Risk as an Impediment to Privatization? The Role of Collective Fields in Patriarchal Family Farms

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1 Introduction

A typical feature of most of the literature devoted to risk and mutual insurance in poor countries, both theoretical and empirical, is its focus on reciprocal, state-contingent voluntary transfers occurring at local or community level (for recent surveys, see Platteau, 2006: 854-74). Little attention has been paid to other mechanisms that have the effect of pooling risks, such as rules of access to natural resources in general, and land in particular. The few works that highlight the insurance function of these rules are concerned with village-level common property resources, or with informal systems of rotating access to natural resource sites (Bromley and Chavas, 1989; Platteau, 1991: 122-35; Platteau and Seki, 2001; Platteau, 2006: 829-46). One of the most elaborated attempts along the former line is a paper by Baland and Franois (2005) in which the authors show that, because of the superior insurance properties of common property resources (which tend to provide income maintenance in low states), any feasible insurance scheme under private property cannot ex ante Pareto-dominate allocations under the commons despite the efficiency gains from privatization (when markets are incomplete).[1] More precisely, even when privatization is done equitably, the loss of insurance resulting from the disappearance of the commons causes the community members to be worse off than before. Interestingly, there is wide empirical support for such forms of income targeting to the poor that come from the presence of resources that are openly accessible to all community members and serve as assets of last resort in times of crisis (Hayami, 1981; Jodha, 1986; McKean, 1986; Agarwal, 1991; Dasgupta and Maler, 1993; Beck, 1994; Baland and Platteau, 1996; Godoy et al., 2000; Pattanayak and Sills, 2001; Wunder, 2001).

Along a similar line, the literature dealing with agricultural producer cooperatives provides us with several studies that are directly relevant to the insurance issue. Thus, Putterman and DiGiorgio (1985) and Carter (1987) have analyzed the role of collective fields as a way to redistribute income from lucky to unlucky members. This effect is achieved because collective output (or at least part of it) is distributed equally among members (Putterman, 1989). If collective farming is subject to the moral-hazard-in-team problem, a trade-off exists between efficiency and risk-sharing. Complete parcellation of cooperative land has been shown by Carter to be suboptimal while intermediate forms that preserve some degree of risk sharing may prove superior. Note carefully that the same argument can be straightforwardly extended to the context of large, patriarchal family farms in which a collective field whose output is equally shared coexists with private plots farmed by individual members (the so-called mixed farms).

Because Carter does not allow for income transfers in addition to a collective mechanism of risk-pooling, his conclusion that complete privatization (of cooperative land) is not optimal does not actually come as a surprise. On the other hand, Baland and Franois allow for such transfers yet reach a similar conclusion. The paradox nevertheless disappears as soon as one realizes that there is no possible trade-off between efficiency and insurance in the latter's framework. As a matter of fact, since labour on the commons is remunerated at the average instead of the marginal product, there is an inefficient over-allocation of labour and, in equilibrium, returns to labour are higher under the commons than under private property.

The really interesting question therefore appears to be the following one: if private production is more efficient than collective production, so that an efficiency-insurance potentially exists, and if members can freely make transfers, is it possible that further (perhaps full) privatization of the available land will enhance both

[1] In Baland and Franois (2005), members of the community owning the resource are identical ex ante but face idiosyncratic and independently distributed random shocks in external income-earning opportunities. They are therefore heterogeneous ex post and those with low outside options prefer to work on the commons than outside.

total output and insurance? A positive answer implies that the efficiency-insurance trade-off could vanish. This is precisely the task that we aim to tackle in this paper. Toward this purpose, we model a patriarchal family farm of the mixed type. While the head of the household decides how to divide the farmland between the collective field and the private plots allotted to each member (and the tax he charges on them), the latter determine the level of income which they want to transfer. Moreover, following Guirkinger and Platteau's analysis of the patriarchal farm (2010), we assume that first-best efficiency is achieved on private plots whereas production on the collective field is plagued by the moral-hazard-in-team problem. Like them, also, we assume that collective output is equally shared and privatized land is equally apportioned among all members (so that privatization is equitable). Unlike them, however, but similarly to Carter or Baland and Franois, we posit the existence of an idiosyncratic shock and of risk aversion on the part of family members.

