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by

Bipasa Datta and Minquan Liu

Department of Economics and Related Studies
University of York
Heslington
York, YO10 5DD

WORK INCENTIVES IN A MODEL OF COLLECTIVE WITH AND WITHOUT UNIVERSAL MEMBERSHIP

Bipasa Datta
Department of Economics
University of York, U.K.

and

Minquan Liu
Hopkins-Nanjing Center
Nanjing University, China

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Abstract: In this paper we focus on the role of expulsion by a collective to explain the agricultural performance in China during the post-1958 period. We model the collective as having access to a costly and imperfect monitoring technology whereby it can punish members if caught shirking either through expulsion or through a reduction in pay. We show that under plausible assumptions about tastes and technology, the threat of expulsion generates greater incentives for both the collective and members to monitor and provide higher effort, respectively. Our model contrasts with the exit right hypothesis advanced by Lin (1990) where the credibility of exit threat is debatable. The threat of expulsion in our model constitutes not only a credible threat but also generates a richer set of equilibrium outcomes which better suit the reality of Chinese collective.

Keywords: Exit right, retaliatory shirking, effort monitoring, universal and non-universal membership, collectivization.

JEL Classification numbers: L23, P32

1. INTRODUCTION

Chinese agricultural collectivization began in 1953 with the formation and popularization of the agricultural cooperatives. Initially, membership was limited, and withdrawal from a cooperative by an incumbent member was possible. Also possible was a cooperative's ability to deny membership to a farmer, both in the sense of barring the farmer from joining and, if already a member, expelling him from the cooperative as a form of discipline. Cooperative or collective membership, however, quickly became universal. By the end of 1956, over 90 per cent of the Chinese farm households had joined the cooperatives. This was soon followed by the communization movement in 1958 when all farmers became collective members.

In the early years of cooperativization until 1958, Chinese agriculture experienced substantial productivity increases (Wen (1993)). The communization in 1958, however, ushered in both a period of absolute and relative agricultural stagnation. In the ensuing few years, agricultural output in absolute terms fell sharply below the 1958 peak level and did not recover that level until 1965. Relative stagnation continued after 1965 in that agricultural productivity index did not resume its trend growth witnessed up to 1958. The years 1959-62 were also the time of the great Chinese famine during which by most estimates millions of people perished.

Both the cause of the famine and of the subsequent agricultural stagnation have been a matter of controversy. Justin Lin (1990) attributes both phenomena to the removal of a farmer's right to exit from a collective, which he believes reduced work incentives. Lin's argument was based on the assumption that effort observability was impossible in a Chinese collective.

"Since effective supervision in agricultural production is too costly, the success of an agricultural collective depends inescapably on a tacit agreement of self-discipline established by the collective members. However, a self-enforcing agreement can be sustained only if the members of the collective have the right to quit the collective when the other members do not honor their agreement." (Lin 1990, p. 1249)

Lin's hypothesis has been challenged by Dong and Dow (1993). Building on Lin's assumption of non-observability of work effort, they show that Lin's result gets completely reversed if members of the collective adopt a retaliatory shirking strategy. They show that retaliation can actually be a stronger deterrent to shirking than expulsion if a member's payoff from mutual shirking is less than the payoff from private farming.[1] If so, then the removal of exit right would actually imply higher agricultural productivity, a conclusion which does not match the actual Chinese experience during the period of 1958-1962 and the stagnation that followed. Based on this, Dong and Dow concluded

> "If the elimination of exit rights is not a plausible explanation for low agricultural productivity, then we need to redirect attention toward more promising alternative hypotheses." (Dong and Dow 1993, p. 473)

In this paper, we propose the loss of incentives by the cooperative to monitor members' work effort following the period of communization as the possible cause of Chinese agricultural stagnation.[2] We argue that universal membership implies not only the removal of a member's right to exit from his or her collective, it also implies the loss of the collective's power to punish a member through expulsion if he or she is found shirking. As a result of this loss of power, the collective's incentives to carry out monitoring was greatly undermined. Our argument is based on the fact that, while perfect observability of members' work effort was not possible due to the costly nature of monitoring, it does not mean that no monitoring ever took place within a collective. In fact, most observers of the actual Chinese experience agree with the view that the collectives in China, both before and after the universalization, exerted considerable amounts of effort and resources in carrying out and experimenting with effort monitoring (see, e.g. Kung (1993), Liu (1994)).[3]

In this paper we show that, when membership is non-universal, the ability of the

[1] Similar arguments have also been given by Putterman and Skillman (1992).

[2] We do not deal with the cause of the famine. On that issue, see Kung (1993), Liu (1993), Yang (1996), Chang and Wen (1997).

collective to expel identified shirkers from the production team constituted a credible threat of punishment which provided both the collective and workers with incentives to monitor and work hard respectively.[4] This resulted in a higher level of agricultural productivity during the period when membership was non-universal. When this power to punish members through expulsion was taken away from the collective by making cooperative membership mandatory, the collective lost incentives to monitor members' effort as extensively as before. As a result, members shirked more and a marked deterioration in agricultural productivity was observed following the period of membership universalization.

We organise the paper as follows. In section 2, we introduce the model. In section 3, we determine members' effort supply and the collective's monitoring level as an equilibrium outcome of a Stackelberg game when membership is non-universal. In section 4, we do the same for the case when membership is universal. In section 5, we discuss and compare our results from sections 3 and 4 with the results of Lin (1990) and Dong and Dow (1993), and present some concluding comments.

2. THE MODEL

Consider a collective team consisting of N identical members, indexed $i = 1, 2, \ldots, N$. The team's net output q is determined by the following production function[5]

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[3]It should be noted that we by no means claim that ours is the first attempt to model monitoring in a cooperative team. In fact there are already quite a few papers on incentive effects of monitoring in the literature of cooperative firms, see, e.g. Bonin and Putterman (1993) and their references. We do however attempt to explain the reasons for agricultural stagnation in China in terms of loss of collective's incentives to monitor members' work effort due to the removal of its power to expel shirking members.

[4]The idea of using the threat of termination to induce higher work effort can also be found in Stiglitz and Weiss (1983).

[5]For the ease of comparison, our model specifications regarding production function and individuals' tastes closely follow those given in Dong and Dow (1993).

$$q = \theta \sum_i e_i - F \tag{1}$$

where e_i is the effort supplied by the ith member, θ is the production parameter known with certainty, and F is the fixed set-up cost that must be incurred in order to produce any positive amount of output.[6]

We assume each member has a quasi-linear utility function given by

$$u_i(y_i, e_i) = y_i - v(e_i) \quad i = 1,....,N \tag{2}$$

where y_i is the income of the ith member and $v(e_i)$ is the member's disutility of effort function satisfying the following: $v(0) = 0$, $v'(.) > 0$, $v''(.) > 0$. While staying within the cooperative, a member recieves an income which is directly proportional to his share of workpoints.[7] Let $w(e_i)$ denote the total workpoints earned by member i if he spends e_i units of effort. For simplicity, we assume that this workpoint rule takes a linear form: $w'(e_i) > 0$, $w''(e_i) = 0$.[8] Then income y_i earned by worker i is given as follows:

$$y_i = \frac{w(e_i)}{\sum_i w(e_i)}[\theta \sum_i e_i - F] \tag{3}$$

The collective specifies a performance standard for work effort, $\bar{e}$, for each member. We say a worker works hard if $e_i = \bar{e}$ and he shirks if $e_i < \bar{e}$. We assume that the specified effort level $\bar{e}$ is the first best level, i.e. it is the effort level when there is no monitoring and incentive problem. Specifically, $\bar{e}$ is obtained as a solution to the following problem where the effort level of each worker is perfectly and costlessly observable,

$$\max_{(e_1, e_2, ... e_N)} \sum_i [\theta e_i - v(e_i)] - F$$

where the first order conditions yield optimal effort level $e_i^* = \bar{e}$, i = 1, 2,....,N, as a solution to the following equation

[6] We later impose restrictions on the magnitude of F.

