Factors Affecting the Illegal Mining Activities in Salanpur Coal belt of West Bengal

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Abstract

This study attempts to provide a glimpse of the nature of illegal mining activities in Salanpurcoalbelt in West Bengal.We explore the socio-economic and demographic factors affecting the participation and volume of earning from illegal coal mining. The probability of participation in illegal coal mining along with its volume for the participants have been estimated applying double-hurdle models formulated by Cragg (1971). Salanpurcoalbelt scatters intotwo community development blocks namely Barabani and Salanpur in PaschimBardhaman district, West Bengal. In this empirical study we have purposively selected five villages from each of the two blocks. Among the five villages in each block three aremining villages and others are non-mining villages. The sample includes data of 500 households taking 50 households from each village. Households from each village have been selected using random number table to make the sample stratified random sample. Our systematic analysis reveals that in contrast to elderly, younger generations are more likely to participate in illegal coal mining activities with higher volume. Education is found as a critical factor which increases the likelihood to participate in illegal coal mining but does not affect the volume of illegal activities. Households with agricultural land and/or having cultivation as ancestor's occupation are less likely to participatein illegal coal mining in Salanpurcoalbelt. However, poverty induces the persons to involve in illegal coal mining activity.

Keywords*: Double-hurdle model, Illegal coal mining,Salanpurcoalbelt in West Bengal,*

1. Introduction

Juxtaposed with the legal coal mining sectors, coal mining in illegal way is common in India. Illegal mining refers to the mining which are going on violating any of the provisions of the applicable Acts, Government rules and Orders. Usually illegal mining arises when sites of legal mining are declared as abandoned. Sometimes illegal mining takes place on fresh land. It is reported that there are 450 illegal mining under the sites of CIL. Most of the illegal mining spots in India belong to the purview of three main coal subsidiaries in India viz. CCL,

BCCL and ECL of CIL. In the states of West Bengal and Jharkhand there are 203 illegal mining spots under the area of ECL. Of them, almost one hundred illegal mining sites are operated in West Bengal. The major illegal coal mining areas in West Bengal are Sripur, Sodepur, Salanpur, Satgram, Kenda, Kunustoria, Bankola, Kajora and Pandaveswar areas of ECL(Standing committee on Coal and Steel, 2010-11, Annexure-I: 36). This study is designed to provide a documentof the natureof illegal coal mining activities in Salanpurareawhich is eight kilometer away from Asansol City.Illegal coal mining in this region has an inherent value to the local people, especially tothe poor. It allows themselves to grow within their own capacities and potentialities and to get access to subsistence resources. It is not surprising that, ignoring the ethics and life risk a section of people from local areas participate in illegal coal mining activities for earning their livelihood or for making money. Illegal mining and selling of coal in Indian coalfields is a common parlance. Yet elaborate and systematic study on the causes and consequences of illegal coalmining is mostly absent until recently. This paper tries to explore the socio-economic and demographic factors affecting the participation and volume of earning from illegal coal mining for the households in Salanpur coal belt, West Bengal.

The paper is organized as follows. Section 2 deals with the reviewof literature. Section 3 gives a brief account of the ramifications of the illegal coal mining in Salanpur coal belt. The data sources and methodology of the empirical study has been explained in section 4. Section 5 is dedicated to results and discussions. Finally, the paper is concluded in section 6.

2. Brief Review of Literature

A few studies have been conducted to analyze the different aspect of coal mining both legal and illegal in India and abroad. Lahiri-Dutt (2003)has discussed the nature of informal mining in an established coal mining region, Raniganj, and its impact on local communities. She has reported the coexistence of informal mining with the formal mining sector inRaniganj where “illegal” mining is the lifelineof almost over 5 lakh people. The people engaged in illegal mining are living on the fringes of the monetized economy, earninglivelihood mainly from traditional cultivation and animal husbandry, supplemented by scavenging for coal. Several legal mines also have an illegal counter- part operation, with which the local villagers work regularly. The mining company, the largest land owners, the prime employer and mover of resources in this region prefers to overlook the existence of illegal mining or views it as a law-and-order problem. However, the authorities of formal company, complains frequently to the local district administration regarding “theft” of coal from its premises. Lahiri-Dutt and Willams (2005)have documented that illegal coal mining initiated staying hidden in full scale in the eastern Indian coalfields of Jharkhand and West Bengal about 7-8 years after nationalization and the raising of coal prices. It is now visible and diversified. They have reported that along the highways and other roads in Raniganj coal belt, a common sight now-a-days are bicycles carrying sacks of coal, the bike being used as

