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Reforms in Forest Management in West Bengal: A Game of Strategic Profile

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ABSTRACT: *This paper attempts to find out the economic outcome of joint forest management (JFM) programme for forest fringe community and government based on a field survey of Bankura district in West Bengal. This empirical study suggests that the economic outcome of the JFM programme has been beneficial for both government and forest community and this is due to the strict dominant cooperative strategy of community, not government. Economically, government was the worst sufferer for her earlier restrictive forest policy. The higher economic outcome of the government is due to the cooperation of community whom government neglected earlier. Our study under the model of common property resource (CPR) game also suggests that in spite of equal effort level for each type of player, cooperative equilibrium is also stable with the highest level of stock. This study also suggests that force or law can not effectively control the illegal collection of timber forest products for the poor agricultural households, which mainly depend on forest resources for livelihood security and that live below poverty line, until and unless a considerable increase in the income from legal forest products and forest wage income meet their livelihood security.*

KEYWORDS: *Bengal forest resource, reforms in forest management, economic outcome of joint forest management, common property resource game, model of legal-illegal income substitutability.*

This paper attempts to find out the economic outcome of joint forest management (JFM) programme for forest fringe community and government based on a field survey of Bankura district in West Bengal.

Forests contribute significantly to the economic, social and environmental well being of a country. Their role is more pronounced in a developing country like India that has a predominantly

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agriculture-based rural economy. Forest in India constitutes just over one-fifth of the land area of the country. Forest meets nearly 40 per cent of the energy needs of the country (more than 80 per cent in the rural sector), the bulk of it as direct subsidy to the poor. They also provide about 25 per cent of the fodder needs of our vast cattle population. Forest products are crucial to the rural and tribal economy. Many of the products, including non-timber forest products (NTFPs), provide sustenance to the rural people who collect a large part of their day-to-day necessities, including food and medicines, from the forests (Sarma and Rai, 2000: 207). The dependence of tribal on forests for sustenance and income generation is also significant, ranging from 15 to 84 per cent, depending on the community and region. The overall estimate is that 33 per cent of the tribal earn their livelihood from forests and forest products. The World Bank Report (2006) indicates that forests offer vast potential for poverty reduction and rural economy growth in India while also supporting critical national conservation goals (World Bank, 2006: xiii). The Report also revels that half of India's 89 million tribal people, the most disadvantaged section of society, live in forest fringe areas and forests have the potential to improve the livelihoods of forest dwelling people, particularly tribal people who are the most disadvantaged group in Indian society (ibid: 2). Increasing interest in rural poverty alleviation has thus resulted in a new focus in the forest dependent poor (Fisher, 2004; Pattanayak et al., 2004; Angelsen and Winder, 2003; Kumar, 2002; Kumar et al., 2000; Arnold, 2001; World Bank, 2001; Wunder, 2001; Cavendish, 1999; Scherr et al., 2002; Somanathan, 1991).

Issues relating to households' income accounts in rural areas of southern Malawi in Africa are presented by Fisher (2004) in two sources – forest and non-forest (farm, self-employment, non-forest wage work, sales assets and transfers)[1]. There is rich empirical evidence to support the claim that forest is an important source of income for the poor forest fringe households through the extraction of wood (timber and firewood) and non-timber forest products (NTFPs) or non-wood forest products (NWFPs) by preserving the forest resource sustainable with the help of cooperative management (Somanathan, 1991; Pattanayak et al., 2004; Guha, 1989; Jodha, 1986, 1992; Kumar et al., 2000; World Bank, 2001). In an attempt to measure the effect of JFM on various social groups – landless, marginal farmer, small farmer, medium farmer and large farmer – Kumar(2002) observes that the poorer sections of village community are disproportionally dependent on non-wood forest products both for subsistence and extra income due to low opportunity cost of labour (p.770). Access to forest for fuelwood is substantially important to local people and makes substantial contribution to households' welfare (Pattanayak et al., 2004: 176). The demand for fuelwood collection for poor households is inelastic with respect to their travel cost (or the shadow price of fuelwood) indicating that fuelwood is essential for these households, whereas improved economic conditions that increase household wealth and raise opportunity cost reduce household dependence on fuel wood from forest(ibid:175). Asset-poor in Malawi in southern Africa are observed more reliant on both low return forest activities (LRFA) – e.g. fuel wood and non-timber forest products – and high return forest activities (HRFA) – e.g. timber – compared with the better off and access to forest income in rural Malawi help the poor not only to prevent by supplementing income, but also to improve their living standard over time (Fisher, 2004: 147-151). Without any legal punishment by law traditional cooperative management system based on self-enforcing social norms and customs – each person knows that if they cheat, the other will as well, and to their supply of forest products in years to come will be jeopardized – were enough to restrain people from overlooping and looping trees from forest and the prevailing conditions ensures that the forest dependent households did not suffer from a scarcity of forest resource on which they were so dependent (Somanathan, 1991:PE 38-9).

This paper attempts to find out the economic outcome of joint forest management (JFM) programme for forest fringe communities and government who jointly manage the forest protection activities, based on a field survey of Bankura district in West Bengal. The present paper is important in that it tries to examine as to whether the institutional arrangements of community management under JFM have been economically beneficial for its member households belonging to agricultural households under three categories – landless, marginal farmer and small farmer – which depends on forest for their subsistence and income, compared with strict regulatory policy system of government before JFM, and contribute to extract forest resources sustainably. This paper is organized as follows. Section II presents the historical perspective of the study. A short review of relevant common pool resource (CPR) game is contained in section III. Section IV deals with survey design and methodology of the empirical exercise. Section V covers the findings of the study. Conclusions and policy implications appear in section VI.

II. Historical Perspective

Evidence of earliest forest management by the state is found in Kautilya’s Arthashastra (BC 321) which refers to ‘forests’ being managed as ‘state reserves for revenue’ and for ‘public use’ (Sarmah and Rai, 2000: 209). But, indeed, no rulers in India did execute these policies in the management of forest resources of our economy before 1988. Rather, the forest policy of India before the year 1988 was oriented with commercial need either of the government or of the rulers of India without safeguarding the traditional rights and concessions of the forest fringe communities on forestland. There was no systematic management of forest in the country before 1865. Some of the recorded forest conservation measures were initiated by Emperor Ashoka, as is testified by the decrees inscribed in rock and pillar edicts (ibid: 209). This concern continued till the beginning of the 6th century. Systematic management of forest in country began in 1864 with the appointment of Dietrich Brandis, a trained German forester, as the Inspector General of Forests. The government decided to treat forests as state property by enacting the Indian Forest Act, 1865 (Act VII of 1865). Although, the first Act of forestry in India was enacted in 1865, the major laws governing forestry have formulated by the Indian Forest Act of 1878, Indian Forest Act of 1927 and the Forest Conservation Act of 1980 (World Bank, 2006: xvi). The Forest Conservation Act of 1878 and that of 1927 emphasized commercial timber production. The Forest Conservation Act of 1980 and the 1988 National Forest Policy shifted the pendulum strongly towards forest conservation and joint forest management (ibid: 16-18). The revision of the National Forest Policy in 1988 marks a major departure from the earlier policies which emphasis on production of commercial wood and disregard for local need (Poffenberger, 1995; Sarmah and Rai, 2000: 213), because Government of India, then, could understand that until and unless the benefit of forest fringe communities is secured, neither forest resources nor forest management can be sustainable. So, in order to execute sustainable forest management system, the active participation of local forest communities in forest management for conservation and development plans of forest resources and the participatory forest management on usufruct sharing basis for safeguarding their traditional rights subject to the carrying capacity of forest was first introduced and implemented by the National Forest Policy of 1988.

However, far-reaching developments in the demographic, economic, social and environmental fields have resulted in the revision of the National Forest Policy in 1988. The national policy of 1988 constitutes a significant departure from earlier policies of forest management practice, for its emphasizes on: 1) obtaining the active participation of local people in forest conservation and development programmes of local forest lands; and 2) the benefit sharing arrangements, which is intended to provide village communities living near the forests a stake in the protection and development on the degraded forests.

JFM programmes in India currently span over 27 states, represent 85000 village communities, and cover more than 17.3 million hectors of forestland. The programme encompasses an estimated 8.3 million families, half of which are SC and ST (Bahuguna, 2004, cited in World Bank, 2006:1). Most JFM committees use the surrounding forests mainly as a safety net or for regular or seasonal subsistence production of firewood, fodder and minor forest products.

The JFM in West Bengal has its origin in the success achieved in rejuvenating a patch of 17 hectares of degraded forests under a pilot project implemented during 1972 near Arabari in Midnapore district. About 618 families living in 11 villages lying in the fringe voluntarily protected these forests when in return they were assured provision of fuelwood and fodder from the regenerated forest and employment in forestry activities. In 1987 these villagers were also declared as beneficiaries for these rejuvenated forests and granted 25 per cent share from the revenue earned from final harvest. This project made both government and community benefited (SFR, 2000:47). It seems to be relevant to mention that the key precursor to JFM in India, from a management perspective, was a local level initiative, dating from the early 1970s, in the Arabari in West Bengal (Jeffery and Sundar, 1999:28).