[7] Without any offense, from now on, we will consider a member being of male gender.

[8] This earning rule will be changed subsequently when we introduce monitoring.

$$\theta = v'(e_i),\ i = 1, 2, \ldots, N. \tag{4}$$

Note that this effort level $\bar{e}$ is also the solution to the following optimisation problem of a private farmer since there is no incentive problem associated with private farming

$$\max_{e_i} \ \theta e_i - v(e_i) - F.$$

However, there is a genuine incentive problem associated with the effort supply of a member within the collective: since output is shared and there are economies of scale, each worker would have a tendency to shirk and yet enjoy the benefits arising out of collective farming. We assume that a worker knows his effort level e_i but the collective is unable to observe e_i directly. However, it can monitor and can potentially observe e_i if it spends some effort on monitoring. We assume that the monitoring technology is imperfect and costly. The details of the monitoring technology are given below.

A member is caught shirking only if the collective can provide 'irrefutable' evidence' that he or she has shirked. The monitoring technology is imperfect in that it may not provide the collective with sufficient evidence for such an accusation. In the absence of such evidence, the member must be given the 'benefit of doubt' as having supplied the prescribed level of effort. We assume that (a) 'irrefutable evidence' can only be established if the member has actually shirked, and (b) if irrefutable evidence is established, it exactly reveals a member's true effort level. We assume that monitoring is undertaken (or not) with certainty. In order to observe a worker's effort supply, the collective must itself expend α units of effort on monitoring. Let π denote the probability that a worker is caught shirking, where $\pi = \pi(\bar{e} - e_i, \alpha)$ is a function of the *extent* of shirking ($\bar{e} - e_i$) and the amount of monitoring effort α expended by the collective. If a worker works hard (i.e. $\bar{e} - e_i = 0$), then he is never caught shirking, i.e. $\pi(0, \alpha) = 0$. Let the subscripts e and α denote the partials with respect to the first and second arguments. We assume that π satisfies the following properties:

1. $\pi_e(.\,,.) > 0$, $\pi_{ee} > 0$ for e $(= \bar{e} - e_i) > 0$, and $\lim_{e \to 0} \pi_e = 0$;
2. $\pi(., 0) = 0$, $\pi_\alpha > 0$, $\pi_{\alpha\alpha} < 0$ for $\alpha > 0$, $\lim_{\alpha \to \infty} \pi_\alpha = 0$, $\lim_{\alpha \to \infty} \pi(e, \alpha) = 1$ for e > 0, and

$\pi_{e\alpha} \geq 0$.

The first property implies that the probability of observing a member shirking increases with the extent of shirking in an increasing manner. The second property says that the probability of observing a worker shirking is a strictly concave function of α, and that even with a very large amount of α there is no guarantee that the worker will be caught shirking. The worker will be caught shirking with certainty (if he does actually shirk) only if α is infinitely large. We call this the case of perfect effort observability. We assume that monitoring is costly: spending α units of effort requires incurring $C(\alpha)$ units of monitoring cost measured in real terms where $C(0) = 0$, $C_\alpha > 0$, and $C_{\alpha\alpha} > 0$.[9]

The sequence of events of this effort supply and monitoring game is as follows: workers decide whether to join the collective (in the case of non-universal membership) and how much effort to supply taking other members' effort supply as given and keeping in mind that monitoring may be undertaken and the possible consequences if found shirking (to be specified below). The collective, acting as a Stackelberg leader, then decides on its level of monitoring effort taking into account the effect monitoring has on members' effort supply decisions. These decisions are then carried out. If a member is found shirking, punishment is imposed in accordance with the membership rule. Finally, output and members' income are realised.

[9]It is worth noting at this point that our specifications of monitoring technology depart from that given in the standard incentive literature and in the literature on collective farming (see Bonin and Putterman (1993) for details on this issue and the references therein). In these studies, monitoring is usually treated as a random event and it either perfectly reveals agents' true effort level or it yields an unbiased estimate of the (true) effort level the variance of which decreases as more monitoring is undertaken. In contrast, in our model monitoring is a certain event but it is imperfect in that it may not come up with irrefutable evidence to establish shirking behaviour of a member. Liu (1997) provides empirical evidence which supports our monitoring technology specifications.

3. THE CASE OF NON-UNIVERSAL MEMBERSHIP

Without universal membership, a worker is expelled if caught shirking in which case he returns to private farming and obtains utility as follows[10]

$$u^P = \theta\bar{e} - v(\bar{e}) - F. \tag{5}$$

We assume that private farming is viable, i.e. $u^P > 0$ which also implies that the magnitude of F must be such that it is strictly less than $(\theta\bar{e} - v(\bar{e}))$.

If a worker is not caught shirking then the collective gives him the 'benefit of doubt' and assigns workpoints equalling $w(\bar{e})$. Let s and u_{nc} denote respectively the share of workpoints and the utility (when not caught shirking) received by a certain member within the collective. While computing his u_{nc}, a member knows that there is a possibility that other members may shirk too and consequently some of them may be expelled, whereas those who stay with the collective will earn $w(\bar{e})$, i.e. a member expects his share of workpoints to be

$$s = w(\bar{e})/\{w(\bar{e}) + \sum_{j\neq i}(1 - \pi(\bar{e} - e_j, \alpha))w(\bar{e})\}.$$

Therefore, a member computes his u_{nc} as follows

$$u_{nc} = s[\theta e_i + \theta\sum_{j\neq i}(1 - \pi(\bar{e} - e_j, \alpha))e_j - F] - v(e_i).$$

The worker i's expected utility given that monitoring takes place then is

$$Eu_i = \pi(\bar{e} - e_i, \alpha)u^P + (1 - \pi(\bar{e} - e_i, \alpha))u_{nc}.$$

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[10]Note that we assume if a member is expelled he is able to resume production as a private farmer immediately without any cost. It may be thought that he is able to "carry" his effort supply which he has already expended with him on leaving. For example, upon leaving the collective will have to give him a share of plots, perhaps with growing crops in them, or he might have been previously put in charge of certain plots and the collective simply then gives him those plots when he leaves which enables him to resume private farming without any loss or delay. We also assume that these ensure that he is fully compensated for the effort he expended inside the collective so that the total collective output would not be complicated by the effort he expended. All members are assumed to be aware of these while making their decisions.

