Factors Influencing on Coal Price and Development of a Pricing Model for Indian Coal

A. Guru brahmam

Abstract: Coal plays a crucial role in India as it fulfills almost 67% of the total commercial energy consumed in Indian industries. Fossil fuels are the major drivers of the country's economy. The coal price is affected by many parameters including its grade, demand at the national level and international coal price. We observed in the year 2017-18, the total production of coal in India was 675 MT but the actual demand for coal in India was 884 Million Tonnes (MT), with the actual supply falling short resulting in a demand deficit. This deficit was offset by import 202 MT of coal. Over 22.8% of coal imports in 2017-18 were sourced from Indonesia followed by import from Australia and South Africa. The study identifies some major factors that may have an influenced on Indian coal price, including coal export, coal import and international coal prices by analysing and processing of Indian coal data which is from 1993to2018 with the help of SPSS software by the regression analysis. The logarithmic coal price is the dependent variable and the hypothesized independent variables are relative value of demand and supply, export, import, stock, international coal price, international oil prices. According to the result, the factors like a relative value of demand and supply, coal production, international oil price are no significant influencing on Indian coal prices and the significant variables are helpful to developing coal pricing mode for Indian coal. The coal pricing model has useful to estimate the future price of Indian coal and also to identify the impact of import coal quantity on Indian coal prices.

Keywords: Influencing Factors, Coal Price, Import coal and Coal pricing model.

I. INTRODUCTION

In India coal plays important role as it fulfils almost 67 percent of the total commercial energy consumed in the country, and it has been projected to remain in such place in future by adding another 2, 20,000 MW of thermal power by 2030 [1].Thus, the issue of coal price has been a matter of concern for coal mining and power industry owing to the fact that the Indian coal has a low calorific value and higher ash content which reduces the operational efficiency of coal-fired power plants resulting in increased costs[2]. This price related issue is henceforth likely to increase in future as stipulated demand for electricity has been projected to grow rapidly in the near future and coal would continue to be used as a prime fuel to meet that demand [3].Annually coal consumption increasing in India (Fig1). Before 1990s the coal consumption was 304MT.After 2000 year the coal consumption was dynamically increased upto 662 MT.
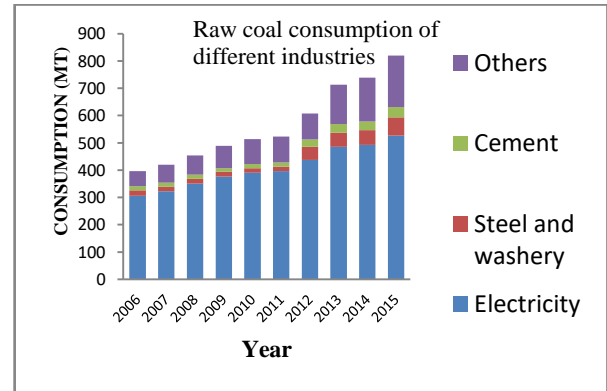
Fig.1. The bar graph shows coal consumption pattern of different industries in India

The International Energy Agency reported that coal will be the mainstay with an average rate growth in the global coal demand of 2.3 per cent per year through 2013-2018 [1]. The actual demand for coal was 884 Million Tonne (MT), with the actual supply falling short resulting in a demand deficit. This deficit was offset by import 202 MT of coal. Over 22.8 per cent of coal imports in 2017-18 were sourced from Indonesia followed by import from Australia and South Africa.

India is making a significant move towards coal The aim of such a move is to improve coal pricing and increasing competition [4]. Prior to the year 2000, the prices of coal were fixed by the government as the entire coal sector was regulated, but today it's solely set by the coal company themselves. In India, since 2012 coal is graded based on the GCV grading system, and accordingly, the prices of coal are different calorific value [5]. Coal grade system of 2017-18 is an exponential increase in the prices as the grade improves.

The purpose of this paper to identifies the factors that may have to influence on Indians coal price and lower the Indian's reliance on coal import quantities by boosting Indian coal production.