In West Bengal, the JFM movement gathered momentum when in 1989 a programme of resuscitation and reestablishment of *moribund sal* and other hardwood forests in the districts of Midnapore, Bankura, Purulia, Burdwan and Birbhum in south West Bengal was initiated by the government with the active participation and involvement of the local people. West Bengal government's resolution in 1989 was issued by declaring the principles of sharing of duties, responsibilities as well as the usufructs from the forests to the participant local people living in the fringe of the forests. The procedures for establishment of the institution called forest protection committee (FPC), comprising of these participants as members, were also defined. The foundation of an innovative forest protection system and the participatory forest management was thus laid for the forests of south West Bengal which covers approximately 38 per cent of the total forest area of the State. West Bengal State Forest Report (2000) clearly mentions:

"*As a result of participatory and joint forest management activities in south West Bengal the vast tract of scattered, over-exploited and degraded forests containing mainly the sal were resuscitated and restored to productivity with great improvement in quality and density*" (SFR, 2000: 47).

Government report (State Forest Report, 2000) reveals that the overexploitation of trees for timber was so severe that thousand and thousand hectares of forest lands in the south West Bengal except *Sundarban* were almost treated as bare plain land, when the JFM was established; but such lands are almost secured after JFM programme. Secondly, government revenue from the degraded forest was almost nil when the JFM was established, but it has significantly increased after JFM.

However, with regard to the historical perspective of the Government of India in general and Government of West Bengal in particular are concerned, we usually observe two forest policies of the government – strictly regulatory policy (SRP) and cooperative policy (CP). The SRP was usually used before 1988 when the JFM was established and CP has been executing as soon as the JFM came into being. Hence the strategy-set of government is {SRP, CP}.

On the contrary, against the custodian forest management system (SRP action of government), the local forest fringe communities in different parts of India have mobilized repeatedly from long past to protect their traditional right on forest (Poffenberger, 1995). In keeping with this, *Santal*, *Bhumij* and *Mahato* tribal with some low cast Hindus in south West Bengal mobilized repeatedly against *Mughal* and *British* rulers to protect their traditional rights on forestland from long past. *Chur Rebellion* (from 1767 to 1805), *Naik Revolt* (1806-16), *Hul Rebellion* (1855) are the glaring examples of the history in south West Bengal where forest fringe communities organized resistance against rulers of India to protect their own right in forestland. During Chur Rebellion, the tribal communities of this area mobilized resistance through a series of armed revolts against the British empowered a new class of zaminders who took attempts to clear forest land and convert it into agricultural land to increase their revenue. Tribal guerrillas were so effective that even as late as 1800, after nearly forty years of British occupation, a collector reported that two thirds of Midnapore consisted of jungle, the greater part of which was inaccessible'(Sarker and Das, 2004: 172). Yet, gradually the Company succeeded in strengthening its control, despite subsequent revolts by forest people, such as the Naik Revolt (1806-16). The pressure on the forest grew further by the 1860s as the growing railway system demanded immense quantities of sal logs to provide sleepers for rail bed. Commercial demand for timber accelerated forest cutting, and raised the value of forestlands. Timber merchants rushed in, even before the rail lines opened and began leasing or purchasing large tracts from the Midnapore Zamindary Company and other zamindars. In early 1855, six to seven thousand Santal tribal from, Birbhum, Bankura, Chotonagpur and Hazribagh began meeting for organizing resistance in response to their growing marginalization. On July 16, 1855 some ten thousand tribal, under the messianic leadership of four Santal brothers stood their ground firmly and fought with bows and a kind of battle-axe in a battle near *Pirpaiti* (Dutta, 1940: 26). The revolt collapsed eventually after half their members were reportedly killed. Despite their defeat, the *Hul Rebellion* (as it is known among the Santal) profoundly influenced the ideological development of many Santal communities (Duyker, 1987: 35), and lives on in the songs and oral traditions of the tribal people of this area.

JFM can, thus, be seen to emerge as the major policy change and attempt to create a new relationship between the government and the community in terms of cooperative framework. Thus, from the standpoint of the forest fringe community is concerned, one may usually find two actions of the community on its forestland – fighting policy (FP), which was mainly executed when government's SRP was in operation. They usually executed this policy to meet up their livelihood security. The cooperative policy (CP) of forest fringe communities has been gaining ground on as soon as the JFM programme came into being. So the community's strategy-set is {FP, CP}.

III. Review of the Relevant CPR Game

The daily livelihood of vast masses of the rural poor in many countries depends on the success with which common pool resources (CPRs) – such as forest and water resources – are managed and on the environmental consequences of their management. "CPR (common pool resource) management is a collective action dilemma: a situation in which mutual cooperation is collectively rational for the group as a whole, but individual cooperation is not necessarily individually rational for each member"(Dayton-Johnson and Bardhan, 2002:577). There is now a vast literature which examines the problem of extracting commonly owned renewable resources by game-theoretic framework (Clark, 1980; Dasgupta and Heal, 1979; Ostrom et al., 1990; Gardner et al., 1990; Ostrom et al., 1992; Chichilnisky, 1994; Sethi and Somanathan, 1996; Dayton-Johnson and Bardhan, 2002). Game theory provides a useful tool for many problems in environmental economics. The theory is concerned with the strategic action of different agents/players where these actions are in some way interlinked. It is said that the absence of private property rights in common property resources is characterized by a negative externality whenever the resource is scare; this leads to inefficiently high levels of extraction, possibly high enough to exceed the maximum sustainable yield, and threaten thereby the long run viability of the resource. But there is considerable literature of common pool resource game which suggests that cooperative management of common property resources guided by social norms and customs have been successful over long period of time (Fudenberg and Maskin, 1986; Williamsen, 1985; Ostrom, 1990; Ostrom et al., 1990; Hecheter, 1987; Acherson, 1993; Sethi and Somanathan, 1996). In a study of CPR institution, Cordell and McKean (1992) identity the established codes of conduct which are far more binding on individual conscience than any governmental regulations. These codes of conduct serve to ensure both sustainable aggregate harvests and an equitable distribution of access to the resource. Acheson (1993) is another example of sustainable management of common resources based on customs and social norms. In fact, self-organized CPR institutions have been devised without reference to centralized authorities and sustained over long period of time (Hechter, 1987; Willamson, 1985).

Empirical evidence suggests that individuals facing social dilemmas in many cases develop credible *ex ante* commitments without relying on external authorities: appropriation from CPRs have repeatedly shown their capacity to organize themselves, establish credible commitments, monitor each other behavior and impose sanctions on those who breaks their commitments (Gardner et al., 1990; Ostrom et al., 1990). Ostrom et al. (1992) find that high level of cooperation can be sustained for the management of CPRs if the possibility of pre-game communication is present, with or without the possibility of costly sanctions. The game-theoretic model of Sethi and Somanathan (1996) suggests that cooperative behavior guided by social norms of restraint may be stable to run the common property resources and pastures in a well defined sense against invasion by narrowly self-interested behavior; when the social norms break down, it generally lead to the lowering of the long run stock, and possibly to its extraction (p.766). This model follows from Somanathan's (1991) empirical evidence which describes a variety of traditional arrangement guided by social norms, customs and courtesy designed to enable Himalayan villages in India exploit their common forest sustainably without the possibility of costly sanctions. The CPR game of our study which emerges from our empirical evidence seeks to examine as to whether the interaction between community and government over a trade off between economic outcome from extracting commonly owned renewable forest resource is beneficial for both guided by a variety of institutional arrangements under JFM programme leading to exploit forest resource more sustainably compared with the system of strict regulatory policy (SRP) of government before JFM.

IV. Survey Design and Methodology

The data have been collected through an intensive field enquiry covering all members from three sample female FPCs and three joint FPCs under Bankura district[2] of West Bengal. We have taken samples from all forest divisions – Bankura (North), Bankura (South) and Panchayet (SC) – under Bankura district, because almost all female FPCs exist in this district only. For the selection of female FPCs, random sampling technique (SRSWOR) is used. *First*, we have taken three sample female FPCs, taking one from each division of the district with the method of SRSWOR. Second, we have taken all members of each sample female FPC for our study. The number of members of each female FPC has been collected from the records of the respective FPC. However, total number of members from three sample-female FPCs is 120 in number – Brindabanpur (56), Agua (23), and Malibona (41). To make a comparative study of FPC members between female FPCs and joint FPCs, we take three joint FPCs along with three sample female FPCs for our study. First, each joint

FPC has been selected based on the criterion of close proximity (nearest distance in km.) to each sample female FPC. Second, all members of joint FPCs have been selected for our final survey. Total number of members from three joint FPCs works out to 182 in number – Katul-2 (93), Balboni (44), and Baragari (45). However, total number of members selected for our field survey including female and joint FPCs, work out to 302. It is worth mentioning that each FPC was formed in the respective village. So FPC/village is synonymous in the study.

The data of six FPC-villages under our study were considered for two-time points – before JFM and after JFM situations. The period of collecting data for 'after situation' in all FPCs is same – between April 2005 and March 2006. But the period of data for 'before situation' was not same to all FPCs. JFM programme in Agua, Belboni, Malibona, Baragari, Brindabanpur and Katul-2 FPC-villages was started on February 1993, February 1993, March 1996, December 1996, April 1991 and September 1990 respectively. 'Before situation' for each FPC is considered for the preceding one-year period from the starting of JFM programme in the respective FPCs. For example, 'before situation' in Agua FPC-village was between February 1992 and January 1993. But the major problems in measuring different socio-economic indicators are the level of measurement (household/village/community/group), types of statistical information (variable/attribute), difficulties in ascribing the changes to a particular programme (like JFM programme) from other variables (programmes) influencing these changes, unit of measurement (for example kilograms/days/standard cattle). To some extent, these problems or limitations can be dealt with through the adoption of appropriate techniques of data generation and estimation procedures. An appropriate baseline survey of the households would contribute to capture the changes better. But such baseline data set are often not available; the problem in such cases is that we cannot observe the participating households without observing the programme at the same time. This is the major loophole of this study. One way of addressing this problem is to have a control group, which is similar to the participating group in all respects except the programme so that the control group may act as the counter factual of the participating group. But it is difficult to find such a matching group in this study, because there is hardly any household of forest fringe communities without JFM programme in the area we surveyed. Even the recent JFM programmes operating in this area originated before the year 2002. A second best solution in this regard is reflexive comparison where 'before' and 'after' scenarios are compared for the participating households. This would be helpful to provide reasonable estimates of the impact provided that there is no serious memory lapse problem among the respondents (Ravallion, 2001). But memory lapse is directly related to the time, which passes away after initiating the programme. By using the 'double difference' method where 'before' and 'after' situations are examined for both control and participating groups, these biases can be further minimized. Due to non-availability of data of matching control group for the causes mentioned earlier, we had to depend on 'reflexive comparison' where 'before' and 'after' situations are examined for participating groups only. 'Before' and 'after' estimation are analyzed for all households involved in the JFM programme under our study. More importantly, the share of timber sale received by each FPC from the forest department was equally distributed among all households irrespective of the economic status of households.