an inanimate packhorse with men pushing them instead of pedaling. They have explored the 'black' coal economy describing the nature and extent of coal supplied by bicycle 'wallahs'. Initially they have counted the number of cycles coming into town along critical roads while the other consisted of interviews with administrators, local police, journalists, as well as talks with coal cycle wallahs. The main customers of this 'cycle-wallahs' are local 'chimney bhattas' or brick kilns throughout the dry months and in most cases the cycle-wallahs sell coal to even small customers like individual homes. Most of these 'cycle-wallahs' belong to the local tribal groups. After having lost their traditional livelihood like farming and forestry, the tribal have participated in illegal coal mining activities for earning their livelihoods. Resosudarmo etal. (2009) have highlighted the illegal mining activities in Indonesia. Illegal coal mining in Indonesia means mining business conducted by a person, group of people or company/foundation which has legal entity, but which in its operation does not hold a legal Government permit. In Indonesian, these miners are called *PenambangTanpaIzin*(PETI) that means mining without permission. Illegal mining activities in Indonesia increased significantly following the 1998 economic crisis resulting unemployment and expanded further due to decentralization. They have observedstrong financial incentives for the locals to conduct these illegal mining activities. Illegal coal mining significantly support local livelihoods and contribute to the local economies. It creates more employment than formal mining operations and accommodates those at lower end of the economy. However, alcohol abuse and prostitution are associated with illegal mining. There are also instances of child labour. In Kalimantan about 10 percent of illegal miners are under 17 years old. These children are more susceptible to health risks and accidents as well as physical and psychological problem than their adult counter parts. Goswami and Goswami (2014) have mentioned that the greatest environmental impact of mining in Raniganj and Jharia coalfields has been on the land in the surrounding areas of mining. Mining has degraded the land not only denuding its forest cover and choking up the natural drainage lines, but has also destroyed the agricultural potential of this region. They have also observed that large areas of forest, agricultural land, and grazing land have been converted into colliery colonies or into fallow land due to rapid expansion of the coal illegal coal mining. Thus, illegal coal miningprovide a breeding ground for social, economic, environmental and health problem.In spite of that a large section of households in Salanpur coal belt have engaged themselves in illegal coal mining business having different socio-economic features. The objective of this study is to identify the nature of the illegal activities and causes of the participation of the local people to this illegal activity in the context of Salanpurcoalbelt in West Bengal.

3. Nature of Illegality in Coal Mining in SalanpurCoalbelt

Mining of coal by digging rat holes are the main facet of the illegal coal mining in Salanpur. Rat holes are dug at abandoned coal mines or at fresh land by crating tunnels under the land in about 60-70 feet depths without any scientific knowledge of underground coal mining technique. The illegal miners can also stick to another type of mining by cutting the coal

seam vertically just like creating well, this type of mining is also known as pit mining. The whole system of illegal coal mining is running violating the safety norms followed by the formal underground coal miners. The illegal diggers are often killed by roof falling incidents, or poisonous gas leaking incident or by mine fire incidents. Often,the coal mafias negotiate with the coal miners, the local police administration, the local political leaders and the coal officials, to run their illegal business smoothly. The local police in the name of raids to these illegal operations make an eye wash for local residents by closing the mouth of the rat hole, but the tunnel or rat hole remains as it is. After a few days the miners just reopen the mouth of that rat holes and restart operation. Note that a large part of this illegal coal are supplied at a relatively lower price to the local brick fields or other small and medium scale factories and to the local households by the 'cycle wallahs'.