First, we determine the Nash equilibrium value of e_i for the members' subgame for any given $\alpha > 0$. For $\infty > \alpha > 0$, we solve for the equilibrium value of effort in a Cournot-Nash manner: each member maximises his expected utility Eu_i by choosing e_i taking all other members' effort supply as given. The best response function e_i of the ith member is obtained by solving the following first order condition

$$\pi_e(u_{nc} - u^P) = (1 - \pi(.))(v'(e_i) - s\theta) \quad \text{for } e_i > 0 \tag{6}$$

Since members are identical, the above first order condition holds for all i, implying that the Nash equilibrium value of effort supply will be identical for all members. Denote this equilibrium value of the effort supply by e_{nu}. In Nash equilibrium, the following holds.

$$\pi_e{}^N(.)(u^N{}_{nc} - u^P) = (1 - \pi^N(.))(v'(e_{nu}) - s^N\theta) \tag{7}$$

where the superscript N stands for the Nash equilibrium value and $s^N = 1/\{1 + (n - 1)(1 - \pi^N)\}$. The right hand side of (7) is the expected value of the marginal disutility net of the share of marginal product obtained from staying with the collective. The left hand side of (7) represents the (expected) extra benefit of staying with the collective brought about by the change in the probability of being caught shirking. In equilibrium, a typical member decides on e_{nu} by simply weighing the expected value of the net marginal disutility against the marginal expected value of the extra benefit.[11] Note that the sign of $(u_{nc} - u^P)$ is the same as the sign of $(v'(e_{nu}) - s\theta)$. This has an important implication. Since members will never stay with the collective if $u_{nc} < u^P$, in equilibrium it must be the case that $u_{nc} \geq u^P \Rightarrow v'(e_{nu}) \geq s\theta$, implying that members will have to supply a certain minimum level of effort if the collective is to survive. Intuitively, the benefit of collective membership stems from sharing of the fixed cost F. This sharing, however, can only be beneficial for the members if they supply at least a minimum level of effort to ensure that the collective does indeed survive. We assume that the second order condition is satisfied at the optimum, i.e.

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[11]From now on we will omit using superscripts for Nash values for notational simplicity and hope that it will not create any confusion.

$$Eu_{ee} = \pi_{ee}(u_{nc} - u^P) + (1 - \pi(.))(v''(e_{nu}) - \theta\frac{\partial s}{\partial e}) + \pi_e(v'(e_{nu}) - s\theta) - \pi_e\frac{\partial}{\partial e}(u_{nc} - u^P) < 0$$

For the rest of the analysis, the following difference will be referred to frequently

$$u_{nc} - u^P = F(1 - s) + v(\bar{e}) - v(e_{nu}) - \theta(\bar{e} - e_{nu}) \qquad (8)$$

The following derivatives will also be used frequently:

$$\frac{\partial s}{\partial e_{nu}} = -(n - 1)\pi_e/[1 + (n - 1)(1 - \pi)]^2 < 0;$$

$$\frac{\partial s}{\partial \alpha} = (n - 1)\pi_\alpha/[1 + (n - 1)(1 - \pi)]^2 > 0.$$

For the sake of comparison, consider the equilibrium value of effort supply when there is no monitoring, i.e. $\alpha = 0$. Denote the equilibrium effort supply in this case by e_0. Then e_0 is simply the solution to the equation: $v'(e_0) = \frac{\theta}{n}$. We assume, without any loss of generality, that the magnitude of F is such that $u_{nc}|_{e_0} < u^P$ holds.[12] Now, from equation (7), let $\underline{e}$ be the level of effort such that $u_{nc} = u^P \Leftrightarrow v'(\underline{e}) = s\theta$ for some value of $\alpha > 0$. The following proposition characterises workers' equilibrium choice of effort for the members' subgame for any given α, if the collective is to survive.

Proposition 1. For the case when membership is non-universal, equilibrium effort supply for the member subgame is given by $e_{nu} = \bar{e}$ if and only if $\alpha = \infty$; otherwise it satisfies $\bar{e} > e_{nu}$

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[12]The condition $u^P > u_{nc}|_{e_0}$ simply boils down to a restriction on the magnitude on F. The inequality $u^P > u_{nc}|_{e_0}$ can be written as $\theta(\bar{e} - e_0) - \{v(\bar{e}) - v(e_0)\} > F(1 - 1/n)$. Expanding $v(e_0)$ and $v'(e_0)$ around $\bar{e}$, and simplifying $\{v'(\bar{e}) - v'(e_0)\}$ as $\theta(1 - 1/n)$ using the first order conditions, the condition $u^P > u_{nc}|_{e_0}$ is satisfied whenever $\theta(\bar{e} - e_0) > 2F$ holds. Recall that the viability of private farming required $\theta\bar{e}$ to be sufficiently larger than F. If $\bar{e}$ is sufficiently large so that $\theta\bar{e} > 2F$, and n is sufficiently large so that e_0 is quite small (from $v'(e_0) = \theta/n$), then $\theta(\bar{e} - e_0) > 2F$ is easily met. Note that our condition of $u_{nc}|_{e_0} < u^P$ is to some extent similar to the assumption made by Dong and Dow (1993) that utility payoff from private farming exceeds the utility payoff from mutual shirking. In Dong and Dow, however, there is only level effort of which corresponds to the mutual shirking effort level. In contrast, in our model the extent of shirking can vary, and (as we are about to show) e_0 corresponds to the effort level where the extent of shirking is greatest. Thus our restriction of $u^P > u_{nc}|_{e_0}$ is imposed only on the utility payoff generated from the maximum shirking effort level.

$\geq \underline{e} > e_0$ for any given α, $\infty > \alpha > 0$.

Proof: If $\alpha = \infty$, any deviation from $\bar{e}$ implies that the worker is expelled. Then for a member $Eu_i|_{shirk} = u^P = \theta\bar{e} - v(\bar{e}) - F$, and $Eu_i|_{work\ hard} = u_{nc}$. 'Work hard' is then indeed sustained as a Nash equilibrium because if everybody supplies $\bar{e}$ (otherwise everybody is expelled) then $u_{nc} = \theta\bar{e} - v(\bar{e}) - F/n > u^P = \theta\bar{e} - v(\bar{e}) - F$. This of course ensures that the collective survives. Therefore, $e_{nu} = \bar{e}$ is the equilibrium effort supply if $\alpha = \infty$. To show that $e_{nu} = \bar{e}$ will be the equilibrium effort supply *only* if $\alpha = \infty$. Suppose not. Suppose it is possible to have $e_{nu} \geq \bar{e}$ also for $\infty > \alpha$ (> 0). If so, then from condition (7) and property 1 for the π function, in Cournot-Nash equilibrium, $v'(e_{nu}) = \theta/n$ must hold. However, at $\bar{e}$, $v'(\bar{e}) = \theta$. If $e_{nu} \geq \bar{e}$ is to be true, then it must be the case that $v'(e_{nu}) = \theta/n \geq \theta = v'(\bar{e})$ which is impossible to hold as $n > 1$. Therefore, it must be the case that $\bar{e} > e_{nu}$ for $\infty > \alpha$. Next, we show that $\underline{e} > e_0$ must be true. For $\infty > \alpha > 0$, $s > 1/n$. $\underline{e} > e_0$ because $v'(\underline{e}) = s\theta > \theta/n = v'(e_0)$. To show that $e_{nu} \geq \underline{e}$ is true, first note that $\underline{e}$ is obviously a possible equilibrium value of e_{nu} from (7) for ($\infty >$) $\alpha > 0$. Now, $\partial u_{nc}/\partial e_{nu} = \{\theta - v'(e_{nu}) - F(\partial s/\partial e_{nu})\} > 0$ as $\theta = v'(\bar{e}) \geq v'(e_{nu})$ and $\partial s/\partial e_{nu} < 0$. Since $\partial(u_{nc} - u^P)/\partial e_{nu} = \partial u_{nc}/\partial e_{nu} > 0$ and at $e_{nu} = \underline{e}$, $u_{nc} = u^P$, for any $e < \underline{e}$, $u_{nc} < u^P \Rightarrow$ workers will return to the private farming. By the same token, for any $e > \underline{e}$, $u_{nc} > u^P$ and members will stay with the collective. Therefore, for $\infty > \alpha > 0$, the equilibrium effort supply of members must satisfy $\bar{e} > e_{nu} \geq \underline{e} > e_0$. $\square$