In this rather complex framework, we are able to show analytically that under some conditions further privatization of the land leads to a win-win situation in which efficiency gains are compounded by greater insurance benefits thanks to increased income transfers by members. Moreover, if family size is sufficiently large implying that the moral-hazard-in-team problem is serious enough, complete privatization is optimal so that there is no more trade-off between efficiency and risk-sharing. The same fortunate outcome obtains if members give sufficient importance to future income flows. These are necessary but not sufficient conditions, though. The efficiency-insurance trade-off may well exist and persist, indicating that the outcome highlighted by Carter and Baland/Franois is a distinct possibility in our particular setup.

The remainder of the paper is structured as follows. In Section 2, we present our theoretical framework and discuss the central assumptions underlying it. Some of them are essential for the argument that we develop while others are made with a view to keeping it analytically tractable. Thereafter, we derive two equilibrium outcomes that correspond to benchmarks useful to bear in mind in the subsequent analysis: the first-best outcome obtained with perfect enforceability of insurance transfers, and the third-best outcome with absent commitment. In Sections 3 and 4, we can then deal with the intermediate case of imperfect commitment by following a multilateral bargaining approach to intra-household decision-making. The Principal-Agent model may actually be seen as a particular case of that general approach. All throughout these sections, attention is focused on the impact of land privatization on collective output, which is negative, and on the amount of insurance transfers, which is a priori unclear. Section 5 examines the effect of varying two key parameters of the model: the size of the family which bears upon the extent of the moral-hazard-in-team problem, on the one hand, and the discount rate which reflects the members' intertemporal preference, on the other hand. Section 6 concludes.

2 The Model

2.1 Household composition, risk and preferences

We consider an extended household composed of a household head and n dependants $i \in N$. dependants are endowed with land and labor. Each dependant has L units of land of homogeneous quality and one unit of productive time, provided he is not sick in the period considered. The head does not work but, as will become clear in later sections, he plays a role in the decision making process.

Uncertainty enters the model through a idiosyncratic health shock.[2] Specifically, in each growing season,

[2]Covariate shocks are not considered here for the sake of clarity. It is however interesting to note that even highly covariate

a subset H of size θn is randomly drawn within the household, with $\theta \in \left\{\frac{1}{n}, \frac{2}{n}, \ldots \frac{n-1}{n}\right\}$. The dependants belonging to this subset $H \subset N$ have one unit of productive time while the others are unable to work for the current season. In other words, ex ante, each dependant receives one unit of labor input with probability θ. The size of H is assumed constant across periods. Put differently, the risk structure does not change over time.

Two important remarks pertaining to this risk structure are worth mentioning. First, in our set-up the state of the world is revealed before the decision on the allocation of effort is taken. The latter therefore takes place under certainty. In this setting, the case of illness is particularly appropriate. If the idiosyncratic risk had taken the form of random yields, for instance, the effort decision would have been affected by risk aversion. The main message of this paper nevertheless remains valid in the case of ex post shocks.

Second, it has to be noted that, in this setting, risk is perfectly negatively correlated among dependants. This assumption does not qualitatively alter our results and has two main advantages. On the one hand, it considerably simplifies computations and, on the other hand, it allows the household to have an aggregate production that is constant over time thereby allowing to reach perfect insurance. It follows that the first best institutional arrangement can be easily defined.[3] It has to be acknowledged, however, that perfectly negatively correlated shocks prevent an important effect to appear in the model, namely the positive impact of the household size on the insurance possibilities. With imperfectly correlated shocks, indeed, an increase in the size of the insurance group may increase the scope for insurance through a diversification effect. We will keep in mind the absence of this effect when discussing the impact of household size at the end of the paper (See Section 5).

Within the household[4], the dependants' per period expected utility is given by

$$V = \theta u(c_h) + (1-\theta) u(c_0), \tag{1}$$

where c_h denotes a member consumption level if he belongs to H (is healthy) and c_0 denotes his consumption otherwise. We assume $u' > 0; u'' < 0$ and that $u(.)$ is characterized by constant absolute risk aversion (CARA). Agents are infinitely lived and discount the future. The objective function of a dependant i belonging to H for the current period therefore writes

$$U_{i \in H} = u(c_h) + \delta V,$$

where $\delta = \frac{\eta}{1-\eta}$, with η the discount factor.