As regards the strategy-set of community is concerned, two FPCs – Baragari joint FPC and Brindabanpur female FPC – out of six provide some distinguishing features. First, Baragari joint FPC under Bankura South Forest Division came into existence in December 1996, although the West Bengal Government's initiative for JFM programme was operative in this forest division on and from 1989, during this period i.e. from 1989 to 1996, the government policy was cooperative but Baragari community's strategy was 'fighting'. This is mainly because of more heterogeneous community structure and high endemic factionalism among the community members in this village. *Secondly*, the establishment of Brindabanpur female FPC under Bankura's Panchayet (SC) Forest Division is a classic example in that a) it is the first female FPC not only in West Bengal but also in India; its leader *Mrs. Parul Lohar* was awarded Government of India's honour for her noble work; still she is the leader of this FPC; and b) unlike the usual practice, the primary initiative for the establishment of FPC was taken by the collective action of the members of this locality[3]. The members of this FPC came forward at first for the establishment of female FPC in their locality and local forest officials responded after three years. By this transition period community's policy was cooperative but government policy was strict (SRP). The distinguishing feature of Brindabanpur female FPC and Baragari joint FPC, however, helps us calculate the economic outcome of forest fringe community and government for their two distinct strategy profiles {FP, CP} and {CP, SRP}, the first and second actions of each distinct strategy profile being the community and the government respectively, based on our field survey.

This study considers simple technique of measurement like arithmetic mean, proportion, and tabular analysis for examining our stated objective. The outcome of the strategy profiles of government and community has been explained in simple game theoretic approach along with common pool resource (CPR) game presented in the appendix. Additionally, a simple mathematical model is also used for our study.

V. Findings

At the very outset, we examine some basic characteristics of our sample FPCs (Table 1). ***First***, all members of FPCs – both female and joint – in five FPCs out of six are either SC or ST (column 11). In Baragari joint FPC, about 90 per cent of members do not belong to SC/ST. ***Second***, about 43 per cent of households (129 out of 302 cases) are landless, about 45 per cent of households are marginal and the rest, about 12 per cent are small (columns 7, 8 and 9 respectively). In our sample there is no household, which belongs to medium or big category[4]. ***Third***, over 77 per cent of households in each village live below poverty line[5] (column 5), the incidence of poverty being the lowest in Baragari (77.78 percentage). ***Fourth***, except Baragari and Katul-2, majority of members in each village are illiterate (column 12). This study, however, indicates the abject economic and social conditions of the tribal people who are among the most disadvantaged group in rural Indian society.

Table 2 presents annual net real income (in Rs.) of sample households from forest source, non- forest source and from all sources along with the change of income between two time points. The real income (in Rs.) is determined after deflating the money income by cost of living index (general) of agricultural labourer. As mention earlier, we consider the year 2005-06 as the base year. In doing so we use the technique of splicing (which consists in combining two or more overlapping series of index number to obtain a single continuous series) [6]. Table 2 shows the following important results: 1) annual net real income (in Rs.) for all categories of households under our sample except small land holding households in Baragai joint FPC have considerably increased (ranging between 12.84 and 41.56 percentage points) after JFM (column 11); 2) the increase of the annual net real income of households from all sources is only due to the net increase in income from forest source after JFM (column 9); 3) the annual net income from non-forest source of sample households in all FPCs has decreased to a large extent (column 10); 4) the dependence on forest income for all categories of households has considerably increased after JFM(column 3). Before JFM programme the annual net real income from forest source out of annual net income from all sources from sample households ranges between 61.56 percentage point and 78.51 percentage points (column 6). It implies that forest was major source of income for all categories before JFM; 5) after JFM, annual net income of forest fringe communities has made a substantial increase. After JFM programme, the contribution of annual net real income from forest source out of annual net real income from all sources from sample households works out between 65.84 and 89.62 percentage points except Baragari FPC (column 3); and 6) the incidence of the dependence on forest income is much lower for the households belonging to the better economic position on land status after JFM programme (column 9). It is important to mention that per capita annual net real income from forest source (PCANRIFS) is considered as the economic outcome (payoff) of the community. In order to calculate PCANRIFS, annual net real income from forest source of all sample households is divided by total number of members (calculated from columns 3 and 6 respectively in Table 2).

The share of annual net real income derived from different sources of forest and non-forest sectors for agricultural households (landless, marginal farmer and small farmer) of six FPC-villages (during before and after situations of JFM programme) under our study appears in Table 3. Some important features that emerge from Table 3 are: i) forest sources – NTFPs, forestry wage and timber forest products (TFPs) – account for major share of annual net real income for all categories of households both after and before JFM programme situations. After JFM net return from all non-forest sources – farm, non-forest wage and others – have decreased for all categories of households except farm income for only small farmer households in Baragari FPC. Conversely, annual net real income from two forest sources – NTFPs and forest wage – has increased for all except NTFPs source in one category of households – small farmer households in Baragari FPC. As the households of small farmer of Baragari FPC could not diversify their income generating activities within forest sources – for example, NTFPs – like others, their share of farm income increases by about 11 percentage after JFM, although their share of annual net real income from farm source out of their annual net real income from all sources are below 20 per cent before and after JFM. ii) more than 80 per cent of annual net real income of landless and marginal farmer households, who are relatively asset poor and that also live below poverty line, come from forest sources except the same categories of households under Baragari FPC after JFM programme, whereas the contribution of net forest income was at best about 65 percentage for the same categories of households before JFM (Table 2). The significant increase of forest income after JFM is due to two sources – NTFPs and forest wage, the highest contribution being the NTFPs source (Table 3). However, the incidence of forest income is higher for the households which belong to lower land-based economic condition after JFM programme. iii) after JFM forest provides much income generating opportunity for all categories of households in all FPC-villages. As regard forest wage labour is concerned, not only the landless and marginal categories of households but also small farmer category of households are involved in forestry works. This is due to attractive high forestry wage rate compared with local wage rate in non-forest sector. Wage rate for forest wage labour is fixed at Rs. 67.50, which is about a double of the average local wage rate, for usually eight hours of service from 8am to 4pm. But forest wage rate and the number of working days as wage labour under forest department by the poor forest fringe communities are more or less fixed. Usually, one person from each poor household with a family size of five or less gets the opportunity of forest work from 35-40 days per year. If the size of member of a poor household is grater than five, usually, two persons get the opportunity; iii) out of annual net real income from all sources, NTFPs' share has increased in all FPCs for all categories of households, except small category of households in Baragari FPC. But most importantly, compared with before JFM period the change of annual net income of NTFPs after JFM, particularly, for landless and marginal categories of households, who are relatively asset poor than small categories of households and that live below poverty line, marks a major increases, ranging between 42.38 percentage point and 440.73 percentage point, in all FPC-villages excepts landless and marginal categories of households in Baragari village. Conversely annual net real income from timber forest products (TFPs) generating from illegal source[7] for landless and marginal categories of households in Baragari FPC-village has increased during after JFM period as compared with before JFM period, whereas net annual real income from TFPs yielding from illegal source for the same categories of households in other FPC-villages has considerably decreased during the same period, ranging between 44.27 percentage point and 72.71 percentage point. Moreover, net annual real income from TFPs has considerably decreased for small category of households in all FPC-villages.

The break-up of annual net real income from legal and illegal forest sources for below poverty line households before and after JFM situations appears in Table 4. It reveals that the illegal income from TFPs after JFM has substantially increased (30.59 percentage point) to poor categories of households which live below poverty line in Baragari joint FPC (column 9). The change of illegal income from TFPs after JFM for the same categories of households to other FPC-villages is highly negative (ranging between 20.77 and 74.47 percentage points). This is mainly because the change of income from legal forest products of the poor categories of households of Baragari FPC after JFM is much lower than that of same categories of households in other FPCs. In all FPCs, except Baragari, the change of income from legal sources of forest is highly positive ranging between 42.91 percentage point to 117.17 percentage point; in Baragari this change is negative (12.92 percentage point). It clearly indicates that force or law can not effectively control the illegal collection of TFPs of the poor categories of households, which live below poverty line, until and unless a considerable income from legal forest source meets up their bare minimum level of subsistence.

However, while considering per capita annual net real income from forest source (PCANRIFS) as the payoff of the community together with the break-up of share of income from different sources, we also calculate the government's economic outcome by considering annual net real income from forestland per FPC (ANRIFFPFPC) as the economic outcome (payoff) of the government. As mentioned earlier, the payoff of the Government of West Bengal (GoWB) from the degraded forest, particularly from south West Bengal is concerned, was almost nil for her SRP. A little payoff that GoWB would usually receive from this forestland was the auction sale of those trees that were removed by rain and/or by storm. As no specific government revenue had been reported from the FPC we surveyed before JFM was established and, on the contrary, government does not give an account of her little revenue for the particular division as a whole, we consider the critical ANRIFFPFPC for government as Re.1 for her SRP.