Proposition 1 says that in an operating production team, even the lowest level of effort that a member can supply ($\underline{e}$) exceeds the level that is obtained with no-monitoring. If there is no monitoring, then the collective disintegrates as everybody supplies such a low level of effort generating such a low level of output that everybody then prefers to leave the collective. Thus the equilibrium level of work effort in a collective must at least be $\underline{e}$. Of course to ensure this, the collective needs to monitor with certainty. However, as the proposition illustrates, even if there is monitoring, the first best effort level $\bar{e}$ cannot be sustained as a Nash equilibrium unless α is infinitely large. In our model, the collective can observe a member's effort with certainty only when α equals ∞ (which we call the case of perfect effort observability). Thus members are willing to supply the 'full' effort only if there is monitoring with perfect effort observability.[13]

Proposition 1 only specifies the range of acceptable (Cournot-Nash) equilibrium values of effort where e_{nu} will be located, for any exogenously given value of α (> 0). To determine the Stackelberg-Nash equilibrium value of α we have to solve the collective's problem. First, however, we need to determine how e_{nu} responds to α. Given our assumptions about the technology and preference, equation (7) determines e_{nu} as a continuous function of α (and also of course of other relevant parameter values such as F, θ, etc.). Suppressing other parameters, let this functional relation be denoted by $e_{nu} = e_{nu}(\alpha)$. To find out how e_{nu} responds to the choice of α, we totally differentiate the first order condition given by (7) to obtain

$$\frac{de_{nu}}{d\alpha} = - \frac{Eu_{e\alpha}}{Eu_{ee}}$$

Now, $Eu_{ee} < 0$ by the second order condition. Therefore, $\frac{de_{nu}}{d\alpha} \geq (<)\ 0$ according as $Eu_{e\alpha} \geq (<)\ 0$ where

$$Eu_{e\alpha} = \{\pi_{e\alpha}(u_{nc} - u^{p}) - \pi_{e}F\frac{\partial s}{\partial \alpha}\} + \{\pi_{\alpha}(v'(e_{nu}) - s\theta) + (1 - \pi(.))\theta\frac{\partial s}{\partial \alpha}\} \tag{9}$$

In the above, the first term $\{\pi_{e\alpha}(u_{nc} - u^{p}) - \pi_{e}F\frac{\partial s}{\partial \alpha}\}$ captures the effect monitoring has on the marginal expected value of the additional benefit of staying with the collective and it is directly related to the 'fixed-cost effect'. Here, α has two opposing effects. On one hand, holding membership constant, a higher value of α provides members with incentives to work harder since members benefit from the saving on F. This is captured by the term $\pi_{e\alpha}(u_{nc} - u^{p})$, which is positive. On the other hand, higher α means a higher probability of a member getting expelled, implying that the remaining members will have to bear a larger portion of F which lowers their incentives to work hard. This is captured by the term $\pi_{e}F\frac{\partial s}{\partial \alpha}$. The second

[13] Although ex ante this is a possibility, we show shortly that it cannot be a Stackelberg equilibrium unless monitoring is costless.

term $\{\pi_\alpha(v'(e_{nu}) - s\theta) + (1 - \pi(.))\theta\frac{\partial s}{\partial\alpha}\}$ captures the effect monitoring has on a member's net expected marginal disutility of effort (recall from equation (7) that the net marginal disutility of effort is $(1 - \pi(.))(v'(e_{nu}) - s\theta)$). Here, α has two effects which reinforce one another. The first part, $\{\pi_\alpha(v'(e_{nu}) - s\theta)\}$, captures the additional benefits obtained due to a fall in the expected net marginal disutility when the probability π is increased. The second part $\{(1 - \pi(.))\theta\frac{\partial s}{\partial\alpha}\}$ shows how a higher probability of observing a member shirking increases members' share of workpoints as, with a higher π, there will be fewer members remaining within the collective. $Eu_{e\alpha}$ is unambiguously positive either (i) if the *net* incentive effects of the saving on the fixed cost is positive (i.e. $\pi_{e\alpha}(u_{nc} - u^P)$ dominates $\pi_e F\frac{\partial s}{\partial\alpha}$), or if not, then (ii) as long the 'net disutility' effect dominates the negative net fixed cost effect.

At this point, without further specifications of functional forms and restrictions on relevent parameter values, we are unable to say whether $e_{nu}(\alpha)$ will be a monotonically increasing function of α. However, in the analysis to follow we show that for a meaningful solution to exist for the overall effort supply and monitoring game, it is necessary to have $de_{nu}/d\alpha$ to be strictly positive. Thus, even if e_{nu} is not monotonically increasing in α, a non-trivial solution to the collective's problem can exist as long as e_{nu} increases in α at least locally.

The collective maximises the net social surplus S by choosing α subject to the participation constraint for each member and taking into account the equilibrium effort response funtion of the member, where S is defined to be the sum of all members' expected utilities who stay within the collective less monitoring costs. With identical members, the collective's problem is formally written as follows[14]

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[14]In the following formulation we include utilities of all members who have joined the collective. One could argue why would the collective care about those members who are to be sacked? Noting that monitoring is yet to be undertaken and all members face the same prospect of being dismissed, ex ante the collective must consider all members even though some of them may be sacked ex post.

$$\underset{\alpha}{max}\ S = nEu - C(\alpha) \text{ subject to } Eu \geq u^P$$

where Eu is the equilibrium value of a member's expected utility. The participation constraint for a member reduces to $u_{nc} \geq u^P$ after simplification. We argue that for a meaningful solution this constraint can not bind: if $u_{nc} = u^P$ then the workers are no better-off staying within the collective while the collective incurs monitoring costs equalling $c(\underline{\alpha})$ where $\underline{\alpha} > 0$ is the level of monitoring required to induce $\underline{e}$. This solution cannot be social surplus maximising as the collective can then always stop monitoring and let workers return to private farming. Therefore, in equilibrium, the participation constraint cannot bind.

Solving the collective's problem as an unconstrained maximisation problem, we obtain the following first order condition for the Stackelberg equilibrium:

$$\Big\{(1 - \pi)\{\theta - v'(e_{nu}) - F\frac{\partial s}{\partial e_{nu}}\} + \pi_e(u_{nc} - u^P)\Big\}\frac{de_{nu}}{d\alpha} + \Big\{(1 - \pi)\frac{\partial u_{nc}}{\partial \alpha} - \pi_\alpha(u_{nc} - u^P)\Big\} \leq C_\alpha/n \quad \text{for } \alpha \geq 0.$$

Since $\frac{\partial u_{nc}}{\partial \alpha} = - F\frac{\partial s}{\partial \alpha}$, rewriting we obtain

$$\Big\{(1 - \pi)\{\theta - v'(e_{nu}) - F\frac{\partial s}{\partial e_{nu}}\} + \pi_e(u_{nc} - u^P)\Big\}\frac{de_{nu}}{d\alpha} \leq C_\alpha/n + \Big\{(1- \pi)F\frac{\partial s}{\partial \alpha} + \pi_\alpha(u_{nc} - u^P)\Big\} \quad \text{for } \alpha \geq 0. \tag{11}$$

The right hand side represents the social marginal cost of monitoring: C_α/n is the per member marginal cost of monitoring and $\Big\{(1- \pi)F\frac{\partial s}{\partial \alpha} + \pi_\alpha(u_{nc} - u^P)\Big\}$ is the reduction in the net expected utility of a member (if he stays within the collective) due to a unit increase in α and therefore constitutes a cost for the member. The left hand side represents the social marginal benefit of monitoring: the coefficient of $de_{nu}/d\alpha$ is strictly positive and it measures the change in net expected utility brought about by α via e_{nu}.