2.2 Production and consumption

The household total land endowment nL is divided between collective and individual fields. Let μ denote the fraction of the aggregate family landholdings that is individually apportioned. Individual fields are of homogeneous size μL and each household member farms his plot independently. Let us call e_{Ii} the time

shocks have some idiosyncratic component, when the extent of the shock is variable among different individuals. While the pure covariant component cannot, by definition, be part of a local insurance arrangement, the idiosyncratic component can and this is the one on which we focus here.

[3]Relaxing the assumption of perfect negative correlation among dependants would introduce a covariate component in our risk so that insurance would not be perfect. However, members could still perfectly share the idiosyncratic component of the risk they face. This is because, even with a covariate component, the level of production is known at the time where the insurance agreement is made, as by assumption, the state of the world is drawn beforehand.

[4]Exit options are defined in a subsequent section.

allocated by member i on his individual plot. The size of the collective field is therefore $(1-\mu)\,nL$. Labor on the collective field is supplied by all members collectively and the proceeding is equally shared among members. Let us call (e_{ci}) the time allocated by member i to the collective field.

The technology is assumed to be identical across collective and individual parcels. Suppose a production function defined on labour e and land l: $f\,(e,l)$, with the following properties:

$$f_e > 0, f_l > 0, f_{ee} < 0, f_{ll} < 0, f_{le} = f_{el} > 0.$$

Let us further assume the existence of constant returns to scale.

Let Y_c and Y_I stand for production on the collective field and on the individual plots, respectively. In order to avoid the presence of fallow land in the model, we make the assumption that the private land of the dependants hit by the health shock ($i \notin H$) is shared between the θn other members and reallocated to their private parcels. The aim of this assumption is to avoid a mechanical effect through which an increase in the size of the collective field (a decrease in μ) would improve efficiency (see infra) by reducing the area of fallow land. Under this assumption, the size of any private parcel writes $l_I = \mu L + n\mu L\frac{1-\theta}{n\theta} = \frac{\mu L}{\theta}$

Under the assumptions made up to now, we have that

$$\begin{aligned}
Y_c &= f\left(\sum_{i\in H} e_{ci}, (1-\mu)\,nL\right), \\
Y_{iI} &= f\left(e_{Ii}, \frac{\mu L}{\theta}\right).
\end{aligned}$$

Members' consumption is then the sum of their individual production, their share of the collective production, the net amount of transfer and their wage income. The time dedicated to working for a wage is the difference between total time endowment, normalized to q, time dedicated to collective production e_c and time dedicated to individual production e_i. Finally the wage income is $w(1-e_c-e_i)$ with w the wage rate. Denoting by t the level of transfer from a healthy member, we thus have:

$$\begin{aligned}
c_{ih} &= \frac{1}{n}Y_c + Y_{iI} - t + w\,(1-e_c-e_I)\,, && (2)\\
c_{i0} &= \frac{1}{n}Y_c + \frac{\theta}{1-\theta}t. && (3)
\end{aligned}$$

Transfers from healthy dependants are equally shared among sick members. To be specific, let t_i and t_o denote transfers in and out, respectively. The budget constraint on transfers is then:

$$n\theta t_o \geq n\,(1-\theta)\,t_i \iff t_i \leq \frac{\theta}{1-\theta}t_o,$$

Equations (2) and (3) assume that the budget constraint is binding.[5] In the following, we explore different assumptions regarding the level of commitment that can be attached to these insurance transfers. After characterizing the members' labor allocation, we will briefly examine the two benchmark cases of perfect enforceability and unenforceability of these insurance transfers. The core of the paper is then dedicated to analysis of the more realistic case of imperfect commitment. In this intermediate situation, an incentive compatibility condition is imposed on the insurance transfers.

[5]Later in the paper, we will allow the household head to make some profit on the insurance scheme. Specifically, we will add a variable τ, distinct from t, by which the household head charges a premium on dependants $i \in H$.

Note that in this model, transfers are not the only mechanism by which income is redistributed from the good to the bad state, or from healthy to sick dependants. The redistribution of the collective production is another way of sharing risk since each dependant receives an equal share of the production on the collective field, whatever his type. In other words, there is an implicit transfer involved in the simple sharing of collective output.