With a list of pure strategies available to each player, we now have the game of two-player (so that the industry is a duopoly) with two strategy sets G ={SRP, CP} and C ={FP, CP} along with its four distinct strategy profiles {SRP, FP}, {SRP, CP}. {CP, FP}, and {CP, CP} in the following simple form. It is assumed that both players choose annual net real income in per capita/per FPC terms rather than annual net money income. First, we use normal form of representation in analyzing static game (simultaneous move) of complete information[8]. In figure 1, payoff in the left hand side indicates the payoff of community and right hand side, the government's payoff.

Obviously for community, FP is strictly dominated by CP, because 2570>2359 and 3723>2613. It seems to be important to mention that for government, the strategy SRP is said to be weakly dominated by CP[9]. But when a strictly dominated strategy equilibrium exists we can confidently predict that this will be the outcome of the game (Bierman and Fernandez, 1998: 34). So as a rational player, community will not play FP. Thus government knows that community is rational; then government will eliminate FP from community's strategy-space. SRP is now strictly dominated by CP for government. Thus community knows that government is rational, and then community will eliminate SRP from government's strategy-space leaving the strategy profile (CP, CP) as the outcome of the game. This process is called *iterated elimination of strictly dominated strategies*. Unlike Prisoner's Dilemmas case, this outcome is Pareto optimum because it is not dominated by any other outcome of the game. The outcome (CP, CP) will hold good as producing cooperative is a dominant strategy for community. So the strategy profile (CP, CP) is the unique Nash equilibrium.

The outcome (CP, CP) will also result if community or government moves first. In the dynamic game of complete and perfect information, we may extend the extensive form of representation of a two-player, two-stage game in figure 2**.** Here the players move in sequence, all previous moves are common knowledge before the next move is chosen, and the players' payoff for each feasible combination of moves are common knowledge.

Now if we think of strategies that the players use, we find that government has choices at one node (the node A) at which she can choose either SRP or CP. Community has to choose at two different nodes B and D. Community's strategies are (FP, CP), (FP, FP), (CP, CP) and (CP, FP). Now what strategy is then equilibrium strategy?

It can easily be verified that two strategy profiles ({CP}, {FP, CP}), ({CP}, {CP, CP}) are the only Nash equilibrium of the game. They both support the equilibrium path A→D→G.

		Community			
		(FP, CP)	(FP, FP)	(CP, CP)	(CP, FP)
Government	SRP	(1, 2359)	(1, 2359)	(1, 2570)	(1, 2570)
	CP	(46650, 3723)	(1, 2613)	(46650, 3723)	(1, 2613)

Do sequential games have equilibra? The answer is yes, because the sequential game is of perfect information obtained by the backward induction method. In our game this sequential game has the unique Nash equilibrium, which is Pareto optimal. Here the prisoner's dilemma is especially important for exploring the alternative theories of individual and group action: "if individuals are selected to act in their self-interest, all will defeat. If they are selected to act the group interest, all will cooperate" (Bergstrom, 2002:69). The CPR game is an example of the prisoners' dilemma type, where cooperation yields an outcome preferred by both parties because they are able to negotiate before the start of the game (sequential game) and obtain binding commitments (Henley et al., 1997:15). However, the problem of extracting CPR (here forest resources) between community and government of this study under JFM is an example of prisoners' dilemma game where cooperation (CP, CP) yields an outcome preferred by both parties as they are able to negotiate before the start of the game (sequential form of game) and obtain binding commitments influencing, thereby, a long run viability of forest resource (a simple model of CPR game is presented in the appendix).

But the long run viability of forest resource depends on the economic outcome of poor forest fringe community, which mainly depends on forest resource for their major source of income. As mentioned in Table 3, the main source of forest income is due to NTFPs. But the price per unit of some NTFPs like kendu leaves and sal seed, the collectors receive from its purchasers is very low in relation to the market price. What is more significant is that whatever amount of more valuable NTFPs per unit (in Rs.) the collectors desire to sell in the market they have only to sell it legally to the agents of LAMS (Large Adibasi Multipurpose Society), which usually pay to their collectors considerably lower price per unit for the amount the latter sell to the former. Table 5 shows that net profit per K.G. of kendu leaves for the agents of LAMPS is about hundred percent of the collector's price. Similarly, net profit per K.G. of sal seeds is more than hundred percent of the collector's price. This situation is more or less similar with Jharkhand state, very close to West Bengal state. In Jharkhand, Jharkhand State Forest Development Corporation (JSFDC), licensed traders operating on behalf of the state, controls kendu leaves marketing in the state, where villagers are little more than collectors operating as pure price takers in a monopsony, with no bargaining position and no incentives to improve quality above minimum standards (World Bank, 2006: 46).

However, the success of JFM programme with respect to economic outcome for forest fringe community and government of this study highlights some particular issues of the poor households of community, which live below poverty line: 1) more than 80 percent of net annual real income of poor forest fringe communities yield from forest source – legal or/and illegal source(s); 2) when NTFPs and wage income from forest are inadequate to meet the bare subsistence level of income of the poor forest communities, who live below poverty line, they are involved in yielding illegal income by removing timber forest products from the forest land to meet up their minimum livelihood security; 3) wage rate for forest wage labour is fixed at Rs. 67.50, which is about a double of the average local wage rate, for usually eight hours of service from 8am to 4pm; 4) forest wage rate and the number of working days as wage labour under forest department by the poor forest fringe communities during present situation of JFM programme are more or less fixed; 5) the price per unit of some NTFPs the collectors (forest communities) receive from the agent of LAMPS is considerably lower than market price; and 6) the incidence of the dependence on forest income is considerably higher for the households which belong to lower economic condition after JFM programme.

Hence the issue is: what are the means to overcome the problem of the poor categories of households, which live below poverty line, when legal forest income (income from legal forest products like NTFPs, fuel wood, timber share from government and wage income from forest) is inadequate to meet up their bare minimum level of subsistence? There seems to be three ways to tackle the situation – *one* is to increase the production of quick growing NTFPs, fuel wood etc. in order that the poor households may increase the legal collection of those products; but its proper execution is hardly short term in nature. The *second* is to increase the existing government wage rate and the increase of the number of working days as wage labour under the department of forest. But the existing government wage rate (Rs. 67.50/- for usually eight hours' of work a day) is high enough as compared with the local wage rate (local wage rate ranges between Rs. 30 to 40 for usually eight hours' of work a day). Similarly the increase of labour days also depends on new aforestation programme, which seem to be hardly possible within a short period. The *third* is to increase the per unit price of Forest Products (FPs) the collectors have to sell to the agents of LAMS. This measure seems to be useful for the short period. The following simple mathematical model is an attempt to analyse this issue in the short run.

We assume $U_i = U_i(Z_{1i}, Z_{2i})$ ….. (1)

where Z_1 = Commodity (like TFPs) that yields illegal income, Y_I (measured in time unit) from forest resource; Z_2 = Commodity (like NTFPs, wage-labour on forest related service) that yields legal income, Y_L (measured in monetary unit) from forest resource; and i = Individual i of poor categories of households which live below poverty line.

Thus we can write $Z_{1i} \equiv Y_{Ii}$

and $Z_{2i} \equiv Y_{Li}$

then $U_i = f(Y_I, Y_L)$ ….. (2)

Y_I is risky and punishable offence for the members of a household if legal authority takes action against the criminal. But its implications seem to be insignificant for the individuals of very poor category of households because Y_I including Y_L, which would yield illegal income for all i before JFM programme, was the major source of livelihood security for the same categories of households before JFM programme; moreover after JFM programme Y_I is one of the major sources of the income for poor individuals in one FPC (Baragari), where legal source of income from forest products is very low in relation to the individuals of very poor category of households in other villages (Table 3). So it is assumed that $f(Y_I, Y_L)$ is continuous and has first and second order partial derivatives; it is regular strictly quasi-concave function. The rate of substitution of Y_L for Y_I is

$$-\frac{dY_L}{dY_I} = \frac{f_1}{f_2}$$

But $Y_I = T_F - [W_L{}' + \overline{W}_L]$ ….. (3)

where T_F = Total units of available time for forest work by an individual; $W_L{}'$ = Total units of available time for the collection of legal forest products like NTFPs and $\overline{W}_L$ = Total time of legal wage work (fixed) under forest department. It is assumed that total available time is 24 hours, and the individual will never work more than 12 hours per day [$\lim_{t-\infty} (W_L' + \overline{W}_L) = 12$].