Illegality also arises when the local police administration seizes coal loaded trucks in their jurisdiction, these seized coal are dumped in the police station. This type of seized coal is called 'zimma' coal. When the stag of 'zimma' coal is overcrowding in the local police station, the local police administrators sell it to some local coal suppliers by issuing a legal challan. However, there is again a possibility of illegality in the marketing of 'zimma' coal. For example, suppose the authority permits a seller to sell a truck of'zimma' coal of Salanpurat Murshidabad and accordingly issue a challan. With that challan the coal suppliers supply coal legally (without any fear of police checking) in the desired destination. In practice, the supplier ofthe 'zimma' coal with a proper challan don't face police checking in the journey due to pact with the policing network. Then using a single challan of 'zimma' coal the coal supplier supply many trucks of illegal coal to Murshidabad.

Sometimes the coal officials are involved in illegal activity. Suppose a factory demands coal say 400 tons from ECL authority. Then ECL authority issues papers of supplying coal of 400 tons to that factory. Usually, the officials supply the coalby trucks or dumpers with formal carrying capacity of 25 ton of coal each in a trip. Then to supply 400 tons of coal 16 trips are required for a truck or dumpers. In the process of supply when coals are loaded from ECL siding, these coal loaded trucks or dumpers are weighted in the weigh bridge. In the weigh bridge the on dutycoal official, called weigh bridge clerk (locally known as 'Kantababu') may make nexus with the supplying factory that each coal loaded truck actually supply 30 tons of coalinstead of supplying 25 tons as per official papers. The extra 5 tons in each trip, which the coal officials including 'Kantababu' supply,is a part of illegal coal mining from legal mines. Thus to supply 400 tons, 80 tons of coals are becoming illegal. This is also another type of illegality in connection with the coal mining which may come from the involvement of coal officials.

4. Methodology and Data Sources

Our second objective is to investigate the factors affecting the decision to participate in

illegal activity and its volume given the positive response towards participation in connection of coal mining. Decision to participate in illegal coal mining activities is a dichotomous variable indicating value '1' for the household having a member participated in illegal coal mining activity, '0' otherwise. The volume of illegal coal mining activity is measured by the percentage of income of the household comes from illegal coal mining activity. It takes value '0' for the non-participants and positive ranging up to 100 for the participants. As participation in illegal coal mining is a binary variable, binary logit or probitmodel is suitable to investigate the responsible factors affecting the probability of household members to participate in illegal coal mining activity. However, in addition to the estimation of the probability of participation we like to estimate the volume of illegal activity done by the participants during the study year. Usually for estimating the volume of illegal activity we apply tobit model. Although the estimation and interpretation of tobit model is straightforward, the main limitation to the tobit model is that it estimates the probability of participation and actual volume of illegal activity given the participationconsidering a single set of explanatory variables. But in practice often different sets of independent variables may determine the positive response toward participation in illegal coal mining and the volume of activities given the positive response, for example duration illegal work definitely determine the volume of illegal activity, while this explanatory variable is totally irrelevant for determining the participation in illegal coal mining. Therefore, we have to be more flexible to estimate the probability of participation along with the volume of illegal activity. As the response for participation and the volume of illegal activity with positive response are determined by two different sets of variableswe formulate Cragg (1971) 'two tier' or double-hurdle model.Double hurdle model estimates the probability of participation in illegal coal mining along with the volume of illegal activity for the participants. It is a two tier estimation tool. In tier one it estimates the decision to participate in illegal coal mining activities and tier two reports the estimate of the volume of illegal activities given the participation considering two different set of explanatory variables.

Given the scope of participation the decision to participate in illegal coal mining for an individual depends on his/her socioeconomic conditions. Literature review and our personal experience find that displacement form the basic livelihood, poverty, family burden, lack of alternative job opportunity, illiteracy and backwardness and trap of network of coal mafia affect the decision to participate and volume of activity in illegal coal mining for a household. With this end in view, we have included eight socio-economic factors as explanatory variable of the model for the decision to participate in illegal coal mining and its volume. The variables age and education level have been considered for checking the role of unemployment, economic status and dependency ratio capture the role poverty and family burden, per capita land holding and father's occupation have been considered for assessing the role of displacement from basic livelihood, inclusion of castes tells the role of backwardness in the decision to participate in illegal coal mining.

We have already defined the two explained variables in our double hurdle model. The selected explanatory variables for the models are specified as follows.