To have a non-trivial Stackelberg-Nash equilibrium where the collective's existence is guaranteed (recall proposition 1), the equilibrium value of α must be positive so that equation (11) holds with strict equality. A necessary condition for that to hold is that $de_{nu}/d\alpha$ must be strictly positive: members can reap benefits from staying with the collective only if monitoring and the threat of subsequent punishment can increase workers' effort level and thereby increase their net expected utility. If $de_{nu}/d\alpha$ is non-positive, then of course there is a trivial equilibrium where $\alpha = 0$, and members supply e_0. However, this immediately makes the collective collapse as u_{nc} then is strictly less than u^P. We assume that the relevant functional forms and parameter specifications are such that e_{nu} is increasing in α at least over some finite values of α so that corresponding to a certain value of α, e_{nu} is uniquely determined from the function $e_{nu}(\alpha)$, and vice versa.[15] Recall that $\underset{\sim}{\alpha}$ is the level of monitoring required to induce $\underset{\sim}{e}$ (i.e. when $u_{nc}|_{\underset{\sim}{e}} = u^P$ holds). Denoting the Stackelberg-Nash equilibrium values by $e^s{}_{nu}$ and $\alpha^s{}_{nu}$ for the entire effort supply-monitoring game when the collective survives, the following proposition characterises the range of possible equilibrium values that the pair $e^s{}_{nu}$ and $\alpha^s{}_{nu}$ can take.

Proposition 2. For the case when membership is not universal, the non-trivial Stackelberg-Nash equilibrium for the effort supply and monitoring game is a pair of strategies $\{e^s{}_{nu}, \alpha^s{}_{nu}\}$ where $\alpha^s{}_{nu}$ is a solution to the equation (11) such that $\infty > \alpha^s{}_{nu} > \underset{\sim}{\alpha}$ (> 0), and $e^s{}_{nu}$ is determined from the function $e_{nu}(\alpha)$ such that $\bar{e} > e^s{}_{nu} > \underset{\sim}{e}$ ($> e_0$).

Proof: Given that $C(\alpha)$ is a strictly convex function of α, if $\alpha^s{}_{nu} = \infty$ then equation (11) cannot hold with equality. Hence $\alpha^s{}_{nu} = \infty$ cannot be a possible equilibrium value. Therefore, a non-trivial Stackelberg equilibrium where $\alpha^s{}_{nu} > 0$, can be obtained only if $\infty > \alpha^s{}_{nu}$. Hence by proposition 1, $\bar{e} > e^s{}_{nu}$. The fact that in a meaningful equilibrium the participation constraint cannot bind (by the arguments given on page 13), implies $e^s{}_{nu} > \underset{\sim}{e}$. Given $e_{nu}(\alpha)$, it then follows that $\alpha^s{}_{nu} > \underset{\sim}{\alpha}$ for $de_{nu}/d\alpha > 0$. Therefore, the Stackelberg-Nash equilibrium strategy pair satisfies $\infty > \alpha^s{}_{nu} > \underset{\sim}{\alpha}$ and $\bar{e} > e^s{}_{nu} > \underset{\sim}{e}$. □

Proposition 1 only gave the range of possible equilibrium values for e_{nu} for any given

[15]Even if the function $e_{nu}(\alpha)$ is not monotonically increasing in α, maximisation of social surplus implies that only the lowest value of α will be chosen from the segment over which $de_{nu}/d\alpha > 0$. If so, then corresponding to a given value of α, e_{nu} can be determined uniquely from the function $e_{nu}(\alpha)$.

α. Proposition 2 now specifies the set of possible equilibrium values from which the Stackelberg-Nash strategy pair $\{e^{s}{}_{nu}, \alpha^{s}{}_{nu}\}$ will be selected. The proposition illustrates that with non-universal membership, expulsion from the collective being a credible and powerful threat[16], both the collective and members have incentives to monitor and supply effort at sufficiently high levels such that the existence of the collective is ensured; although the first best effort level can still not be induced due to the costly and imperfect nature of the monitoring technology. Lin (1990) noted that the "collapse of some collectives is like a safety valve for the collectivization movement" (Lin 1990, p. 1429). He, however, attributed that phenomenon to members' having the exit right as it would make the potential violators recognise the fact that honouring non-shirking agreement is to their best interest. In our model, this 'safety valve' feature comes from the collective's having the ability to sack the identified shirkers as it makes members recognise that reducing the extent of shirking is to their advantage.

In the following section, we demonstrate when the collective loses its power to expel members when they are found shirking, it weakens its incentives to monitor extensively, and hence members lose their incentives to work sufficiently hard.

4. THE CASE OF UNIVERSAL MEMBERSHIP

Universal membership implies lack of a collective's power to expel a member when he is caught shirking. In this case if a worker is caught shirking he gets workpoints in accordance with the amount of effort he actually supplied. Thus with universal membership, the maximum punishment that a worker bears is the amount of foregone workpoints he could otherwise earn. As in the previous case, while computing his workpoints the worker knows that others may shirk too and lose their workpoints. Let s_{nd} and s_d denote the shares of workpoints

[16] With effort observability, punishment through expulsion is a credible threat as the collective can credibly commit itself to expel a member from the production team if (s)he is found shirking. Also see our discussion of section 5 for further details on this issue.

a member expects to earn in the events of being not detected and detected shirking respectively. As before, a worker who is not caught shirking gets the benefit of the doubt and earns $w(\bar{e})$ while if caught he earns workpoints according to the effort he actually supplied. Therefore

$$s_{nd} = w(\bar{e})/\{w(\bar{e}) + \sum_{j \neq i}[\pi(\bar{e} - e_j, \alpha)w(e_j) + (1 - \pi(.))w(\bar{e})]\}, \text{ and}$$

$$s_d = w(e_i)/\{w(e_i) + \sum_{j \neq i}[\pi(\bar{e} - e_j, \alpha)w(e_j) + (1 - \pi(.))w(\bar{e})]\}.$$

The worker's expected utility given that monitoring takes place is

$$Eu_i = \pi(\bar{e} - e_i, \alpha)[s_d q - v(e_i)] + (1 - \pi(\bar{e} - e_i, \alpha))[s_{nd} q - v(e_i)].$$

where q is the total income generated within the collective as given by equation (1). Once again, member i chooses his effort supply taking all other members' effort supply and α as given. Note that in the member's optimisation problem although s_{nd} is still parametric, s_d no longer is. For $\alpha > 0$, the best response function of the ith member is then obtained from the first order condition which takes the following form after simplification

$$\pi_e[(s_{nd} - s_d)q] + \pi(.)s_d' q + (1 - \pi(.))s_{nd}\theta + \pi(.)s_d\theta = v'(e_i) \tag{12}$$