2.3 Allocation of Work Effort: Moral Hazard in Team

After the move of nature, the dependants $i \in H$ have to allocate their time endowment between work on the collective field (e_c), on individual plot, (e_I), and on off farm activities $(1 - e_c - e_I)$ which is remunerated with a constant wage w. Since this choice is made once the risk is realized, risk aversion does not play any role and the dependants simply maximize income for the current period (2). The arbitrage condition states that

$$\frac{1}{n} f_e^c = f_e^I = w, \tag{4}$$

where the superscripts c and I stand for collective and individual, respectively. As expected, given the equal sharing rule, production on the collective field is plagued by a moral hazard in team problem. As equation (4) illustrates, the marginal productivity of the labor input is n times higher on the collective field than on individual plots and effort is thus underprovided on the former. Besides, as is shown in Appendix 1,

$$\frac{de_c^*}{dn} < 0; \frac{de_I^*}{dn} > 0; \frac{de_c^*}{d\mu} < 0; \frac{de_I^*}{d\mu} > 0.$$

On the one hand, for a given rate of individualization of land tenure, the larger the household size, the more the effort allocation is biased at the expense of collective production. This result is intuitive since the moral hazard in team problem tends to worsen as the number of players increases. On the other hand, following an increase in individualization of land, the labor input is reallocated towards individual parcels which causes total production to grow. Lemma **??** establishes this result.

Lemma 1 *The sum of farm production and outside incomes is monotonically and positively related to the rate of individualization of land: $\partial Y / \partial \mu > 0$.*

Proof. Aggregate production at the household level writes

$$\begin{aligned} Y &= Y_c\left(e_c^*\right) + n\theta\left[Y_i\left(e_I^*\right) + w\left(1 - e_c^* - e_I^*\right)\right] \\ &= n\theta w + R_c^* + R_I^*, \end{aligned}$$

where R_c^* and R_I^* are the values of the rents generated on the collective field and individual parcels, respectively, so that:

$$\begin{aligned} R_c^* &= Y_c - n\theta w e_c^*, \\ R_I^* &= n\theta\left(Y_I - w e_I^*\right). \end{aligned}$$

We have to show that $\partial Y / \partial \mu > 0$. Since $\partial Y / \partial \mu = \partial\left(R_c^* + R_I^*\right) / \partial \mu$, let us concentrate on the derivatives of the rents with respect to μ.

First,

$$\frac{\partial R_I^*}{\partial \mu} = n\theta\left(f_e^I \frac{\partial e_I^*}{\partial \mu} + f_l^I \frac{L}{\theta} - w \frac{\partial e_I^*}{\partial \mu}\right) = nLf_l^I,$$

by arbitrage (4). Under constant returns to scale, Euler's theorem allows to write

$$ef_e + lf_l = f \iff f_l = \frac{f - ef_e}{l}.$$

Hence,

$$f_l^I = \frac{Y_I - e_I^* w}{\mu \frac{L}{\theta}} = \frac{R_I^*}{\mu n L}.$$

We end up with

$$\frac{\partial R_I^*}{\partial \mu} = \frac{R_I^*}{\mu}.$$

The marginal increase in individual rent from an increase in the size of individual plots is equal to the average rent per unit of area. This result hinges crucially on the constant return to scale assumption and on the constant opportunity cost of time, w. Following a similar reasoning for the collective rent,

$$\frac{\partial R_c^*}{\partial \mu} = n\theta \left(f_e^c \frac{\partial e_c^*}{\partial \mu} - f_l^c \frac{L}{\theta} - w \frac{\partial e_c^*}{\partial \mu} \right) = n\theta \left((n-1)\, w \frac{\partial e_c^*}{\partial \mu} - f_l^c \frac{L}{\theta} \right),$$

by arbitrage (4). Making use of Euler's theorem and (4) again, we find

$$f_l^c = \frac{Y_c - n^2 \theta e_c^* w}{(1-\mu)\, nL} = \frac{R_c^*}{(1-\mu)\, nL} - \frac{(n-1)\, \theta e_c^* w}{(1-\mu)\, L}.$$

Substituting for f_l^c and bearing in mind that $\frac{\partial e_c^*}{\partial \mu} = -\frac{e_c^*}{(1-\mu)}$ (see Appendix 1), we have

$$\frac{\partial R_c^*}{\partial \mu} = -\frac{R_c^*}{1-\mu}.$$

Finally,

$$\frac{\partial Y}{\partial \mu} = \frac{R_I^*}{\mu} - \frac{R_c^*}{1-\mu} > 0.$$

If one unit of land area is withdrawn from the collective field and reallocated to individual plots, household production changes by the difference between the rents per unit of land area generated on individual parcels and on the collective field. This difference is unambiguously positive. To see it recall that e_I^* is such that R_I^* is maximized, as the marginal productivity of labor on the individual plots is equal to its external opportunity cost w. Conversely, on the collective field there is under-application of labor. Furthermore, the assumption of constant returns to scale implies that the size of the respective fields does not influence the rents per land unit. As a result the rent per unit of land on individual fields $\frac{R_I^*}{\mu}$ is larger than on collective field $\frac{R_c^*}{1-\mu}$. . ■

The following sections are devoted to an exploration of the interaction between collective production and risk-sharing.

