A Linear Programming approach to Optimal Utilization of Good Quality Coking Coal

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Abstract: *The development of mathematical programming has risen hopes that this is just the right tool to solve the problem. The price system is a vector which has to satisfy some conditions imposed on it in advance. We are searching for a vector which would be "rational" or since it became fashionable to use this word "optimal". Mathematical programming supplies us with techniques of finding out the optimal vector in the set of feasible vectors.In this paper we present a a linear programming approach to optimal utilization of good quality coking coal*

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1. Introduction

Coal is available in different states of India, such as Jharkhand, Madhya Pradesh, Utter Pradesh, Bengal, Orissa, Bihar, Maharashtra and Andhra Pradesh. Coal is a very important constituent of the development of any country. Now India's economy dependents upon coal. Various qualities of coal is produced in India. The role of good quality of coal is essential for production of thermal electricity, for the production of Mechanical energy from coal etc. A very brief historical introduction seems necessary. In the famous discussion on the economics of socialism which took place in the thirties the critics of socialism (l.VanMises, F.Hayek) Claim that centrally planned economy (CP-economy) would be unable to work rationally (or even to exist) because- deprived of free market- it would be at the same time deprived of the rational price system, which is the necessary basis of economic calculation and decision-making. Although in the seventies we do not have to worry about the existence of socialism, it must be admitted that the problem of rational price formation in the CP-economy has not been solved satisfactorily yet, neither in theory nor in (practice) Practicians often complain of the existing prices, pointing out that they "do from economic calculation" "do not reflect real social in puts) "do not correspond to current economic conditions" do not favour right economic decisions" etc. Theoreticians are still far from a common opinion as to what the rational price system ought to be like. The development of mathematical programming has risen hopes that this is just the right tool to solve the problem. The price system is a vector which has to satisfy some conditions imposed on it in advance. We are searching for a vector which would be "rational" or since it became fashionable to use this word "optimal". Mathematical programming supplies us with techniques of finding out the optimal vector in the set of feasible vectors.

2. A linear Programming Approach to Optimal Utilization of Good Quality Coking Coal

In the following section we develop a method for optimal utilization of good quality coking coal. Minerals, in general, form an important component of the material and economic base of a nation: some of them are more important than others depending on the state of economic development of the country concerned. Its importance arises from their being an essential input in a large number of industrial activities. It grows when the proven reserves of such resources are grossly inadequate for meeting the growing demand for them in years to follow. For the Indian economy coking is such a raw material. IN the form of coke this mineral finds application in the growing iron and steel, ferro-alloys, fertilizer, chemical and engineering industries of the country.

Report (1963) on Assessment of Resources by the committee set up by Minister of Mines and Fuel. Government of India, unmistakably points out how limited are the Indian reserves of good quality coal. The situation has not changed much since. Good quality coking coal is available only in Barakar Measures of Jharia coal field in seams 1x and above in the Eastern Region of the country.Against this picture of availability, it is only observed that in 1966 the perspective planning division estimated 1975-76 domestic requirement of coke at 23.505 million tones.

With 64 percent coke recovery, 50 percentwashery yield and 50 percent recovery from the mines, it would have meant 146.8 milliontones of coking consumption in a single year, 1975-76, if everything went as the planning commission expected the total assessed reserve of expectable quality of coking up to a dept of 2000 ft. in Jharia coalfields implies no more than 1450 million tones ofmaterurgical coal. Viewed against the level of per capita steel consumption envisaged in the perspective plan and the rapid rate of population growth, this reserve can be expected to last no more than three or four decades. It thus becomes imperative to conserve our reserve of good quality coking coal. One way of doing it is to use good quality coking coal in blends with interior types. On the basis of their volatile matter content, fixed carbon content and coking index individual coking coal in India can be classified under three broad heads- (i)Prime Coking, (ii)Medium Coking, & (iii)Week Coking Coals.

Of these, the prime variety alone directly is suitable for hard coke production, the other two varieties are available in blends with prime coking coal. Pilot plant investigation at the Central Fuel Research Institute, Dhanbad, demonstrated the possibility of blending weak coking coal to the extent of 20 percent in the charge for coke ovens. Their experiment indicated that to get the maximum yield of coke, proportion of individual coking coal in the final blend should be so adjusted that the percentage of volatile matters in the final blend should be so adjusted that the percentage of volatile matters in the final blend lies between 26 and 28 percent. Experiments also showed that a respective proportion of 40:45:15 of prime, medium and weak coking coals would bring the volatile matters content with the desired limit. In 1963 Hindustan Steel Plant of Bhilai, worked with an almost similar blend composition with good results.