II. REVIEW OF LITERATURE

There are many researches and scholars who have studied the factors that can affect Indian and other country coal prices. All those studies can be divided into two categories, theory and data based analysis.

For example Wang Lijie (2001): forecast coal prices by using B-J method combining Qinhuangdao trade of coal market [6].

Zhang Tonggong (2005): explains the transportation cost and supply-demand relationship. Transportation. And also he analysed the coal price affect factors like a national policy and related products.

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The research mainly based on theoretical and related to national policy. The result of analysis cannot perform the effect of each factor.

Xie Shouxiang (2006): was using error correction model to explain the coal demand has a long-trem memory to affect the coal price fluctuations. And also export, import factors are affect the coal prices but no more than 10 years [7]. Wang Xilian(2008): explained the reason why coal prices would in great fluctuate by combining the Brownain motion characteristics of coal prices through computer [8]. This kind of research include lots of data, researchers can get the correlation coefficient by processing the data or forecast the trend of coal prices by analysing time series.

Tan Zhanglu (2009): was found the down-stream product, coal output, international coal prices, rail capacity and stock of coal by using backward elimination method [9].

Analysis of influencing some factors on the price coal based on the angle of the downstream industry' demand for coal. And found the chase relationship between the price of oil and coal based on the principle of alternatives[10].

Wang Feng(2011): estimated the trend of coal prices by spatial model [11].

Lei Qiang (2013): found co-integration relation between export and import thermal coal in china based on co-integration theory, VECM model, and pulse influence function and variance decomposition

Anjali Ramakrishnan & Swati Dsouza (2016) :focusing on pricing of domestic non-coking coal in the power sectors [12].

Compared to the theoretical, data-based research and analysing with has more persuasion, but still inaccurate. They just get a result of data but didn't explain the result by using economic theory. The meaning of the result is just in math, but not in reality. So the veracity of the prediction will be reduced. In this paper, by using the experience of predecessors' research, it is concluded the mathematic expression of the general sense based on a large number of real data processing. Then after explain each factor on coal price. The factors that have effects on coal prices and the effect of the impact will be found.

III. OBJECTIVES OF THE STUDY

1. To review the coal pricing of India and to study factors that influence coal pricing.
2. To analyse the influencing factor of coal price in India and developed a coal pricing model for Indian coal.
3. To estimate the future coal price in Indian.
4. To identify the impact of import quantity on Indian coal price.

IV. METHODOLOGY OF STUDY

This study is aimed at determining the relationship between coal prices and various influencing parameters by using a backward elimination method of regression analysis with the help of **SPSS** software. The backward elimination method is a popular technique to excluded input variables in multiple regression models. We assume that the coal price is taken as a dependent variable and independent variables are

export, import, stock, and coal production, the relative value of demand and supply, international coal, oil prices.

A. Description of Data

The data corresponding to relative value of demand and supply, export, import, coal production, stock, international oil prices, international coal prices, average coal prices were obtained from annual reports published by Coal India Limited, other sources and the prices are taken has a dollars, to reduce the impact of these outliers on all data[13]. Then after to normalize the distribution of the entire data.

Coal Indian limited producing different types of coal grades (G1-G17), for the simplicity purpose the average analysis price is calculated by considering the weight of volumes of individual quality from (G1-G17) of coal sold along with its sales amount. The corresponding data obtained from the provisional coal statistics report and coal directory available at the website of Ministry of Coal, Government of India. Then the other data-driven graphs involving international coal, oil prices were made by using this are obtained data from EIA, PWC, and Market insider website and reports.
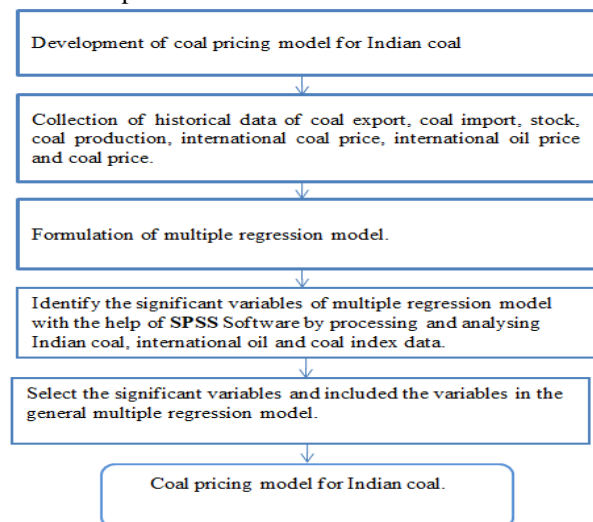

Fig.2. Methodology flow chart.