In equation (12), it can be easily checked that for the ith member $(s_{nd} - s_d) > 0$ and $s_d' = \partial s_d/\partial e_i > 0$. Denote the Cournot-Nash equilibrium value of the effort supply in the case of universal membership by e_u. Then equation (13) holds in Cournot-Nash equilibrium. [17]

$$q\{\pi_e(s_{nd} - s_d) + \pi s'_d\} + \theta\{(1 - \pi(.))s_{nd} + \pi(.)s_d\} = v'(e_u) \tag{13}$$

where

$$s_{nd} = w(\bar{e})/\{w(\bar{e}) + (n - 1)[(1 - \pi)w(\bar{e}) + \pi w(e_u)]\};$$

$$s_d = w(e_u)/\{w(e_u) + (n - 1)[(1 - \pi)w(\bar{e}) + \pi w(e_u)]\}$$

are the equilibrium values of s_{nd} and s_d respectively, and $q = (n\theta e_u - F)$ in equilibrium. The right hand side of (13) is the marginal disutility of effort while the left hand side is the change in worker's income brought about by a unit change in effort. This marginal income consists of

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[17] Henceforth 'primes' will denote the partials with respect to e_u.

two parts. The first part $q\{\pi_e(s_{nd} - s_d) + \pi s'_d\}$ captures the effect e has on the share of workpoints (it again consists of two terms: the first term shows how the net share of workpoints is affected when the probability of detection changes while the second term shows the change in s_d itself holding π constant). The second part $\theta\{(1 - \pi(.))s_{nd} + \pi(.)s_d\}$ is the value of marginal product evaluated at the expected share of workpoints. A typical member decides on e by weighing the marginal benefit of effort with its marginal disutility. We assume that the second order condition for the member's optimisation problem is satisfied i.e. $Eu_{ee}<0$.

Recalling from section 3 that e_0 is the level of effort when there is no monitoring, we characterise equilibrium effort supply for the members' subgame in proposition 3 for a given α.

***Proposition* 3.** For the case when membership is universal, equilibrium effort supply for the member subgame is given by $\bar{e} > e_u \geq e_0$ for any given α, $\infty \geq \alpha \geq 0$.

Proof. If $\alpha = \infty$, then $Eu_i = \frac{w(e_i)}{\Sigma w(e_i)}q - v(e_i)$. Without any loss of generality, assuming $w(e_i) = e_i$, the first order condition then yields: $(1 - \frac{e_i}{\Sigma e_i})\frac{q}{\Sigma e_i} + \frac{e_i}{\Sigma e_i}\theta = v'(e_i)$. Thus, the marginal income is the weighted average of the average and marginal net product. Since the average product $(\theta\Sigma e_i - F)/\Sigma e_i <$ marginal product θ, therefore the left hand side $(= v'(e_i)) < \theta = v'(\bar{e})$ implying that the member will supply an effort level lower than the first best level at $\alpha = \infty$.[18] Since it is true for all members, therefore in equilibrium $e_u < \bar{e}$. If $\infty > \alpha$, then also $e_u < \bar{e}$, because if not, then equation (13) yields $v'(e_u) = \theta s_{nd}$ and $s_{nd} = 1/n$ in equilibrium if $e_u = \bar{e}$ is to be true, which is impossible to hold as $n > 1$. If $\alpha = 0$, then $\pi(. , 0) = 0$ and hence $e_u = e_0$. For $\infty > \alpha > 0$, e_u is obtained from equation (13) and can take any value between $\bar{e}$ and e_0. Therefore, the equilibrium effort supply of members satisfy $\bar{e} > e_u \geq e_0$ for any α, $\infty \geq \alpha \geq 0$. □

Proposition 3 says that even when the collective monitors with infinite intensity so

[18] This contrasts with the well-known 'over-allocation' result of Sen (1966) where a different production technology was used such that marginal product of labour first lies above and then falls below the average product, to generate the over-allocation result.

that it perfectly observes members' work effort, members still do not supply effort at the first best level. With universal membership, the collective is unable to punish members through expulsion when they are detected shirking. Thus, even if there is perfect effort observability ($\alpha = \infty$), members do not have incentives to supply $\bar{e}$.

Proposition 3 specifies the set of possible values which e_u can take for any exogenously given value of α. However, to determine the precise relationship between e_u and α required for solving the Stackelberg game, we need to find out how e_u responds to α. From equation (13), e_u emerges as a continuous function of α and other parameters values. Suppressing other parameter values, denote this function by $e_u(\alpha)$. Total differentiation of the first order condition given by equation (13) then yields $\frac{de_u}{d\alpha} = -\frac{Eu_{e\alpha}}{Eu_{ee}}$. Since $Eu_{ee} < 0$ by the second order condition for the optimisation, sign of $\frac{de_u}{d\alpha}$ = sign of $Eu_{e\alpha}$ where

$$Eu_{e\alpha} = \pi_{e\alpha}q(s_{nd} - s_d) + \pi_e q\{\frac{\partial s_{nd}}{\partial \alpha} - \frac{\partial s_d}{\partial \alpha}\} + \pi_\alpha\{s_d{}'q - \theta(s_{nd} - s_d)\} + \pi\{q\frac{\partial s'_d}{\partial \alpha} + \theta\frac{\partial s_d}{\partial \alpha}\} + (1 - \pi)\theta\frac{\partial s_{nd}}{\partial \alpha}. \tag{14}$$

In the appendix we show that $Eu_{e\alpha} > 0$. Hence $\frac{de_u}{d\alpha} > 0$. Thus in the universal membership case, members always respond positively to the collective's monitoring strategies.[19]

As in the non-universal membership case, the collective acting as a Stackelberg leader maximises the net social surplus S by choosing α and taking into account the effort response function of members. However, in contrary to the previous case, with universal membership the collective no longer needs to take into account participation constraints of members even in the ex ante sense, i.e. the collective solves the following problem:

$$\max_{\alpha} S = nEu - C(\alpha)$$

where Eu is the (Cournot-Nash) equilibrium value of a member's expected utility. The first order condition to the collective's problem is given by

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[19]This along with proposition 3 imply that e_u must be a concave function of α which approaches $\bar{e}$ only asymptotically.

$$\Big\{n\theta[\pi s_d + (1 - \pi)s_{nd}] + \pi_e(s_{nd} - s_d)q + q[\pi s_d' + (1 - \pi)s'_{nd}] - v'(e_u)\Big\}\frac{de_u}{d\alpha} +$$

$$q\{\pi\frac{\partial s_d}{\partial\alpha} + (1 - \pi)\frac{\partial s_{nd}}{\partial\alpha}\} - q\pi_\alpha(s_{nd} - s_d) \ \leq C_\alpha/n \qquad \text{for } \alpha \geq 0.$$

Substituting for $v'(e_u)$ from the members' first order condition (equation 13), the above can be simplified as follows

$$\Big\{(n - 1)\theta[\pi s_d + (1 - \pi)s_{nd}] + (1 - \pi)qs'_{nd}\Big\}\frac{de_u}{d\alpha} + q\Big\{\pi\frac{\partial s_d}{\partial\alpha} + (1 - \pi)\frac{\partial s_{nd}}{\partial\alpha} - \pi_\alpha(s_{nd} - s_d)\Big\}$$
$$\leq C_\alpha/n \qquad \text{for } \alpha \geq 0. \tag{15}$$