Age of the Respondent: Age is the physical age of the respondent. It is measured in years. In this analysis age of the person has been considered as a categorical variable. The persons aged below 40 years are grouped in 'age group 1'. The persons belonging to age group 40 to 50 years are grouped in 'age group 2'. Finally, the persons older than 50 years are considered in 'age group 3'. Therefore, we have taken two dummies for age group, one for age group1 and another for age group 2. Age group 3 is considered as reference age group for understanding the impact of age group. Dummies for age groups are considered as explanatory variable in both the models.

Education Level of the Respondent: The education level of the person is expected to be a factor affecting the participation in illegal coal mining and the volume of illegal activities. As majority of the households have less the elementary level education this study undertakes education level of the respondent as dummy indicating value 1 for the person having at least primary level education i.e. fifth standard, '0' otherwise. We did not categorize the education level in different levels because there is no sufficient variation in educational qualification for the sample respondents. Education is taken as explanatory variable in both the models with the expectation of negative impact on illegal coal mining activities.

Dependency ratio: It is defined as the proportion of dependents or non-working members to the total members of the family. The dependency ratio in the household is expressed as percentage. This variable is included in both the models.

Economic Status of the Households: Economic status of the households is identified by the information whether the households has BPL card or not. If the household has the BPL card we treat the households as poor otherwise rich. Actually family status is a dummy variable indicating value 1 for the households holding BPL card and '0' otherwise. It is included in the model for participation not in the model for volume of illegal activities. Because the volume of illegal activities for the poor who participated are almost invariant.

Per capita landholding: We have measured the total landholding of a households by adding the agricultural land and non-agriculture land in bigha owned by the household members. The per capita landholding is calculated by dividing total landholding of the family by the family size and measured in bigha (1 bigha = 0.4 acre). This explanatory variable is considered in both the models.

Father's Occupation: In order to gauge the impact of ancestor's occupation on the participation in illegal activity we consider father's occupation as an explanatory variable to determine the decision to participate in mining activities. In the econometric model father's occupation is a dummy variable taking value '1' when the father of the respondent is engaged in cultivation and '0' otherwise. This variable is expected to have a negative effect of the probability of participation in illegal coal mining activities but not a factor to determine the volume of illegal activity. Thus, we consider it as an explanatory for the participation

variable only.

Duration of Participation in Illegal Mining Activity: it the total duration, the respondent is engaged in illegal coal mining and/or selling. It is counted in years. This variable definitely affects the volume of illegal activities so we include it as explanatory variable of the volume of illegal activities to examine explanatory power and magnitude of the effect. However, this variable have no role to determine the participation decision of the respondent.

Caste: Caste of a person is a categorical variable indicating the person belonging to a specific caste, namely General Caste, Other Backward Classes (OBC), Scheduled castes (SC), Scheduled tribe (ST). Therefore, we use three dummy explanatory variables in connection with the social castes of the respondent. These three dummies in our model are Caste-OBC, Caste-SC, and Caste- ST. Caste-OBC takes value '1' if the respondent belongs to other backward classes and '0' otherwise. Caste-SC is equal to '1' if the person belongs to scheduled castes and '0' otherwise. Caste-ST takes value '1' if the responding family belongs to scheduled tribes and '0' otherwise. The category of general castes is the reference categories for analyzing the effect of the dummies for castes. In inclusion of castes help us to examine the role of castes to choose the illegal coal mining as a part of livelihood and in what extent.

In order to estimate the empirical model we have conducted a household survey in Salanpur coal belt. Salanpur coal belt scatters into two community development blocks namely Barabani block and Salanpur block in PaschimBardhaman district, West Bengal. At the first step we have purposively selected five villages from each block. Among five villages in each block three are mining villages and others are non-mining or controlled villages. Mining villages refers to the villages where formal or/and illegal coal mining are situated within 2 km from the selected villages and non-mining villages whereas non-mining villages are 8 to 10 km away from the formal or informal coal mines. The sample includes 500 household data taking 50 households from each village. Households from each village have been selected using random number table to make the sample stratified random sample. The data has been collected from personal interview with the active earning member of the household formulating a structured questionnaire from each selected households.In view of the above sampling designthe field survey in SalanpurCoalbelt area has been conducted during May 2017 to January 2018.