2.4 Benchmarks: first and third best

Before embarking on a description of the game played by household members and the definition of an equilibrium outcome, it is useful to define the optimal level of individualization under two extreme assumptions regarding the enforceability of insurance transfers: the cases of perfect and absent commitment.

2.4.1 Perfect commitment

Under perfect commitment, the insurance scheme implemented within the household is not constrained by an incentive compatibility condition. In other words, any transfer t is enforceable. As developed below (see Section 3), this case is not realistic since a high level of transfer provides the dependants $i \in H$ with strong incentives to renege on the insurance agreement. Exploring the case of perfect commitment nevertheless allows us to characterize the first best institutional arrangement, namely the optimal rate of individualization and the optimal amount of (unconstrained) insurance transfers.

Proposition 1 *The first-best outcome is characterized by a complete individualization of land tenure and perfect insurance. Under perfect commitment, the optimal institutional arrangement writes* $\left(\mu^{PC}, t^{PC}\right) = (\mu^*, t^*) = \left(1, (1-\theta)\left(w + \frac{R_I^*}{n\theta}\right)\right)$.[6]

Proof. The first order condition for the expected utility V (defined by Equation (1)) with respect to t is given by

$$\frac{\partial V(\mu, t)}{\partial t} = -\theta u'(c_h) + (1-\theta) u'(c_0) \frac{\theta}{1-\theta} = 0 \iff c_h = c_0$$

Using (2) and (3), we have:

$$t^* = (1-\theta)\left[Y_I(e_I^*) + w(1 - e_c^* - e_I^*)\right].$$

As expected, the optimal lumpsum transfer t achieves full income pooling and, under the assumption of perfectly negatively correlated risks, perfect insurance.[7] Therefore,

$$V(\mu, t^*) = u\left(\frac{Y(\mu)}{n}\right).$$

Since we know by Lemma 1 that $\partial Y / \partial \mu > 0$, the rate of individualization μ is at its upper bound. Therefore, $\mu = 1$, $e_c = 0$ and, since $R_I^* = n\theta(Y_I - we_I^*)$, we can write:

$$t^* = (1-\theta)\left(w + \frac{R_I^*}{n\theta}\right).$$

■

Proposition 1 defines the first-best institutional arrangement in which idiosyncratic risks are completely shared and land parcels totally individualized. This outcome is achievable provided that insurance transfers are not impeded by a commitment issue. In this model, complete risk-sharing is obtained through transfers only, there is not need to maintain a collective field at the expense of production efficiency.

2.4.2 No commitment

Let us now assume that insurance transfers are totally unenforceable ($t = 0$), implying that insurance is provided through the distribution of collective production only. There exists then a basic trade-off between efficiency and risk-sharing: privatization increases farm production, and thus aggregate consumption, but decreases insurance. We call this situation “third best” because, compared to this situation, imperfect commitment allows both productivity and insurance to be enhanced, therefore corresponding to a “second best” outcome.

[6] The superscript PC stands for perfect commitment.

[7] Note that, as intuition would suggest, the optimal insurance transfer is decreasing in the share of sick members, $\frac{dt^*}{d\theta} < 0$ and increasing in the flat wage, $\frac{dt^*}{dw} > 0$

In the absence of commitment, the level of privatization that maximizes a member's expected utility is such that the efficiency gain of a marginal increase in μ is exactly offset by the insurance loss. The following proposition states this result:

Proposition 2 *The (constrained) optimal institutional arrangement writes* $\left(\mu^{NC}, t^{NC}\right)$.[8] *By assumption,* $t^{NC} = 0$. *The land tenure regime* μ^{NC} *must satisfy*

$$\frac{\partial Y}{\partial \mu} = n \frac{\partial \phi}{\partial \mu},$$

where $\phi\left(c_h, c_0; \theta\right)$ *denotes the risk premium. If insurance transfers are unenforceable, there is a tradeoff between production efficiency and the level of risk-sharing achieved.*