In the above equation, the coefficient of $de_u/d\alpha$ in the first term (call it coefficient 1) captures the effect monitoring has on a member's income via e_u; and the coefficient of q in the second term (call it coefficient 2) captures how monitoring affects a member's workpoint share directly by affecting the probability of detection. We observe that both these coefficients can be ambiguous in sign. In coefficient 1, the term $(n - 1)\theta[\pi s_d + (1 - \pi)s_{nd}]$ gives a member's expected share of other (n - 1) members' marginal product and is strictly positive; while the term $(1 - \pi)qs'_{nd}$ measures the decrease in his expected income due to an increase in those (n - 1) members' share of q and is strictly negative (since $s'_{nd} = -(n-1)w(\bar{e})[\pi_e\{w(\bar{e}) - w(e_u)\} + \pi w'(e_u)]/\{w(\bar{e}) + (n - 1)[(1 - \pi)w(\bar{e}) + \pi w(e_u)]\}^2 < 0$: an increase in the equilibrium level of effort by other members reduces this member's relative share of workpoints when not detected). Therefore, coefficient 1 can have a negative sign if the decline in the member's expected income is large enough. The sign of the coefficient 2 can be ambiguous as well: an increase in α directly increases the expected value of share of workpoints (as shown by $[\pi\frac{\partial s_d}{\partial\alpha} + (1 - \pi)\frac{\partial s_{nd}}{\partial\alpha}]$ where both $\frac{\partial s_d}{\partial\alpha}$ and $\frac{\partial s_{nd}}{\partial\alpha}$ are positive) but it also means that the member now has to forego some (expected) workpoints because his own chance of being detected increases (as shown by $\pi_\alpha(s_{nd} - s_d)$). Therefore, coefficient 2 can be negative if this opportunity cost of foregone workpoints offsets the increment in workpoint share brought about by α. Thus, even with $de_u/d\alpha > 0$, undertaking monitoring cannot be social welfare maximising if both the coefficients are negative. If so, then the social welfare *loss* should be minimised by setting α equal to zero. Hence we conclude that in order to have $\alpha > 0$, we must have either coefficient 1 capturing the effect of monitoring on a member's income via his effort supply, or coefficient 2 capturing the effect of monitoring on a members' share of workpoints, or both, positive.

In the light of the above discussion, proposition 4 characterises the Stackelberg-Nash equilibrium solution for this game where the superscript s denotes the Stackelberg-Nash equilibrium values.

Proposition 4. For the case when membership is universal, the Stackelberg-Nash equilibrium for the effort supply and monitoring game is a pair of strategies $\{e^s{}_u, \alpha^s{}_u\}$ where $\alpha^s{}_u$ is determined from equation (15) such that $\infty > \alpha^s{}_u \geq 0$, and e_u is determined from the function $e_u(\alpha)$ such that $\bar{e} > e_u \geq e_0$.

Proof: C(α) being a strictly convex function of α, $\alpha^s{}_u = \infty$ cannot be a possible equilibrium value as then equation (15) cannot hold with equality. Therefore, the equilibrium value of α must be less than ∞. With $\infty > \alpha$, if equation (15) holds with strict inequality, then $\alpha = 0$. If so, then a worker's best response to $\alpha = 0$ is to supply e_0, and the pair $\{e_0, \alpha = 0\}$ constitutes an equilibrium. If $\alpha^s{}_u$ satisfying equation (15) is strictly positive, then $e^s{}_u > e_0$ as $\frac{de_u}{d\alpha} > 0$. Therefore, the Stackelberg-Nash equilibrium strategy pair satisfies $\infty > \alpha^s{}_u \geq 0$ and $\bar{e} > e_u \geq e_0$. $\square$

Proposition 4 demonstrates with membership being universal it is now possible to have an equilibrium for the overall game where members supply the lowest possible effort (the extent of shirking is largest) and the collective does not monitor. This result is in stark constrast with the previous case where $\{\alpha^s{}_{nu} = 0,\ e^s{}_{nu} = e_0\}$ could never be a sustainable non-trivial equilibrium. Even with $\alpha^s{}_u > 0$ and $e^s{}_u > e_0$, the Stackelberg equilibrium will still be characterised by very low levels of monitoring and work effort (relative to the non-universal membership case) if $\underline{e} > e^s{}_u$. The analysis illustrates when the threat of punishment is considerably weakened by the removal of the collective's power to expel, the collective may lose its incentive to monitor as extensively and hence members may lose incentives to work as hard. Consequently, with universal membership, an equilibrium may emerge where very little monitoring will be undertaken and very low level of effort will be supplied.

5. DISCUSSION AND CONLCUDING COMMENTS

Attempts to explain work incentives in Chinese collectives before and after the period of collectivization have generated a lot of controversy in recent years. Justin Lin in his 1990 paper reasons that the lack of incentives to work creating agricultural stagnation in China in the years following 1958 was caused by the removal of members' right to exit from collectives. Building on the exit cost hypothesis (MacLeod (1988)), Dong and Dow (1993) demonstrate that Lin's hypothesis is problematic on theoretical grounds: given plausible restrictions on utility payoffs of the members, namely when utility from private farming exceeds the utility from mutual shirking, removal of exit right could strengthen members' incentives to work hard through the threat of retaliatory shirking. If so, then universal membership would imply productivity growth and not agricultural stagnation. Dong and Dow's challenge to Lin's hypothesis has further been criticised by Lin (1993) as being based on specific assumptions about workers' utility functions. A crucial assumption made in all these papers however is that effort observation through monitoring was not possible in Chinese collectives. While it is true that because of enormous practical difficulties involved, collectives in China might have exerted inadequate amounts of effort on monitoring both before and after the collectivization, this however is a problem to be studied and not to be taken as an assumption to begin with.

In this paper, we have taken an approach different from the exit right/retaliatory shirking approach to analyse work incentives in China's collectives following the year of 1958. Accepting the fact that conducting appropriate amount of supervision was both difficult and costly in collectives, we have focused on the role of expulsion by the collective in generating incentive effects of monitoring on members' labour supply. We believe that our approach is more suitable for studying the effect of membership universalization on workers' incentives to supply effort as it does not suffer from many of the criticisms of exit right/retaliatory shirking approach.

We have shown that effort monitoring exerts a greater impact on members' work incentives and labour supply when membership is not universal. We find that while in both the cases of non-universal and universal membership the equilibrium effort level is below the full (first best) effort level, with non-universal membership members' equilibrium effort supply is always above a certain threshold level $\underline{e}$ which is strictly greater than e_0, the level where the extent of shirking is the largest; whereas with universal membership the lower limit for the equilibrium effort supply is e_0. This relatively high level of work effort could only be induced in the non-universal membership case as the collective itself had incentives to monitor with at least a minimum effort level $\underline{\alpha}$ when it had the ability to punish a shirking member through expulsion. When membership was made universal, this power of expulsion was removed and penalty became restricted: a member received only less pay reflecting exactly his true effort exertion according to the actual practice in China's collectives. Consequently, the collective's monitoring level could easily fall below $\underline{\alpha}$ and even reach the level of zero monitoring, and members' equilibrium effort supply could fall below the threshold level $\underline{e}$ and reach the maximum shirking effort level e_0. We argue that it is the removal of this power of expulsion that was responsible for the Chinese agricultural stagnation as it created disincentives to the collective to monitor members' effort supply extensively, and consequently provided poor incentives to members to work hard.