B. Design Model

The model includes different types of influencing parameters which are affecting the coal prices. Such parameters are used in the model as input variables based on the literature review. The differentials are influencing parameters on Indian coal price.
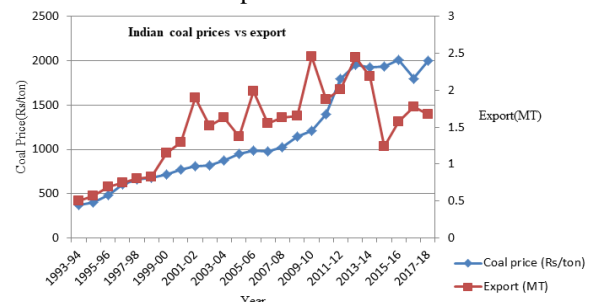

Fig.3. The graph shows trending of coal price and export quantity over the years

The model is shown in figure depicting input variables alongside response variables. The input variables including **LN D-S, LNEX, LNIMP, LN C PDTN, LNSCTK, LN IN C P, LN IN OIL P** while the response variable log coal price is indicated as **LN C P**. The abbreviations are defined below:

LN C P- Log Coal price
LN D-S—Log relative value of demand and supply
LN EX-Log Export
LN IMP-Log Import
LN C PDTN-Log Coal Production
LN SCTK-Log Stock
LN IN C P-Log International coal price
LN IN OIL P-Log International oil price.

The Indian coal prices assumed to be a function of various parameters as shown below;

LN C P =f (LN D-S, LNEX, LN IMP, LN C PDTN, LN SCTK, LN IN C P, LN IN OIL P)

Where the price is in $/ton and coal quantity in MT

Regression Model:

The multiple linear regression models are used to determine the bond of two or more explanatory variables and a response variable by fitting a simple linear equation to the observed data points. In the other way, the model can be represented as follows

$$Y = b_o + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + b7X7 + \mu \qquad (1)$$

Y is the depended on a variable (log coal price $/ton), b is the coefficient of the variable and the μ is the residual.

Backward elimination of multiple linear regression analysis is used to develop a model of coal price from relative value of demand and supply, coal export quantity, import quantity, coal production, stock quantity, international coal prices, international oil prices.

Table-I: The selected variables

Category Based	Variable
Influencing factors related Supply and Demand.	LN D-S (X1)
	LN (export) (X2)
	LN (Import) (X3)
	LN (Stock)(X5)
	LN (production)(X4)
Influencing factors related to products	LN (international coal price) (X6)
	LN (international oil price) (X7)

C. **International Coal Prices**

The international coal prices and national coal prices are close. Indian's production of coal accounts for over 9.2% of world production, Indian's coal production was about 675 MT, making it the third largest producer globally. The consumption accounts for 11% of total world consumption. The contact of the domestic coal market and international coal market is more and more closely, with the advance of Indian's coal market, international coal prices will have more impact on national coal prices [14]

D. **Export Quantity**

Indian domestic markets are facing the high demand for coal quantity to fulfil that and its need to be the energy sectors. We export coal to Nepal, Bangladesh, and Bhutan to create a market for the long term, through bilateral agreement basis Indian coal market a very small quantity of coal export to neighbouring countries [15].