3. Results and Discussion

The discussion begins with a simple observation. If a result of S supplying coal to someone rather than C, and C consuming coal from someone rather than S, S and C together obtain a profit of less than Rs. 0.80 lakh per million Btu of delivered coal, then we would expect them to prefer that S supply coal to C; in this way, they would obtain a combined profit of Rs. 0.80 lakh per million Btu of Coal. Therefore, the prediction that S's profit on each million Btu is supplies (up to the amount C consumers) added to C's profit on each million Btu it consumes (up to the amount S can provide) will be at least Rs. 0.80 lakh of course. A similar condition applied to the profits of any other subset of suppliers and consumers.

More precisely letting V_{ikl} denote the supplier's profit on each unit (specifically, a loan of raw coal) delivered, while letting u_{mj} denote the consumer's profit on each unit (specifically, a million Btu of coal) received, out restriction on the combined profit from the subset $\underline{S^1}$ $(0 \leq S^1 \leq S)$ of supplies and the subset d1 $(0 \leq d^1 \leq d)$ of demands becomes.

$\Sigma_{mj} S^1{}_{ikl} V_{ikl} + \Sigma_{mj} d^1{}_{mj}\, u_{mj} \geq V(S^1, d^1)$,

where

$$v(s^1, d^1) = \max \sum_{iklmj} (W_{mj} - C_{iklmd})\, X_{iklmj}$$

subject to

$\sum_{ikl} X_{iklmj} \leq d_{mj}$ for each mj

$\sum_{mj} a_{ikl} X_{iklmj} \leq S^I_{ikl}$ for each ikl

$X_{iklmj} \geq 0$ for each iklmj

Here $V(S^l, d^1)$ represents the maximum profit that the subset S1 of supplies together with the subset d1 of demands can generate by trading solely among themselves. In addition, the total profits cannot exceed the maximum combined rent that all the suppliers and consumers would generate by working together. This means that $\Sigma_{ikl} S_{ikl} V_{ikl} + \Sigma_{mj} d_{mj} u_{mj} < V(S,d)$. Therefore, the V function may be viewed as a von Neumann and Moregenstern (1947) "Characteristic function" of a game. The allocation of profit satisfying our restriction would then be the game's "core" as defined by Gillies (1953). Ideally, the above restriction holds for each possible subset S^1 of the supplies and d^1 of the demands.

In this case the total wage fund amounts to rR, and this in the savingless economy is equal to $\pi^0 y^0$. Hence by equality both expressions [1] and [2] are equal to

$$\sum_{k=1}^{K} \beta^k b^k + \chi H + (\rho - r)(R - R_0)$$

Let us add that in the case (a) p > 0, but nothing can be said about the relation of ρto r.

Case (b). The solution to the COP is such that labour force is not fully employed. The ρ= 0*, and

$$R_1 < R - R_0 \quad [1]$$

Let

$$L = R - R_0 - R_1 \quad [2]$$

be the unemployed labour force. Assuming that the unemployed labour force must be maintained by the economic system, but that the employment benefit is equal to the wage rate, we would get for social expenditures the expression.

$$\pi^1 v^1 + \pi^2 v^2 + r(R_0 + L) \quad [3]$$

The equality $rR = \pi^0 y^0$ again holds, although rR denotes now the wage fund increased by unemployment benefits. By equality [1] both expression [2] and [3] are now equal to

$$\sum_{k=1}^{K} \beta^k b^k + \chi H - rR_1$$

So the financial equilibrium of the whole system will be attained in any case. Notice that we speak of the equilibrium of the system as a whole.

4. Conclusions

We do not decide how to organize financial flows within the system e.g., should the center take over all the profits and cover social expenditures out of the central budget, or Should it order enterprises to cover all or some expenses for investment or collective consumption, etc. Anyway, financial means accumulated in the whole system will suffice to cover all social expenditure, provided prices are optimal and economy is saving less. Not much can be said if households save a part of their incomes.

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