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A Markov Chain Analysis For Estimating The Changes In Prices of Petrol and Diesel In India

Gulab Singh Bura, Divya Yadav and Sabhiya Singh
Department of Mathematics and Statistics,
Banasthali Vidyapith,
Rajasthan email:burastats@gmail.com

ABSTRACT

In the present paper we have used the theory of Markov chain for estimating the price of petrol and diesel in India. Since 16 June, 2017 the price of petrol and diesel in India changes on daily basis. This allows us to make use of the Markov chain for estimation of prices of petrol and diesel in India. We have defined two Markov chains one for petrol and another for diesel prices and obtained the transition probability matrix for both the cases. Also we have obtained the stationary distribution of the above mentioned Markov Chains.

JEL Classifications: C13, C25, C44

Keywords: Stochastic Process, Markov Chain, Transition matrix, petrol price and diesel price.

INTRODUCTION

Stochastic Process is used since centuries but its most influential part Markov Chain was highlighted by a Russian Mathematician Andrey Markov. The Markov (1906) chain model has been applied in various fields such as chemistry, physics, economics, queuing theory, finance, and health sciences etc. Markov chains serve as one of the most important methods in applications of applied probability theory to real world models involving uncertainty. In this study, we have used Markov chains theory for estimating the changes in the prices of petrol and diesel in India. The variation in petrol and diesel prices influences almost everybody in one or the other way. The steep rise in crude prices and a falling rupee have had a major impact on fuel costs. The other responsible factors are refinery cost, transfer cost, and various taxes. Petrol and diesel are excessively used fuels in India; so their continuously increasing prices are a serious problem for the society including industrial areas. So their rising prices and other problems which arise with these increasing prices give us the motivation to deeply study this field and to conclude some results and favorable suggestions.

LITERATURE REVIEW

Markov chain model has been extensively used by many authors in various fields such as chemistry, physics, economics, queuing theory, finance, and health sciences etc. (John & Koutsiumaris , 2010) have used Markov decision model for the treatment of early Prostate Cancer.(Dharmara ja, Pasricha & Tardelli, 2017)have used Markov Chain Model with Catastrophe to Determine Mean Time to Default of Credit Risky Assets. (Chunling & Chris, 2009) have used Markov Modeling for Breast Cancer.(Doubleday & Esunge , 2011) have applied Markov Chains to Stocks Trend..(Murthy & Rao, 2014), have used a Markov Chain model to determine the behaviour of different company share prices.(Mung'atu & Ndanguza, 2017), have forecast the Rainfall in Gasabo District using Markov Chain properties.(Sharma & Adlakha, 2014).have used Markov Chain model to study the gene expression. So, Markov chain has been used in various areas but first time we have used it for predication for future probabilities of price changes in petrol and diesel.

STUDY AREA

In this study we select the national capital Delhi as the study area. Delhi is the national capital of India and every Indian is connected with Delhi in some way. The minor change in the prices of petrol and diesel in Delhi makes news for all news channels and for every Indian. Due to that reason we select Delhi as our study area. The prices of petrol and diesel from Delhi are studied from June 16, 2017 to August 15, 2017.

OBJECTIVE OF THE STUDY

The objective of this study is to determine the changes in petrol and diesel prices for long run.

ANALYSIS

Markov chains offer ideal conditions for the study and mathematical modeling of a certain kind of situations depending on random variables. Markov chain provide us simple solutions of very complicated problems in different areas or we can say Markov Chain give the solution of major problems which happen in our environment.

Consider a random process X_n of random variables with state space S = 1, 2, 3, ..., s where Xn represents the state of the process at the nth step. The transitions possible among the three states in this study, decrement in petrol and diesel prices, constancy in petrol and diesel prices and increment in petrol and diesel prices. A random process is called a Markov Chain if the future state is depends only on the present state not on the past. Mathematically,

$$P(X_{n+1} = j/X_n = i, X_{n-1} = i_1, X_{n-2} = i_2, ..., X_0 = i_n) = P(X_{n+1} = j/X_n = i) \quad (1)$$

for every sequence $i_1, i_2, ..., i_n$ of elements of S and every $n \geq 0$. The transition probability

$$P_{ij} = P(X_{n+1} = j/X_n = i) \quad (2)$$

is defined as the probability that whenever the chain in state i it moves to state j in one step. A transition probability matrix P consisting of all the transition probabilities between stages in a matrix form is given by:

$$P = \begin{bmatrix} p_{11} & p_{12} & \cdot & \cdot & \cdot & \cdot & p_{1s} \\ p_{21} & p_{22} & \cdot & \cdot & \cdot & \cdot & p_{2s} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ p_{s1} & p_{s2} & \cdot & \cdot & \cdot & \cdot & p_{ss} \end{bmatrix}$$

Let FP and FD be the transition frequency matrix for petrol and diesel prices respectively.