Then the budget constraint is

$$Y_L = pW_L' + \bar{r}\,\overline{W}_L \qquad \text{..... (4)}$$

where p = price of legal NTFPs; and r = forest wage rate, which is fixed at $\bar{r}$.

$$\text{Thus} \quad U = f(T_F - [W_L' + \overline{W}_L],\ pW_L' + \bar{r}\,\overline{W}_L) \qquad \text{..... (5)}$$

To maximize utility we set the derivative of (5) with respect to W_L' equal zero

$$\frac{dU}{dW_L'} = -f_1 + f_2 p = 0$$

and therefore

$$-\frac{dY_L}{dY_I} = \frac{f_1}{f_2} = p \qquad \text{.....(6)}$$

This second order condition is satisfied provided that it is negative.

$$\frac{d^2U}{dW_L'^2} = f_{11} - 2f_{12}\,p' + f_{22}p^2 < 0$$

Equation (6) is a relation in terms of legal forest work (W_L') and price of legal forest commodities (p) and is based on the behavior of individual, who live below poverty line. Equation (6) is, therefore, the supply curve for legal forest work and states how much individual i will legally work at various prices of NTFPs. Since the supply curve of legal forest work is equivalent to demand for legal income, (6) indirectly provides the individual's demand curve for legal income. We also assume that Y_I is a normal good. Then hours in legal forest work will increase with the increase of price of NTFPs. The higher price for legal forest products like NTFPs will induce the individual i to reduce his illegal work time of forest related work (like collection of TFPs) and so reduces Y_I (Figure 3) so long as individual i's economic condition does not improve. So, the positive relationship between W_L' and p and the consequent reduction of Y_I will continue till the point (P_3). When the price makes individual i so well off that he is induced to cut down legal working time W_L (i.e. increase the Y_I time) and earn a higher income. But this condition implies a better economic condition (or upward mobility) of very poor categories of individuals. Practically, when the individual will be well off, he will also have more opportunities to increase his income other than forest source. Out study also clearly suggests that more well off individuals are less dependent on income from forest resources (Table 2). So P_4 provides an indication that individual i is less dependent on income from forest resource (a better economic condition or a upward mobility of individual i).

VI. Conclusions and Policy Implications

This empirical study suggests that the economic outcome of the JFM programme has been beneficial for both community belonging to marginal landholding, small landholding and landless agricultural households and government and this is due to the strict dominant cooperative strategy of community. But the earlier forest policy of the government was oriented with the commercial need of the government disregarding the traditional right and benefit of the forest fringe communities. Economically government was the worst sufferer for her SRP, because law or force could not effectively control the illegal collection of forest products of the poor forest fringe communities which mainly depend on income from forest resource and that live below poverty line, until and unless a bare minimum level of subsistence level of these communities was met up. The success of JFM programme has proved that active involvement of forest fringe communities in protection, regeneration and development planning of forest resource not only provides a significant increase in income of the community but also begets a major increase in income of the government who failed to receive such income while she executed SRP. The higher economic outcome of the government is due to the cooperation of community whom government neglected earlier. Similarly, the coordinated action by the community, which belong to marginal landholding, small landholding and landless agricultural households, also help them generate a substantial increase of forest income after JFM as compared with before JFM mainly from two sources – NTFPs and forest wage, the highest contribution being the NTFPs' source. But the incidence of forest income is higher for the households which belong to lower land-based economic condition and that live below poverty line after JFM. However, the CPR game of our study, which follows from our empirical evidence, suggests that the interaction between community and government over a trade off between economic outcome from extracting commonly owned renewable forest resource has been beneficial for both guided by cooperation (CP, CP) preferred by both parties within a variety of institutional arrangement under JFM programme leading, thereby, to exploit the forest more sustainably compared with the system of strict regulatory policy (SRP) of government before JFM. Although forest resource of south West Bengal including our study area was resuscitated and restored to productivity with great improved in quality and density after JFM compared with before JFM, as mentioned in SFR (2000:47), the institutional arrangement of JFM could not retain the poor households which are mainly dependent on forest resource for their livelihood security and that live below poverty line, from illegal collection of timber products until and unless a considerable income from legal forest sources – NTFPs, forestry wage and government' timber share – meets their livelihood security. This study also suggests that the prices per unit of NTFPs the collectors have to sell to the agents of LAMPS are considerably lower than their market prices.

In this perspective, however, there seems to be three ways to tackle these problems within the existing JFM programme – one is to increase the production of quick growing NTFPs, fuelwood etc. in order that the very poor households may increase the legal collection of those products; but this depends on the participatory forest management programmes and its proper execution which is hardly short term in nature. *Secondly*, the existing government wage rate on forest work is considerably higher (about a double) than that of the average local wage rate. The increase of labour days by the forest department depends on new afforestation programme, which also seems to be hardly possible within a short period. The *third* is to increase the price per unit of NTFPs the collectors have to sell to the agents of LAMS. So, in order to have the higher economic outcome and the higher outreach of the JFM programme, government should restrict the power of the LAMPS so that the collectors of NTFPs may sell their products at a higher price in the market and increase their income. But the increase of the collectors' price of NTFPs may not increase considerable income of the households below poverty line for the long period. Together with it, more pro-poor programmes under both government and non-government initiatives that complement the benefit of JFM programme need to be introduced.

Appendix:

We start with a static model of the CPR as an n-person game (Dasgupta and Heal, 1979; Chichilnisky, 1994; Ostrom et al., 1992) which has been used by Sethi and Somanathan (1996). We exclude the assumption of costly sanction on the violation of illegal collection of forest products or of institutional arrangement under JFM. As mentioned in the text, institutional arrangement of JFM could not restrain the poor households, which are mainly dependent on forest resource for their livelihood security and that live below poverty line, from illegal collection of forest products (timber) until and unless a considerable income from legal forest sources meets up their minimum livelihood security. Force or law can not effectively control the illegal collection of TFPs of the landless and marginal categories of households. Hence the possibility of costly sanction against the violation of extracting illegal forest products under JFM programme of this study is ruled out. We also assume a fixed number of n individuals who have complete rights of access and removal to the forest resource, a renewable natural resource, from a 'common pool' under institutional arrangements of JFM. Let the labour or effort expanded per unit of time by agent (FPC member household) i on resource extraction be l_i and the aggregate lobour expanded, L. The sum of individual labour flows:

$$L = \sum_{i=1}^{n} l_i$$

First, we assume the case where the total stock of resource $K=K_o$, an exogenously given constant. Then the aggregate harvesting per unit of time is a function of aggregate flow L and exogenously given constant K_o i.e.

$h(L, K_o) = f(L)$ …………….(1)

We assume $f_L>0, f_{LL}<0$ i.e. the total harvest per unit of time is an increasing function of effort and the value of the function is increasing at a deceasing rate. We also assume $A(L)= f(L)/L$ is decreasing. Each extra effort (labour) of an individual FPC member reduces the harvest available for other FPC member and therefore the average harvest. In other words $f(L)/L$ diminishes as l_i increases. Let us assume that the cost of labour per unit of time is w, which is constant and exogenously given. This is true because empirical evidence of this study reveals that the wage rate for forest wage labour per day is fixed at Rs.67.50 (discussed in the text). If we normalize the price of resource to unity, the efficient level of effort (we ignore changes in the stock) at which the marginal product of labour equals the wage

$f'(L) = w$ …………….(2)

The share of total harvest obtained by ith FPC member is directly proportional to the share of FPC member i's effort to total effort, so that FPC member i's net benefit from resource extraction, denoted by Π_i , is

$$\Pi_i (l_1, l_2,\ldots, l_n) = \frac{l_i}{L} f(L) - wl_i$$

Therefore the aggregate payoff p $(l_1, l_2, \ldots, l_n)$ satisfies

$$p(l_1, l_2, \ldots l_n) = \sum_{i=1}^{n} \pi_i = f(L) - wL$$

Let $L_{\hat{c}}$ be the level of aggregate effort which maximizes p. this is the efficient level of effort (given the stock) at which the marginal product of labour equals the wage $f'(L_{\hat{c}}) = w$.

This is shown in Figure a. $L_{\hat{c}}$ is unique due to concavity of the function.

Let us now examine what the outcome will be under the usual assumption of rational, self-interested behaviour by each FPC member. Each FPC member will compare his/her return $A(L) = (f(L)/L)$ with the cost of effort, w. Concavity of the function means that A(L) is decreasing (mentioned earlier). The FPC member intending harvesting an additional unit will compare f(L+1)/(L+1) with w and will go on harvesting if f(L+1)/(L+1)> w. However, from individual point of view labour will be added to the stock harvesting until $L_{\dot{C}} / \dot{c} = w$ (Figure a). This may be interpreted as free entry, zero profit condition with

A(L)$= w$ ……………(3)

Payoff of ith FPC member is now

$\Pi_i (l_i, L) = l_i(A(L) - w)$

While the aggregate payoff is

$P = L(A(L) - w)$

Thus if the resource is characterized by open access, so that the number of user can expand without limit, then it is clear that labour will be put in until the average product equals the wage and rents(profits) are driven to zero as shown at $L_{\dot{C}}$ in Figure a. This is clearly inefficient, because adding harvesting has a negative externality effect on the forest resource. However, disregarding the negative externality, each individual will put in more labour them is efficient so long as there is positively rent (profit) from the extraction (or harvesting). The CRP game has a unique Nash equilibrium, which is symmetric with $L_i = L_{\overline{C}}$ for all FPC members. It is inefficient and involves overexploitation $L_{\hat{C}} < L_{\overline{C}}$. There are positive rents in equilibrium: $L_{\overline{C}} = nL_{\overline{C}} < L_{\dot{C}}$ so that $A(L_{\overline{C}}) > w$. This is the classic problem of the common users: each individual would be better off if all would restrain their use, but it is never in the interest of any individual to do so (Dasgupta and Heal, 1979; Hardin, 1968; Weitzman, 1974; Sethi and Somanathan, 1996).