5. Result and Discussion

Basic socio-economic and demographic features of the sample households have been presented in table 1. Average family size of the sample households is four. Average per capita income of the sample households is almost Rs 3500 per month. The average per capita expenditure of the sample household is Rs 1930 per month which is close to median and mode per capita income. That means the economic status of the sample households on an average is satisfactory and is sufficient enough to maintain the daily life. However, from the

table we can observe that average per capita illegal income of the sample household is Rs 830 per month with wide variation. Since the sample households earn a considerable amount (23.71%) from illegal sources, so they want to remain on that occupation. Average education level of the respondent is seventh standard. Majority of the respondent don't have elementary level education. We see that average dependency ratio is quite high (0.69) in the study area. It is reported that the average per capita land holding is 0.59 bigha (1bigha=0.4 acre). Respondents who are engaged in illegal mining whether formal or informal mining, average years of mining is more than 8 years, though it varies from 3 to 18 years.

Table 1 Descriptive Statistics of the Sample Households (n=500)

	Family size	Education level (Year)	Age (Year)	Dependency ratio	Per capita landholdings	Years of Mining	Per capita expenditure	Per head income (Thousand)	Per capita illegal income (Thousand)
Mean	4.176	6.760	46.230	0.694	0.585	8.650	1928.63	3.49	0.83
Median	4.000	7.000	46.000	0.750	0.400	8.000	1629.16	2.12	0.000
Mode	4.000	8.000	45.000	0.750	0.000	8.000	1425.00	2.00	0.00
S.D.	1.000	3.474	8.914	0.110	0.740	3.158	882.008	3.47	1.94
C.V	0.239	51.391	19.282	15.788	126.59	36.50	0.457	0.993	2.344
Mini	2.000	0.000	22.000	0.250	0.000	3.000	816.667	0.91	0.000
Maxi	8.000	19.000	86.000	0.860	5.000	18.00	7000.00	22.50	16.66

Source: Authors' computation based on primary data collected from household survey 2018

Table 2 Frequency Distribution of the Attributes of the Sample Households

Attributes	Frequency	Percent
Economic Status of the Households (BPL Cardholder)	185	37.0
Caste of the Respondent (General)	130	26.0

Caste of the Respondent (OBC)	99	19.8
Caste of the Respondent (SC)	224	44.8
Caste of the Respondent (ST)	47	9.4
Type of village of the households (Mining Village)	298	59.6
Occupation of Father of the respondent (Cultivation)	168	33.6
Occupation of Father of the respondent (Casual labour)	249	49.8
Occupation of Father of the respondent (Self Employed)	38	7.6
Occupation of Father of the respondent (Service holder)	45	9.0
Households having no land (Landless)	231	46.2
Participation in illegal coal mining activity (participation)	168	33.6

Source: Author's computation based on primary data collected from household survey 2018

Table 2 depicts that around 37 percent of the sample households in our study is BPL card holders. Among the sample households 26 percent belongs to General castes, 20 percent belongs to OBC category, 45 percent belongs to SC category and 9 percent belongs to ST category. Sixty percent of the households are from mining villages and the remaining 40 percent from control villages. Data also depicts that almost 34 percent of the respondents' father have the occupation of cultivation, whereas 50 percent of them are casual labour, 7 percent of them are self-employed and 9 percent of them are service holders. So, major portion of the respondent's father has the occupation of casual labour. Almost 46 percent of the households have no land at their disposal. It is observed that one third of the sample households have participated in illegal coal mining business in Salanpur coal belt area.

We now report the estimate of the likelihood of participation in illegal coal mining and its volume given the participation considering selected set of explanatory variables. Table 3 shows the result of double hurdle model for estimating the participation along with the volume of illegal activities. The results of tier 1 are almost identical with the result with estimation of a probit model for participation variable only. It happens due to the separability property of the likelihood function under Cragg's double hurdle model. The primary benefit of using this model is its ability to facilitate post estimation analysis and interpretation. However, it should be noted that separability in estimation does not imply separability in interpretation.

Let us first interpret the result of tier 1. We find the coefficient of the dummies for age statistically significant at 5percent level. If a person in the Salanpurcoalbelt area belongs to age group 1, log likelihood for participation in illegal coal mining activity would be higher by 0.34 points compared to the log likelihood of the person belonging to age group 3 assuming other thing remaining unchanged. The coefficient of age group 2 indicates that log likelihood of the participation in illegal coal mining of the middle aged person is 0.30 points

higher compared to the elderly. Therefore, in contrast to the elderly group, young group of the people in the area under study are more likely to participate in illegal coal mining activities.