E. **Import Quantity:**

The amount of import is a drop of 8% for the last three years, and in 2017-18, the quantity of coal in 202 MT has imported. The steel industry in relevant globally as a country is regarded as the third largest steel producing on world. The steel industry, nevertheless, is among the core industries in India with a contribution of nearly 2% to the country's GDP. Steel producers wants more coal quantity, this is the one of the reason of increase of coal price in international market, predominantly in Australia, where the frequently supply disruptions cause the coal prices to rise abruptly now and then, forcing the country's steel makers to bear the brunt [16].

V. **RESULT & DISCUSSION**

All the data related to coal as can be mention in an appendix, it consists of 200 data points used to the estimation of parameters and the all the data obtained from different sources like a coal provisional reports, coal directory, a business web site between the years (1993-2018). The quantities are taken MT, prices have taken in a $/ton, and all the data points transform into logarithms values.

In the study of statistics coal export, coal import, coal production, stock, international coal price, and international oil prices are taken as independent variables or predictor variables while coal price is expected or response variable.

All data points are analysis by backward elimination method using SPSS Software. The SPSS software completed the whole process in five steps as shown in "table iii" which provide a coal price model. In the first step at 10% significance level the coal export and coal import are significant. In the second model excluded the relative value of demand and supply from the model. After that third, fourth models excluded coal production quantity, stock quantity, and international oil prices from the model after that their no improvement in the model. In the final model results of depicts the probable relationship between the coal price and variables which are import, export, international coal prices.

Table-II: Descriptive statistics of coal

Variables	Mean	St. Deviation	N
LN C P	1.334	0.14	25
LN D-S	0.045	0.042	25
LN EX	0.134	0.194	25
LN IMP	1.614	0.469	25
LN C PDTN	2.613	0.141	25
LN SCTK	1.607	0.197	25
LN IN C P	1.568	0.162	25
LN IN OIL P	1.629	0.272	25

Table-III: Regression model values

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.097	.692		1.586	.131
	LN D- S	-.025	.368	-.008	-.068	.946
	LN EX	.148	.078	.205	1.893	.076
	LN IMP	.196	.094	.655	2.094	.052
	LN C PDTN	-.258	.330	-.259	-.780	.446
	LN SCTK	.129	.085	.181	1.515	.148
	LN IN C P	.166	.210	.192	.788	.441
	LN IN OIL P	.067	.134	.130	.500	.623
2	(Constant)	1.099	.672		1.634	.120
	LN EX	.148	.076	.206	1.965	.065
	LN IMP	.193	.082	.646	2.363	.030
	LN C PDTN	-.257	.321	-.259	-.801	.434
	LN SCTK	.129	.082	.181	1.560	.136
	LN IN C P	.163	.202	.189	.810	.429
	LN IN OIL P	.070	.123	.135	.568	.577
3	(Constant)	1.006	.640		1.571	.133
	LN EX	.166	.068	.230	2.449	.024
	LN IMP	.189	.080	.633	2.366	.029
	LN C PDTN	-.224	.310	-.226	-.723	.479
	LN SCTK	.106	.070	.148	1.498	.151
	LN IN C P	.266	.088	.308	3.012	.007
4	(Constant)	.547	.087		6.290	.000
	LN EX	.147	.062	.204	2.382	.027
	LN IMP	.136	.031	.455	4.406	.000
	LN SCTK	.089	.066	.125	1.352	.191
	LN IN C P	.258	.087	.299	2.982	.007
5	(Constant)	.551	.089		6.214	.000
	LN EX	.098	.051	.136	1.924	.068
	LN IMP	.159	.026	.532	6.079	.000
	LN IN C P	.327	.071	.380	4.598	.000

Dependent Variable: LN C P

Table-IV: Multicollinearity

Coefficient	b 0	b 1	b 2	b 3	b 4	b 5	b 6	b 7
Estimated Value	0.551	.025	.098	.159	.224	.089	.327	.070
SE	.089	.368	.051	.026	.310	.070	.071	.123
P Value	.000	.946	.068	.001	.479	.191	.001	.577