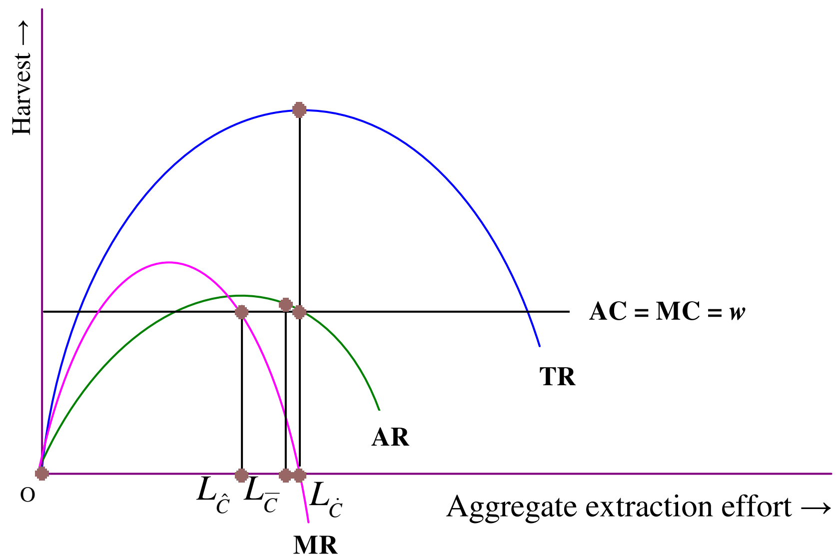

Figure a

In the case of resource dynamics, the case of renewable forest resources is different from the assumption of exogenously given forest resource by virtue of the fact that it is naturally generated within a time period relevant to human exploitation. Renewable resources are often assumed to follow a 'natural growth law' which is assumed to be simply a function of the size of resource stock. The relationship is not monotonic, but inverse U-shape (the logistic growth function). The growth rate at first rises with the size of stock, and then falls i.e., the slope of the curve is positive and decreasing. It is due to the fact that the natural environment has a 'carrying capacity' for the resource; a maximum population that it can sustain. There is zero growth rate for this size of stock. We assume equal effort level by each type of player – government and community – under cooperative management of forest in the dynamic analysis. This is, mainly, because the CPR game of our study considers two types of players – community and government – in community forestry where forest department and community jointly manage the forest protection activities within a joint cooperative institutional framework without any costly sanctions. Hence we assume equal effort level for both – community and government. Then there is the unique Nash equilibrium for all FPC members at which maximum sustainable yield is equated to the corresponding resource stock. This stage is called the socially optimum average effort level corresponding to the resource stock (Sethi and Somanathan, 1996, 777-8). This is shown at K_M in Figure b. If we indigenize K, the aggregate harvest per unit of time is a function

H(L, K) ……………………(4)

As renewable resources are often assumed to follow natural growth law, $H_K>0$, $H_{KK}<0$.

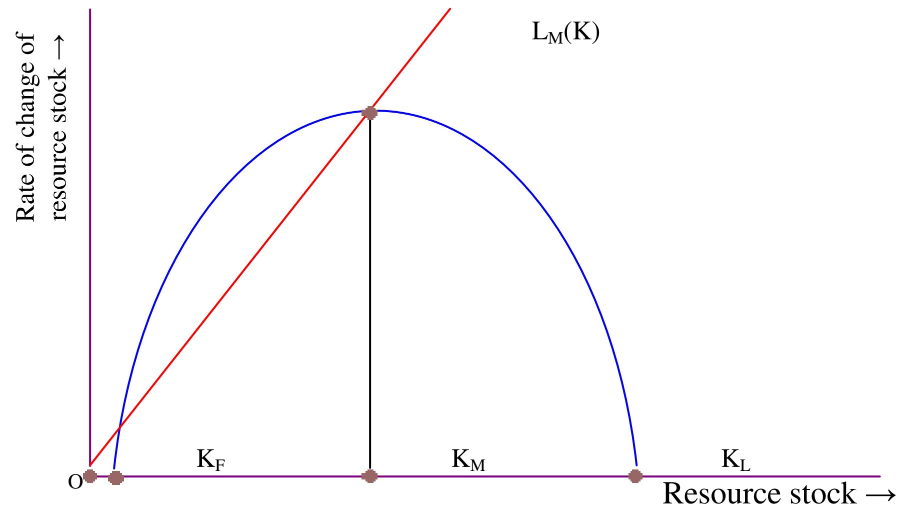

Figure b

In addition to its dependence on the harvest, the evolution of the resource stock will depend on its own natural rate of replenishment, which we represent by the differentiable function $R(K)$. There is finite carrying capacity of the resource stock (K_L in Figure b) so that $R(K)<0$ for $K>K_L$, and $R(K_L) = 0$. Let $K_F>0$ be the minimum viable stock, so that $R(K) > 0$ for $K_F<K<K_L$, and $R(K) < 0$ for $0<K<K_F$. The minimum viable stock is the level below which the resource can not recover by natural reproduction even in the absence of harvesting. Finally, let R be a unique maximum at some K_M. This is the standard specification used to characterize the dynamic of renewable resources. The growth rate of the resource stock, taking account of harvesting, is then given by

$$\dot{K} = I(K) - H(L, K) \quad \ldots\ldots\ldots\ldots\ldots(5)$$

The extraction per unit of effort is assumed constant proportion of the stock. Letting $L_M(K)$ denote the (statistically) socially optimum average effort level and $L_N(K)$ denotes the Nash equilibrium effort level corresponding to resource stock K, it is clear that $L_M(K)=L_N(K)=0$. The stable cooperative equilibrium point of the system is the type of behaviour and levels of resource stock that we may expect to see in the long run. This is satisfied at the aggregate effort levels L and resource stock K for which $\dot{K} = 0$. For any $K_F<K<K_L$, $I(K)>0$, so by putting in enough effort the harvest can be raised high enough that it equals the rate of replenishment, thus causing $\dot{K}$ to equals zero (K_M in Figure b). The average product now depends both on aggregate extraction effort and the resource stock

$$A(L,K) = \frac{H(L,K)}{L}$$

As we assume equal effort level for each type of player – government and community – under cooperative management of forest, the payoff of each type of player will be

$$\pi_i = l_i(K)\big(A(L,K) - w\big)$$

Therefore, the aggregate payoff is

$$\sum_{i=1}^{n} \pi_i = L(K)\big(A(L,K) - w\big)$$

In this perspective it is relevant to mention that the game theoretic framework of Sethi and Somanathan (1996) shows that whenever there is a stable non-cooperative equilibrium (one in which individuals do not restrain their use with different effort level) with a positive renewable stock, then there is a cooperative equilibrium with a higher stock and that cooperative norms of behaviour is stable. The CPR model of our study also suggests that in spite of equal effort level for each type of player, cooperative equilibrium is also stable with the highest level of stock.

Let us consider a two stage game: the first stage discussed in the CPR game and the second one is the game in which individuals have the option of imposing sanctions on other agent in response to their observed extraction level. Sanctioning behaviour is costly not only for the punished, but also for the punisher (Sethi and Somanathan, 1996:771). But such a sanctioning behaviour is unimportant in our empirical study. Hence at K_M, there is unique sub-game perfect equilibrium in which all agents choose L_N effort level and no agent sanctions any other. Hirshleifer and Rasmusen (1989) show that cooperation can be sustained in sub-game perfect equilibrium in a finitely repeated prisoners' dilemma with rationing. Ostrom et al.(1992) show that even in clearing specified finite horizon games designed to extract commons, high level cooperation can be sustained if the possibility of pre-game communication is present, with or without the possibility of costly sanctions. It seems to be relevant to mention that despite without the possibility of costly sanctions against the violators (poor forest fringe communities) of extracting illegal forest products, forest resources in south West Bengal including our study area was resuscitated and restored to productivity with great improvement in quality and density as a result of participatory and JFM activities compared with before JFM situation (SFR, 2000:47).

Notes

1) Farm income implies earnings from sales of field crops including fruit crops. Self-employment includes non-forest based business like resale of agricultural commodities, tailor, money lending, sales of fish, grocery sales, public transport operation, radio and bike repair, tinsmith, and stone breaking. Wage work includes non-forest off-farm employment like contract agricultural labour, forestry officer, teacher, mechanic, watchman, and village headperson. Sales assets consider sales of livestock and poultry, property rental, and sales of personal and household items. Transfers include remittance from household residents, gifts from relatives, and loans.
2) We take all samples for our study from Bankura district only since almost all female FPCs in West Bengal are operating in Bankura district, being extended to all three forest divisions – Bankura (north), Bankura (south), and Panchet S C – of the district. As this paper has been prepared based on PhD research work entitled **'Women's Dependence on Forest and Participation in Forestry: *A Case Study of Joint Forest Management Programme in West Bengal*'**, we consider all samples from Bankura district in south West Bengal where the vast tract of forest land containing mainly the sal were overexploited and degraded before JFM situation. After JFM the forest land under our study have been resuscitated and restored to productivity with great improvement in quality and density.
3) It is worth mentioning that forest officials usually take the primary initiative (during 1988-89) for the establishment of both joint FPC and female FPCs in this area. They first speak to the local forest communities, local *panchayet* bodies about the utility of the establishment of FPC under JFM programme. Later, local forest communities and local panchayet respond to it.
4) In the irrigated area households possessing cultivable land between 0.01 and 2.49 acres are treated as marginal farmer households, between 2.50 and 4.99 acres, as small farmer households, while in the unirrigated area, this is twice the area of their irrigated lands.
5) Poverty line income in rural West Bengal on the basis of PCME (per capita monthly expenditure) by NSS of 55th round (1999-00) is Rs. 350.17. Based on the CPIAL (Consumer Price Index of Agricultural Labour [General]) per capita monthly expenditure for the year 2005-06, the poverty line income for the year 2005-06 is calculated as Rs. 393 approximately.
6) Indian Labour Journal (1991, Vol. 32, No. 4: p. 662) provides the Consumer Price Index Number of Agriculture Labour (General) for rural West Bengal on and from 1990-91 to 1995-96, the base year being 1960-61. Similarly, Indian Labour Journal (2005, Vol. 46, No. 12: p. 1225) provides the same for rural West Bengal on and from 1995-96 to 2005-06 with 1986-87 as base year. We then shift the base year of 1960-61 to 1986-87 for all the years from 1990-91 to 2005-06. Again we shift the base year from 1986-87 to 2005-06 and calculate the CPIAL from 1990-91 to 2005-06.