From our data these are obtained as follows:

$$F_p = \begin{array}{c} \\ -1 \\ 0 \\ +1 \end{array} \begin{array}{c} \begin{array}{ccc} -1 & 0 & +1 \end{array} \\ \begin{pmatrix} 10 & 3 & 3 \\ 4 & 1 & 4 \\ 2 & 4 & 29 \end{pmatrix} \end{array}$$

$$F_D = \begin{array}{c} \\ -1 \\ 0 \\ +1 \end{array} \begin{array}{c} \begin{array}{ccc} -1 & 0 & +1 \end{array} \\ \begin{pmatrix} 11 & 3 & 4 \\ 5 & 2 & 2 \\ 2 & 3 & 28 \end{pmatrix} \end{array}$$

The frequency matrix may be converted into probability matrix by using the formula.

$$P_{ij} = \frac{a_{ij}}{\sum_j a_{ij}} \qquad (3)$$

where,
i = rows,
j = columns
(i, j) = 1, 2, 3

Let P_P and P_D be the transition probability matrices for petrol and diesel prices respectively.

Hence

for Petrol

$$p_P = \begin{array}{c} \\ -1 \\ 0 \\ +1 \end{array} \begin{array}{c} \begin{array}{ccc} -1 & 0 & +1 \end{array} \\ \begin{pmatrix} 0.625 & 0.187 & 0.187 \\ 0.444 & 0.111 & 0.444 \\ 0.057 & 0.114 & 0.828 \end{pmatrix} \end{array}$$

And for Diesel,

$$p_D = \begin{array}{c} \\ -1 \\ 0 \\ +1 \end{array} \begin{array}{c} \begin{array}{ccc} -1 & 0 & +1 \end{array} \\ \begin{pmatrix} 0.611 & 0.166 & 0.222 \\ 0.555 & 0.222 & 0.222 \\ 0.060 & 0.090 & 0.848 \end{pmatrix} \end{array}$$

From the above transition probability matrices we have concluded that Petrol prices has highest probability i.e., 0.828 for the transition from state 1 to 1, which means that petrol prices has high probability with increasing tendency. Similarly diesel prices has highest probability i.e., 0.848 for the transition from state 1 to 1, which means that continuous increment in diesel prices may be expected.

STATIONARY DISTRIBUTION OR THE LIMITING PROBABILITIES

Since both the transition probability matrix are irreducible and aperiodic in nature and hence all states are non null recurrent. Therefore these matrix are ergodic in nature. So we have obtained their stationary (Steady state) distribu- tion by using the formula

$$\Pi = \Pi P \qquad (4)$$

where $\Pi = [\Pi_{-1}\ \Pi_0\ \Pi_1]$ and P be the transition probability matrix. Therefore

For Petrol prices

$$\Pi = [\Pi_{-1}\ \Pi_0\ \Pi_1] \begin{bmatrix} 0.625 & 0.187 & 0.187 \\ 0.444 & 0.111 & 0.444 \\ 0.057 & 0.114 & 0.828 \end{bmatrix} = [0.250\ 0.132\ 0.616]$$

For Diesel prices

$$\Pi = [\Pi_{-1}\ \Pi_0\ \Pi_1] \begin{bmatrix} 0.611 & 0.166 & 0.222 \\ 0.555 & 0.222 & 0.222 \\ 0.060 & 0.090 & 0.848 \end{bmatrix} = [0.271\ 0.127\ 0.601]$$

RESULTS AND CONCLUSIONS

We have obtained the stationary probability matrix for both petrol and diesel. We have obtained that, for petrol, the probability of decrement in prices is 25 percent, the price may be same is 13 percent and the probability of increment in price is 62 percent. Similarly for diesel, the probability of decrement in prices is 27 percent, the price may be same is 13 percent and the probability of increment in price is 60 percent. Therefore we conclude that, in both the cases there is a high chance of increment in prices in future. Since petrol and diesel are very useful in transportation, agriculture and many other areas. From our study we have obtained that the prices of petrol and diesel increases rapidly which affects every Indian.

SUGGESTIONS

As Goods and Service Tax in India lead to one more step on the path of devel- opment. As it is happily accepted by people. If petrol and diesel are also taken under GST then this might lead to significantly cheaper prices of petrol and diesel. If 28% GST is applied on petrol and diesel then petrol price in Delhi will tend to approximately Rs.43.52/liter and diesel price will tend to approximately Rs. 42.17/liter. That will be much beneficial for people.

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