In our model, effort observation being feasible, expulsion of identified shirkers from the production team constitutes a credible punishment threat by the collective. Previous work by Lin (1990) and Dong and Dow (1993), based solely on exit right and retaliatory shirking approach, suffer from credibility problems as they ignore the possibility of effort observation altogether. For example, Dong and Dow demonstrate that for the exit right to have greater deterrence power than retaliatory shirking, the utility payoff associated with private farming needs to be less than the utility payoff associated with universal shirking. But if that is so then, assuming members' preferences are not significantly different, exit cannot constitute a credible punishment threat as members would prefer to stay with the collective even if they all shirk. Dong and Dow also assert that an exit trigger strategy is equivalent to expulsion in that when all diligent members leave the collective the shirking member is automatically expelled from it. With direct effort observation being impossible, expulsion of this kind cannot be a credible threat either as in that case the collective would have to expel all remaining members causing the collapse of the collective. If private farming yields a lower utility payoff than mutual shirking for all members, a social welfare maximising collective would not want to do that. Expulsion however does become a credible threat when effort observation is feasible. A welfare-maximising collective can then elicit higher effort from the members by credibly committing itself to expel those members from the collective having been identified as shirkers, a strategy which becomes feasible when the collective can monitor and observe members' effort even if imperfectly.

By incorporating imperfect effort observability, we have been able to generate a richer set of possible equilibrium outcomes. In our model, equilibrium levels of effort supply and monitoring can take on any value within the permissible range. This implies, depending upon the state of the monitoring technology (as well as preference specification), the intensity of monitoring and the extent of shirking can vary in our model. In contrast, in both Lin (1990) and Dong and Dow (1993), the extent of shirking did not figure. Because direct effort observation was assumed to be impossible, disciplining shirking members could only be based on output observation: everytime the output fell below a certain specified level (the full effort level in both Lin and Dong and Dow), disciplining would take place either by honest members exiting the production team (as in Lin) or through retaliatory shirking (as in Dong and Dow). As a result, the equilibrium outcome in these papers could take only one of the two extreme forms: either all members shirking at a fixed effort level or all members not shirking (i.e.

supplying full effort). Judging by the diverse performance of collectives in China during the period 1958 to 1978, the degree of variability in equilibrium monitoring and effort supply levels in our model appears to fit the reality better.

We conclude this paper by noting that we do not deal with the problem of heterogeinty in this paper; neither do we deal with a multiple period model. Incorporating heterogeneity and extending the model into a multiple period setting would certainly be important for future research. Our objective however has been to demonstrate the difference between the exit-right based hypothesis and an expulsion-right based hypothesis in a simplest possible model. We believe our single period model has been adequate for that purpose. Also, by focusing on identical members case, we are able to highlight the crucial difference between the two approaches. Dong and Dow demonstrated that for the exit right hypothesis to be a valid explanation for the agricultural stagnation in China after 1958, the utility payoff associated with private farming needed to be less than that of mutual shirking. We have discussed above how it immediately raises the question about credibility of the exit strategy. For this reason, Lin (1993) appeals to membership heterogneity to resolve the dilemma. However, with identical members, while credibility is clearly a problem of the exit right hypothesis, this is no longer true for the expulsion right-based models of the type developed in our paper.

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APPENDIX

The sign of $Eu_{e\alpha}$.

$$Eu_{e\alpha} = \pi_{e\alpha}q(s_{nd} - s_d) + \pi_e q\{\frac{\partial s_{nd}}{\partial\alpha} - \frac{\partial s_d}{\partial\alpha}\} + \pi_\alpha\{s_d{}'q - \theta(s_{nd} - s_d)\} +$$
$$\pi\{q\frac{\partial s'_d}{\partial\alpha} + \theta\frac{\partial s_d}{\partial\alpha}\} + (1 - \pi)\theta\frac{\partial s_{nd}}{\partial\alpha}$$

Let $D = \{w(\bar{e}) + (n - 1)\{(1 - \pi)w(\bar{e}) + \pi w(e_u)\}$, $D(e) = \{w(e_u) + (n - 1)\{(1 - \pi)w(\bar{e}) + \pi w(e_u)\}$, and $x = (n - 1)\{(1 - \pi)w(\bar{e}) + \pi w(e_u)\}$. Hence, $D = w(\bar{e}) + x$, and $D(e) = w(e_u)+x$, and $D > D(e)$. The term $\pi_{e\alpha}q(s_{nd} - s_d) > 0$ because $\pi_{e\alpha} > 0$ and

$$(s_{nd} - s_d) = x[w(\bar{e}) - w(e_u)]/D(e)D \quad > 0 \text{ as } w(\bar{e}) > w(e_u).$$

The second term $\pi_e q\{\frac{\partial s_{nd}}{\partial\alpha} - \frac{\partial s_d}{\partial\alpha}\} > 0$ because $\frac{\partial s_{nd}}{\partial\alpha} = w(\bar{e})(n - 1)\pi_\alpha\{w(\bar{e}) - w(e_u)\}/D^2 > 0$, $\frac{\partial s_d}{\partial\alpha} = w(e_u)(n - 1)\pi_\alpha\{w(\bar{e}) - w(e_u)\}/(D(e))^2 > 0$, and the difference

$$\{\frac{\partial s_{nd}}{\partial\alpha} - \frac{\partial s_d}{\partial\alpha}\} = \{w(\bar{e}) - w(e_u)\}(x^2 - w(\bar{e})w(e_u))/(D(e)D)^2 \quad > 0.$$

Also,

$$\frac{\partial s'_d}{\partial\alpha} = w'(e_u)\pi_\alpha(n - 1)\{w(\bar{e}) - w(e_u)\}[(1 - \pi)(n - 1)\{w(\bar{e}) - w(e_u)\}+(n - 2)\pi w(e_u)]/(D(e))^3>0$$

so that the term $\{q\frac{\partial s'_d}{\partial\alpha} + \theta\frac{\partial s_d}{\partial\alpha}\} > 0$. Therefore, the sign of $Eu_{e\alpha}$ depends on the sign of $\{s_d{}'q - \theta(s_{nd} - s_d)\}$. Simplifying, we obtain

$$\{s_d{}'q - \theta(s_{nd} - s_d)\} = \{(n - 1)\{(1 - \pi)w(\bar{e}) + \pi w(e_u)/D(e)\}[\frac{w'(e_u)q}{D(e)} - \frac{\theta\{w(\bar{e}) - w(e_u)\}}{D}].$$

Since $w(e_u)$ is a linear function, taking first order Taylor's expansion $\{w(\bar{e}) - w(e_u)\}$ can be approximated as $w'(e)(\bar{e} - e_u)$. Hence $\{s_d{}'q - \theta(s_{nd} - s_d)\}$ is unambiguously positive if $(n + 1)\theta e_u - \theta\bar{e} \geq F$. For n large enough, $(n + 1)\theta e_u - \theta\bar{e} \simeq n\theta e_u > F$ since q must be positive. Therefore, we can assume, without any loss of generality, that $\{s_d{}'q - \theta(s_{nd} - s_d)\}$ is positive as well $\Rightarrow Eu_{e\alpha} > 0$.