Proof. The per period expected utility V (1) can be rewritten as

$$V = u\left\{\theta c_h + (1-\theta)\, c_0 - \phi\left(c_h, c_0; \theta\right)\right\} = u\left(\frac{1}{n} Y - \phi\right).$$

The first order condition with respect to μ is simply

$$\frac{\partial V}{\partial \mu} = 0 \iff \frac{\partial Y}{\partial \mu} = n \frac{\partial \phi}{\partial \mu}.$$

■

In this setting, land tenure is a unique instrument to simultaneously deal with production efficiency and risk considerations. On the one hand, as already shown, individualization of land tenure increases total production: $\partial Y / \partial \mu > 0$ (Lemma 1). On the other hand, the level of risk is positively related to individualization. This is intuitive since collective output is shared equally between lucky and unlucky dependants, while individualization increases the gap between the consumption levels of these two groups.[9] The equality $\frac{\partial Y}{\partial \mu} = n \frac{\partial \phi}{\partial \mu}$ states that, when the expected utility is maximized, the increase in risk premium induced by a marginal increase in μ for all members has to be exactly offset by the increase in total production (and thus consumption).

In the following sections, we turn to the more interesting case of imperfect commitment. We will allow for the existence of mutual insurance transfers t that are limited in scope by a commitment issue. Indeed, once the state of the world is realized, agents who benefit from a high income draw have an incentive to renege on the insurance agreement.

[8] The superscript NC stands for no commitment.

[9] On the one hand,

$$\frac{\partial c_0}{\partial \mu} = \frac{1}{n}\left(f_e^c n \theta \frac{\partial e_c^*}{\partial \mu} - f_l^c n L\right) < 0.$$

Production on the collective field unambiguously decreases since both land and labor inputs are reduced when a larger share of the household land is allotted to private plots. On the other hand, we know that the aggregate farm and off-farm production Y increases with μ (Lemma 1). Hence, aggregate family income increases while the share devoted to dependants $i \notin H$ decreases. Therefore, it must be that $\partial c_h / \partial \mu > 0$. However, expected income Y/n also increases with μ. It follows that, under decreasing absolute risk aversion, we have a negative partial effect on the risk premium. A formal proof that $\partial \phi / \partial \mu > 0$ under CARA is provided in Section 5.

3 Timing of the game and equilibrium concept with imperfect commitment

In order to find the optimal institutional arrangement in the case of imperfect commitment $\left(\mu^{IC}, t^{IC}\right)$, we need to add a stage in the game to allow members to deviate from the insurance arrangement.[10] We also need to precisely define the household decision-making process.

3.1 Timing of the game

The timing of the game is:

1. Household members define the parameters (μ, t) of a contract linking production and insurance.[11]

2. Nature draws a subset $H \subset N$ of size θn. The dependants belonging to H are endowed with one unit of productive time.

3. The dependants $i \in H$ choose either to stay on the family farm and to abide by the insurance agreement or to leave with the output of their private parcel at the end of the season.

4. The dependants $i \in H$ decide the allocation of their work effort between individual plots, the collective field and off-farm activities.

5. At the end of the season, the dependants who had chosen so in stage 3 leave the household for ever, taking along with them the output of their private parcel and their land endowment.

6. This sequence is infinitely repeated.

Two remarks are worth mentioning at this stage. First, even if the dependant leaves at the end of the season, the decision to leave is taken beforehand. Indeed, this decision should have an impact on the dependant's optimal allocation of labor. In particular, since we assume that a dependant who leaves the household does not receive his share of the collective output, he should not take part in collective production.

Second, we assume that, if the dependant reneges on the insurance agreement, the unique option is to leave the household. In other words, there is a credible threat of ostracism. The dependant avoids paying the transfer t only at the cost of giving up his share of collective production in the current period and the insurance services associated with household membership in the future.

Following Coate & Ravallion (1993), let us call "ad interim participation constraint" the incentive compatibility condition ensuring that it is optimal to abide by the insurance agreement. Let $\bar{V}$ denote the per period utility level that a dependant receives outside the household. The value of this exit option is exogenous. Anticipating that $e_c^* = 0$ if the dependant decides to leave[12], the ad interim participation constraint writes

$$u\left\{Y_I + w\left(1 - e_I^*\right)\right\} + \delta\bar{V} \leq u\left\{\frac{1}{n}Y_c + Y_I - (t + \tau) + w\left(1 - e_c^* - e_I^*\right)\right\} + \delta V, \tag{5}$$

where τ denotes a premium that the household head could charge on dependants $i \in H$.