The coefficient of the dummy for education of the person is positive and statistically significant. If the person has primary level education, the log likelihood in favour of participation in illegal coal mining will rise by 0.51 point. The probability of participation in illegal coal mining increases if the respondent has at least primary level education. We can interpret the result in such a manner that to participate in illegal coal mining activities described in section 2 as a non-labour worker or manager the persons need some minimum level of education and knowledge to handle different paper works and official connections. Besides for a last few years educated persons don't have any formal employment opportunities as per our observations and from different government reports. That is why;the educated persons are compelled to participate in illegal coal mining in the area under study. However, it does not imply that really educated persons participate in illegal coal mining. This paper fails to capture the real impact of education on the decision to participate in illegal coal mining because they are few in our sample as well as in population in the villages under study.
The coefficient of dependency ratio is found negative but it is statistically insignificant. Therefore, our model did not give sufficient knowledge to understand the impact of the dependency ratio on the log likelihood of the participation in illegal coal mining from the family.

The coefficient of the dummy for father's education (1=cultivation) is reported as negative and significant. If father's occupation of the person is cultivation, the log of likelihood in favour of participating in illegal coal mining would be lower by55 percentage compared to the other occupation of the respondent's father. It means that if the occupation of the respondent's father is cultivation then the probability of participation in illegal coal mining activity would be smallercompared to the probability of participation for the person with father's occupation other than cultivation. The result reveals that father's occupation is an important determinant of the participation in illegal coal mining activities in Salanpurcoalbelt area. The person whose father are engaged in off farm activity like work in mining sector, legal or illegal, there is high chance that his successor is to be engaged in illegal activities. Thus if the person inherit agriculture as occupation they do not interested in illegal coal mining activities in the area under study. Moreover, landholding is an important determinant of the participation in illegal coal mining activity. The coefficient of per capita land holding in tier-1 is statistically significant. One bigha extra per capita landholding reduces the log likelihood in favour of the participation in illegal coal mining by 0.5 point, other thing holding constant.

Table 3 Determinants of the Participation in Illegal Coal Mining Activities and Its Volume

Estimating Cragg'stobit alternative assumes conditional independence Iteration 6: Log pseudolikelihood = -952.9102	Number of observations 500 Wald chi2(10) 78.18Prob> chi2 0			
	Coef.	Robust SE.	z	P>z
Tier1				
Constant	-0.250	0.447	-0.560	0.575
Age of the Person (Below 40 years =1)	0.347	0.180	1.920	0.055
Age of the Person (between 40 years and 50 years =1)	0.302	0.145	2.080	0.038
Education level (At least primary =1)	0.511	0.207	2.470	0.014
Dependency ratio (Percentage)	-0.844	0.572	-1.470	0.140
Per Capita Land holdings(Bigha)	-0.506	0.126	-4.010	0.000
Father's Occupation (Cultivator=1)	-0.552	0.164	-3.360	0.001
Family Economic Status (BPL=1)	0.435	0.134	3.240	0.001
Caste-SC (the respondent belongs to SC=1)	-0.210	0.162	-1.300	0.194
Caste -ST (the respondent belongs to ST=1)	0.370	0.243	1.520	0.128
Caste-OBC (the respondent belongs to OBC=1)	0.206	0.195	1.060	0.290
Tier2				
Constant	30.497	11.520	2.650	0.008
Age of the Person (Below 40 years =1)	12.235	3.670	3.330	0.001
Age of the Person (between 40 years and 50 years =1)	7.941	3.242	2.450	0.014
Education level (At least primary =1)	1.285	4.148	0.310	0.757
Per Capita Land holdings(Bigha)	-13.036	2.290	-5.690	0.000
Dependency ratio (Percentage)	61.711	14.712	4.190	0.000
Duration of participation in illegal mining activity (Years)	1.205	0.279	4.330	0.000
Caste of the respondent (SC=1)	-1.502	2.894	-0.520	0.604
Caste of the respondent (ST=1)	5.345	3.676	1.450	0.146
Caste of the respondent (OBC=1)	0.282	3.262	0.090	0.931
sigma _cons	14.360	1.077	13.330	0.000