Table-V: Type of correlation

Dependent Variable	Independent Variable	Pearson Correlation	Type of Correlation
Indian Coal Price	Coal Import	0.224	Positive Correlation
Indian Coal Price	Coal Export	0.195	Positive Correlation
Indian Coal Price	International Coal Price	0.212	Positive Correlation

In the final coal pricing model as follows:

$$LN\ C\ P = 0.551 + 0.098\ LN\ EXP + 0.159\ LN\ IMP +$$

$$0.327\ LN\ IN\ C\ P \qquad (2)$$

$R^2 = 0.95$

When the coal export quantity will raise 1 unit, Indian coal prices increases .09 % .while coal import quantity will raise 1 unit, Indian coal prices increases 0.16%. While international coal price will raise 1 unit, Indian coal prices increases 0.33%.
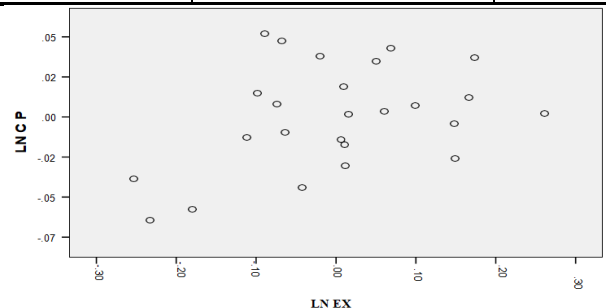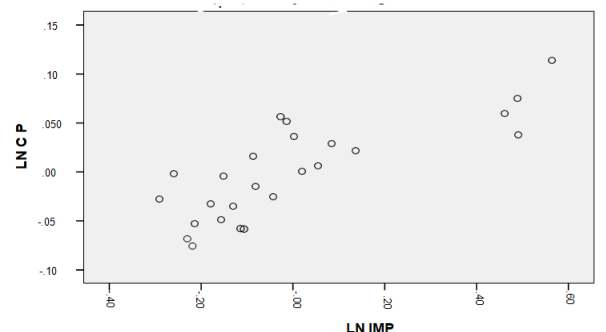

Fig.4. Correlation plot coal price and export quantity

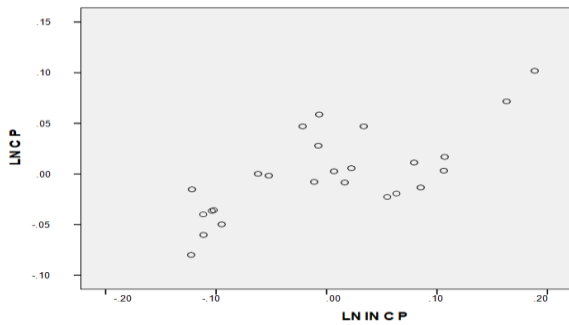**Fig.5. Correlation plot coal price and import quantity**

Fig.6. Correlation plot coal price and international coal prices

VI. CONCLUSION

After the extensive research we conclude that Indian coal prices are affected by the coal export quantity, coal import quantity and international coal prices. And also identifies the in import quantity directly affect the Indian coal prices. When the coal export quantity will raise 1 unit, Indian coal prices increases .09 % .while coal import quantity will raise 1 unit, Indian coal prices increases 0.16 %. While international coal price will raise 1 unit, Indian coal prices increases 0.33 %. The Indian coal production, relative value of demand-supply and international oil price is not significant. Based on significate variables we developed coal pricing model for Indian coal. In the future this coal pricing model may be helpful to estimate the Indian coal prices and also to identify the import coal quantity impact on Indian coal prices.

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AUTHOR PROFILE

A. Guru Brahmam ,post graduated from Indian Institute of Technology (BHU). His currently working as Assistant Professor in the Department of Mining in AMET University, Chennai. His area of research on Data Analysis, Mine Safety Analysis, Feasibility Study, Mine Planning .The author has become a member of Institute for Engineering Research and Publication (IFERP) and The International Journal of Engineering Educators Association (ITEEA). Mobile no: 9989801185.
Email ID: gurubrahmam602@ametuniv.ac.in
Address:Asst. Professor
Department of Mining
AMET University, Chennai-603112.