7) Never did the respondents say that their source of income was illegal; rather, while examining the answer from the respondents regarding their break-up of their source of income, the distinction between legal and illegal source was clearly demarcated.
8) It might be a game of complete information because each player's payoff function (the function that determines the player's payoff from the combination of action chosen by the players) is common knowledge among all the players (Gibbons, 1992: 2).
9) SRP is no longer strictly dominated by CP, because both strategies provide same payoff (Re 1) to the government if community adopts a FP strategy, but strictly higher payoff to government if community adopts CP.

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Table 1: Some Basic Characteristics of the Sample FPC/Village Households

Division	FPC/Village	No. of HH	Average size of HH	% of HH live below poverty line*	Size of forest land (ha.) protected under JFMP	Status of agricultural land holding**			Sex of FPC member	% of HH belongs to SC [ST] category	% of illiterate FPC member
						Land less	Marginal	Small	Female {Male}		
1	2	3	4	5	6	7	8	9	10	11	12
Bankura North	Agua	23	4.52	100	13.75	19	4	0	23{0}	100 [0]	95.24
	Belboni	44	4.95	100	70	41	3	0	2{42}	100 [0]	86.36
Bankura South	Malibona	41	4.97	95.12	70	4	35	2	41{0}	9.75[90.25]	51.22
	Baragari	45	5.44	77.78	70	3	32	10	2{43}	2.22 [8.89]	33.33
Panchayet S C	Brindabanpur	56	4.80	80.36	56	29	16	11	56{0}	100 [0]	77.50
	Katul-2	93	5.08	84.95	180	33	46	14	3{90}	100 [0]	42.63

* Poverty line in year 2005-06 is per capita expenditure of Rs. 393 /-

** Holding of agricultural land from 0.01 to 2.50 acres are treated as marginal, from 2.51 to 5.00 acres as small. For unirrigated land these would be doubled.

Table 2: Annual Net Real Income (in Rs.) from All Sources of Sample Households*

FPC/ Village	Category of house-holds	Present						Before						% change		
		Net return from forest sources	CV	Net return from non-forest sources	CV	Net return from all sources	CV	Net return from forest sources	CV	Net return from non-forest sources	CV	Net return from all sources	CV	Net return from forest sources	Net return from non-forest source	Net return from all sources
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Agua	Landless	327825.8 (86.14)	0.29	52747.4 (13.86)	1.48	380573.2 (100.00)	1.08	173018.4 (64.36)	0.36	95810.6 (35.64)	3.42	268829.0 (100.00)	2.11	89.47	- 44.95	41.56
	Marginal	65496.0 (85.06)	0.38	11503.8 (14.94)	1.59	76999.80 (100.00)	1.19	42175.6 (67.87)	0.48	19964.2 (32.13)	3.96	62139.8 (100.00)	2.49	55.29	- 42.38	38.04

Belboni	Landless	766193.2 (87.66)	0.24	107857.9 (12.34)	1.16	874051.1 (100.00)	1.01	430512.0 (63.92)	0.33	243004.9 (36.08)	3.09	673516.9 (100.00)	1.90	77.97	- 55.61	29.77
	Marginal	53202.7 (85.84)	0.30	8776.2 (14.16)	1.31	61978.9 (100.00)	1.12	31508.2 (64.89)	0.44	17048.2 (35.11)	3.48	48556.4 (100.00)	2.21	68.85	- 48.52	27.64
Malibona	Landless	76308.4 (89.62)	0.32	8838.2 (10.38)	1.86	85146.6 (100.00)	1.30	44898.8 (65.12)	0.38	24049.1 (34.88)	3.57	68947.9 (100.00)	2.20	69.96	- 63.25	23.49
	Marginal	681299.2 (88.18)	0.41	91324.0 (11.82)	1.92	772623.2 (100.00)	1.39	425916.3 (64.88)	0.51	230551.6 (35.12)	3.95	656467.9 (100.00)	2.53	59.96	- 60.39	17.69
	Small	37745.8 (86.20)	0.83	6042.8 (13.80)	2.21	43788.60 (100.00)	1.96	26510.9 (78.51)	1.25	7256.4 (21.49)	4.12	33767.3 (100.00)	3.36	42.38	- 16.72	29.68
Baragari	Landless	51154.2 (72.16)	0.39	19735.8 (27.84)	1.66	70890.00 (100.00)	1.27	38831.5 (64.11)	0.62	21738.6 (35.89)	3.75	60570.1 (100.00)	2.54	31.73	- 9.21	17.04
	Marginal	574257.2 (70.75)	0.58	237413.8 (29.25)	2.12	811671.0 (100.00)	1.69	460344.3 (64.00)	0.99	258943.6 (36.00)	3.92	719287.9 (100.00)	3.02	24.74	- 8.31	12.84
	Small	133182.4 (56.06)	0.98	104388.8 (43.94)	2.57	237571.2 (100.00)	2.31	140987.2 (61.56)	1.67	88036.8 (38.44)	4.26	229024.0 (100.00)	3.85	- 5.53	- 18.60	3.73
Brindabanpur	Landless	574140.6 (81.24)	0.35	132581.0 (18.76)	1.75	706721.6 (100.00)	1.25	360161.6 (62.10)	0.41	219808.8 (37.90)	3.41	579970.4 (100.00)	2.17	59.41	- 39.68	21.85
	Marginal	298869.9 (80.91)	0.44	70515.7 (19.09)	1.99	369385.6 (100.00)	1.48	214342.2 (66.40)	0.83	108461.4 (33.60)	3.68	322803.6 (100.00)	2.71	43.42	- 34.98	14.43
	Small	166586.3 (79.83)	0.76	42090.1 (20.17)	2.57	208676.4 (100.00)	2.09	116871.0 (70.58)	1.08	48718.5 (29.42)	3.89	165589.5 (100.00)	3.09	42.54	- 13.60	26.02
Katul-2	Landless	651273.6 (83.12)	0.36	132260.6 (16.88)	1.82	783534.2 (100.00)	1.31	374660.7 (63.23)	0.59	217875.5 (36.77)	3.50	592536.2 (100.00)	2.40	73.83	- 39.29	32.23
	Marginal	846732.2 (82.55)	0.51	178988.2 (17.45)	2.04	1025720.4 (100.00)	1.56	519358.3 (65.25)	0.92	276542.3 (34.75)	3.82	795900.6 (100.00)	2.88	63.03	- 35.28	28.87
	Small	295158.8 (80.72)	0.85	70498.8 (19.28)	2.55	365657.6 (100.00)	2.18	211210.5 (72.20)	1.14	81344.8 (27.80)	4.01	292553.3 (100.00)	3.20	39.75	- 13.33	24.99

*The real income is determined after deflating the money income by cost of living index (general) of agricultural labour. We consider 2005-06 as the base year.

CV = coefficient of variation.

Table 3: Annual Net Real Income Share (in percentage) by Sources of Sample Households

FPC/Village	Category of households	Net return from forest sources				Net return from non-forest sources			% change					
		NTFPs	Forestry wage	TFPs[a]		Farm[b]	Non-forest wage[c]	Others[d]	Net return from forest sources			Net return from non-forest sources		
				Total	Illegal				NTFPs	Forestry wage	TFPs	Farm	Non-forest wage	Others
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agua	Landless	58.68 (19.67)	14.52 (8.24)	11.86 (36.45)	11.67 (36.45)	0.00 (0.00)	8.59 (25.35)	5.27 (10.29)	198.32	76.21	- 64.50 [- 67.98]	-	- 66.11	- 48.79
	Marginal	58.92 (22.73)	13.97 (8.27)	11.17 (36.87)	10.86 (36.87)	5.08 (5.99)	4.31 (14.21)	5.55 (11.93)	159.21	68.92	-66.99 [- 70.57]	- 15.19	- 69.67	- 53.48
Belboni	Landless	53.56 (15.75)	15.35 (7.50)	17.32 (40.67)	17.18 (40.67)	0.00 (0.00)	8.83 (26.64)	3.51 (9.44)	240.19	104.67	- 53.91 [- 57.76]	-	- 66.85	- 62.82
	Marginal	54.54 (14.45)	13.34 (8.18)	16.96 (42.26)	16.34 (42.26)	4.72 (5.17)	4.55 (18.78)	4.89 (11.16)	277.47	63.08	- 57.51 [- 61.33]	- 8.70	- 75.77	- 56.18
Malibona	Landless	53.61 (19.46)	16.34 (10.36)	18.46 (35.30)	18.58 (35.30)	0.00 (0.00)	6.80 (23.62)	3.58 (11.26)	175.47	57.72	- 44.27 [- 47.37]	-	- 71.21	- 68.21
	Marginal	55.93 (19.61)	14.17 (10.41)	17.68 (34.86)	17.03 (34.86)	4.58 (4.90)	2.40 (16.45)	4.84 (13.77)	185.19	36.12	- 48.12 [- 51.15]	- 6.53	- 85.41	- 64.85
	Small	59.79 (38.14)	11.62 (7.75)	14.79 (32.62)	13.73 (32.62)	7.35 (7.62)	0.00 (0.00)	6.45 (13.87)	56.76	49.94	- 54.66 [- 57.92]	- 3.54	-	- 53.50
Baragari	Landless	17.55 (14.46)	8.61 (6.64)	45.99 (43.01)	44.85 (43.01)	0.00 (0.00)	18.44 (22.45)	9.40 (13.44)	21.39	29.67	6.94 [4.28]	-	- 17.86	- 30.06
	Marginal	18.36 (17.07)	8.51 (5.87)	43.17 (41.06)	42.81 (41.06)	3.88 (4.05)	15.50 (18.20)	9.87 (13.75)	7.57	44.97	6.86 [4.26]	- 4.20	- 14.84	- 28.22
	Small	19.45 (20.44)	4.77 (3.15)	31.84 (37.97)	30.70 (37.97)	19.48 (17.55)	0.00 (0.00)	24.46 (20.89)	- 4.84	51.43	- 16.14 [- 19.15]	11.00	-	- 17.09
Brindabanpur	Landless	57.77 (34.85)	17.61 (8.16)	4.09 (19.09)	3.51 (19.09)	0.00 (0.00)	10.30 (22.15)	8.46 (15.75)	65.76	115.81	- 69.30 [- 81.61]	-	- 53.50	- 46.29
	Marginal	58.89 (41.36)	17.24 (8.08)	3.41 (16.96)	2.30 (16.96)	6.32 (7.56)	4.07 (9.86)	8.70 (16.18)	42.38	113.37	- 71.80 [- 86.44]	- 16.4	-58.72	- 46.23
	Small	64.62 (48.39)	12.05 (6.40)	3.16 (15.79)	0.14 (15.79)	10.94 (12.05)	0.00 (0.00)	9.23 (17.37)	33.54	88.28	- 79.99 [- 99.11]	- 9.21	-	- 46.86

