captured by the probability distribution of price. The daily change in price is seen to have two most frequently occurring prices where as the in the other case there is only one value of price which has maximum probability of occurrence. Second set of data is showing more consistent pattern as compared to the first set and the lesser consistency in the first set may be attributed to the wide range of prices of petrol. The uncertainty of both data sets is quantified by entropy measure. It has been observed that, although the average petrol price is more in the second set, this is more consistently changing and comparatively more ordered.

Investigation of oil price volatility can also be conducted by time frequency analysis or by forecasting techniques e.g. ARCH or GARCH models which is under consideration for future work.

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