Source: Authors' computation based on primary data collected from household survey 2018

Economic status of a family in the mining zone would affect the decision to participate in

illegal coal mining activity. It is expected that the members of the households living in the below poverty line are more likely to participate in the illegal coal mining activities if it is available. The coefficient of the economic status confirms this expectation. The value of the coefficient is 0. 43 which is statistically significant at 1 percent level. It tells us if a person lives in a poor family the log of likelihood in favour of participating illegal coal mining would be higher by 43 percentage compared to that of the persons belonging to non-poor family. Thus, the probability of participation in illegal coal mining for a poor person is higher than that for a non-poor person. We find that the participation in illegal coal mining is invariant for the caste of the person in Salanpur coal belt. Therefore, economic status is more important than social status to take decision to participate in illegal coal mining activities.

Let us now interpret the result of tier 2 of the model. Age is a significant determinant of the volume of illegal coal mining activity given that participation is positive. If the person participating in illegal mining activity belongs to age group 1, volume of illegal activity that is proportion of illegal income is 12 percent higher compared to that for the elderly participated person. This result is statistically significant at 1 percent level. Similarly we can say volume of illegal activities for the middle age group participants is higher than that for the elderly participants. Therefore, age not only influence the decision to participate in illegal activity it also increases the volumes for the younger participants.

Now we look at the coefficient of the education of the person. In the first tier it is positive and statistically significant while in the second tier it is positive but insignificant. It indicates that minimum education of household head may induce the person to participate in illegal coal mining activity, but education has no role to determine the volume of illegal activity. Our double hurdle model establishes that per capita landholding not only reduces the probability of participation but it also reduces the volume of illegal activities once the person already participated. Therefore, landholding is an instrument to prevent the household from the participation in illegal coal mining activities.

The key feature of the estimation of double hurdle model is that it can estimate the effect of a variable, which may not influence the decision to participate, on the volume of illegal coal mining activity. In our case the duration of participation in illegal mining activity is such a variable. The coefficient of this variable is positive and statistically significant but magnitude is very low. The value of the coefficient measures that if the duration of participation increases by one year, the volume of illegal activity would increase by 1.2 percent. This result tells us permanent office of the formal mining workers may encourage the persons from formal mining office and outsiders to involve in illegal activities in a greater volume.

It is worthy to note that dependency ratio is immaterial to determine the decision to participation in illegal coal mining but it has a positive significant impact on the volume of

illegal activity given that the person has participated in illegal coal mining activities. Social caste of the person is immaterial to determine the decision to participation as well as the volume of the illegal activity for a household in Salanpur coal belt in West Bengal.

Conclusions

These is no doubt that the presence and running of illegal coal mining activity in Salanpur coal beltleads to huge amount of monetary loss of the government. This loss can be regulated or controlled by adopting suitable monitoring measures jointly taken by local administration and coal mining authority. We have identified the factors that induce persons to engage in illegal coal mining activity. The estimation of the participation and the volume of illegal activity reveal that younger generation is more likely to participate in illegal coal mining activity. The volume of illegal activity is higher for the young generation. Our personal observation note that due to lack of alternative employment opportunity they are compelled to engage themselves in illegal coal mining activities as an easy alternative to ensure employment. Therefore, the government needs to ensure employment of the younger generation for reducing the volume of illegal coal mining activity in the area under study. Secondly, it is proved that poor household members are more keens to engage themselves in illegal coal mining activities. Therefore, different poverty alleviation programmes are needed more extensively in the area under study. Thirdly, per capita land holding is imperative to curb the volume of illegal activity. The respondent with father's occupation cultivation are less likely to be engaged in illegal activities. It may be the case that these persons did not face displacement of basic livelihood and did not fall in social network of coal mafia. Landholding of the household discourage the household member to participate in illegal coal mining activity. Therefore, proper land redistribution and strong policies for avoiding displacement from basic livelihood deserve in this area for arresting the illegal activity in the area under study. It is reported that duration of engagement in illegal activities in formal and informal coal mining sector increase the volume of illegal activities. Thus regular transfer system of the officials may be helpful to curb the illegal activities relating to coal mining in Salanpur coal belt.

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