Katul-2	Landless	52.77 (9.76)	16.47 (7.42)	12.45 (46.05)	12.75 (46.05)	0.00 (0.00)	9.60 (23.88)	7.28 (12.89)	440.73	121.97	- 69.87 [- 72.31]	-	- 59.80	- 43.52
	Marginal	54.67 (14.01)	15.80 (6.98)	11.78 (44.26)	10.88 (44.26)	6.57 (6.90)	3.25 (12.84)	7.63 (15.01)	290.23	126.36	- 72.71 [- 75.42]	- 4.78	- 74.69	- 49.17
	Small	59.90 (26.24)	11.48 (5.33)	9.34 (40.63)	8.32 (40.63)	11.06 (11.51)	0.00 (0.00)	8.22 (16.29)	128.28	115.38	- 77.01 [- 79.53]	- 3.91	-	- 49.54

Notes: 1. Figures within ( ) and [ ] represent the value during before situation of JFM programme and percentage change of illegal timber forest products respectively;

2. a) TFPs(timber forest products) include net return from two sources – share from government' timber sale and sale of illegally collected timber; b) net return from sale of farm crops including households crops; c) non-forest wage includes farm and/or non-farm labour wage other than forest wage employment; and d) others' non-forest source includes net return from self-employment(business activities like market middle man, tailor, and radio and bike repair) and net return from sale of livestock, personal and household items etc.

Table 4: Annual Net Real Income (Rs.) from Forest for BPL Categories of Households

FPC/ Village	Present net return of forest from			Before net return of forest from			% change		
	Legal sources	Illegal sources	All sources	Legal sources	Illegal sources	All sources	Legal sources	Illegal sources	All sources
1	2	3	4	5	6	7	8	9	10
Agua	281848 (71.66)	45360 (11.53)	393322 [85.96]	136594 (63.47)	78600 (36.52)	215194 [65.00]	106.34	- 42.29	82.78
Belboni	549153 (67.02)	140280 (17.12)	819396 [87.54]	273620 (59.22)	188400 (40.78)	462020 [63.98]	100.70	- 25.54	77.35
Malibona	516157 (68.13)	130200 (17.19)	757608 [88.32]	306487 (65.10)	164278 (34.90)	470765 [64.90]	68.41	- 20.77	60.93
Baragari	255426 (40.84)	268800 (42.98)	625411 [70.86]	293343 (58.76)	205833 (41.23)	499176 [64.00]	- 12.92	30.59	25.28
Brindabanpur	670515 (76.80)	26880 (3.08)	873010 [81.13]	469198 (81.67)	105306 (18.33)	574504 [63.64]	42.91	- 74.47	51.96
Katul-2	1067680 (71.27)	174720 (11.66)	1498006 [82.80]	491638 (54.99)	402381 (45.01)	894019 [64.39]	117.17	- 56.58	67.56
Total	556796 (67.13)	131040 (15.83)	827792 [82.51]	328480 (63.26)	190808 (36.74)	519288 [64.25]	69.51	- 31.32	59.41

* Figures within ( ) represent percentages out of total forest income; Figures within [ ] represent percentages of forest income out of total income.

Table 5: Variation in Price of Some Valuable NTFPs the Collectors' sell to the Agents of LAMPS

Rs. per KG
Midvalue and range+

Name of NTFPs	Collectors' price	Processing, transport and other costs	Market price	Profit *
1	2	3	4	5
Kendu leaves	20±5	13±4	52±4.50	19±4.50
Sal seeds	0.75±0.50	1.50±0.70	4.00±0.60	1.75±0.60

+ The method is suggested by Rudra (1992)
* Column 5 = [4 – (2 + 3)]

Figure 1: Payoff matrix of static game

Government's strategy →

Community's strategy ↓

	SRP	CP
FP	(2399, 1)	(2613, 1)
CP	(2570, 1)	(3723, 46650)

Figure 2: Equilibrium in dynamic game

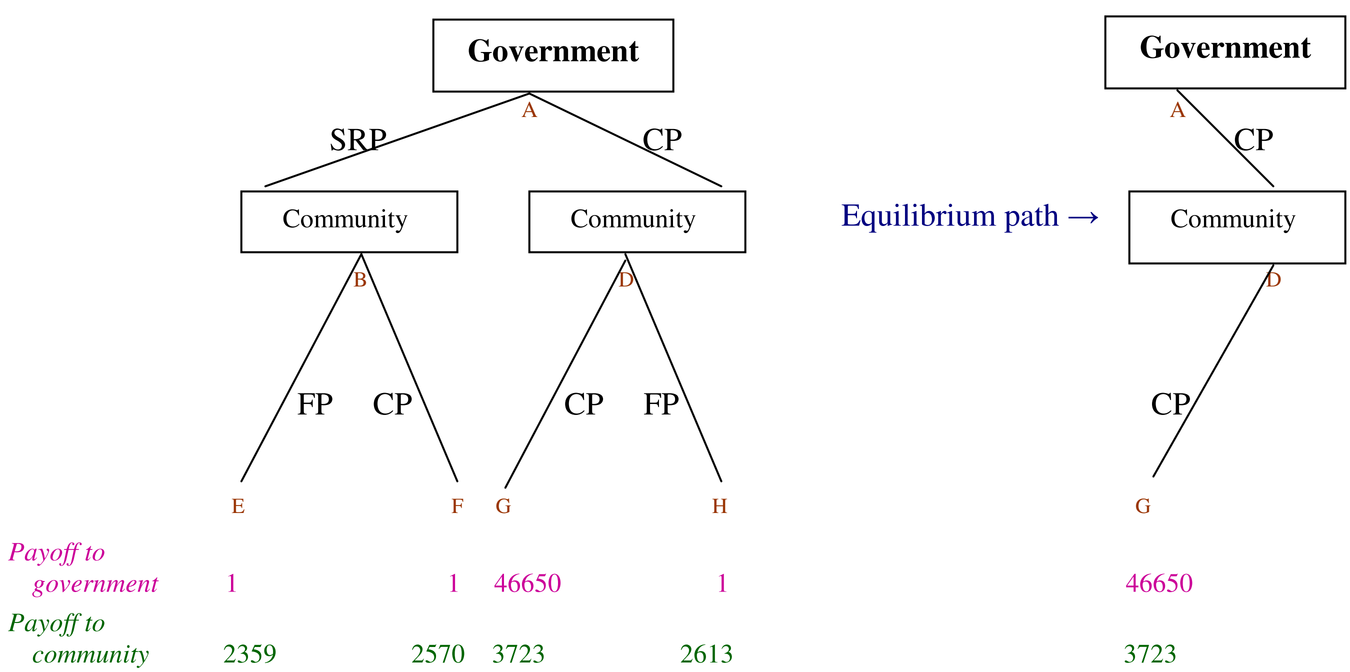
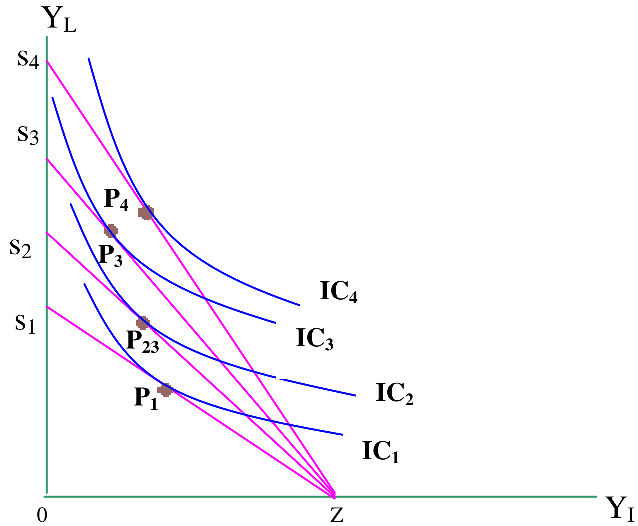


Figure 3: Legal-illegal income substitutability



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