[10] The superscript IC stands for imperfect commitment.

[11] The way this contract is selected is defined below.

[12] As can be seen in equation (4), e_I^* and e_c^* are determined independenlty from one another. Therefore, the decision to leave has no impact on the value of e_I^*.

3.2 Intra-household decision making: A Multilateral Bargaining Approach

In the line of the work of Bell (1989), we make use of a multilateral bargaining approach to find the optimal institutional arrangement. This solution concept works as follows: it is assumed that each of the n dependants bargains over an individual "household contract" (μ_i, t_i, τ_i) with the head. The size of the collective field is therefore $\sum_{i \in N} (1-\mu_i) L$. When considering the bilateral bargaining between the household head and a given dependant i, the terms of the $(n-1)$ other contracts are fixed. Assuming that $(n-1)$ contracts are already concluded, we apply the Nash bargaining solution to find the terms of the contract between the household head and the residual dependant $i = n$. Afterwards, those terms are applied to all household members, by symmetry. At the end of this procedure, it is easy to see that the resulting institutional arrangement is an equilibrium.[13]

The dependant's per period utility level writes $V(\mu_n, t_n, \tau_n)$ under the contract and $\bar{V}$ outside the contract. Assume, for simplicity, that the head is risk-neutral[14]. his expected per period income is given by

$$E(\Gamma) = \sum_{i \in N} \theta \tau_i,$$

since the dependant i pays the premium τ_i with probability θ.

The specification of the threat point has consequences for the result of the bargaining process and it is therefore useful to carefully examine this question. In particular, we need to further specify the property rights arrangement so as to decide whether the dependant leaves the household with his entire land endowment L or not. If he does, the problem is simplified for two reasons. First, there is no problem of land reallocation so that a member's departure does not affect the $(n-1)$ other contracts in the bargaining process. Second, the threat point is exogenous to the contractual parameters, which simplifies the mathematical resolution of the problem. In other words, we assume that continued household membership is not a prerequisite for access to land.[15] This is the definition we decided to adopt. Alternative assumptions about the threat point would add unnecessary complication to the model without yielding additional insights. To see this, consider two other intuitive possibilities. First, suppose that the member cannot take his land with him. In that case, the resolution of the problem remains unchanged ($\bar{V}$ is still exogenous to the contract terms) as long as the land is left fallow for the period under consideration (otherwise, the assumption that the $(n-1)$ other contracts are constant would be violated). Second, suppose that the departing member only keeps his individual plot μL but cannot claim his share of the collective field. In these conditions, privatization has an impact on the member's exit option ($\bar{V}$ is a function of μ). The direction of the effect is nevertheless obvious: privatization increases the attractiveness of the exit option, thereby tightening the ad-interim participation constraint. Adding this mechanical effect would unnecessarily complicate the model. We thus assume that departing members keep L units of land. Accordingly, the threat point is given by $\left(\sum_{i \in N \setminus \{n\}} \theta \tau_i, \bar{V} \right)$ and the log-linearized Nash bargaining program writes

$$\begin{array}{ll} \underset{\{\mu_n, t_n, \tau_n\}}{Max} & \Phi(\mu_n, t_n, \tau_n) = p \ln(\theta \tau_n) + (1-p) \ln \left(V(\mu_n, t_n, \tau_n) - \bar{V} \right) \\ s.t. & u(c_d) \leq u(c_h) + \delta \left(V(\mu_n, t_n, \tau_n) - \bar{V} \right), \end{array}$$

[13] We do not impose coalition-proofness. The contracts are only required to be robust to individual deviations.

[14] In equilibrium, every dependant is charged the same τ. As a result, the household head's income $(\theta n \tau)$ is constant over time and this assumption is not needed.

[15] This is in line with the argument made by Platteau and Baland () and Goetghebuer and Platteau () according to which in lineage-based societies land is, as a rule, bequeathed in equal parts to all (male) members, whether pre- or post-mortem.

where c_d and c_h denote the current consumption flows when the member has departed or stayed within the household, respectively:

$$\begin{aligned} c_d &= Y_I + w\left(1 - e_I^*\right), \\ c_h &= \frac{1}{n}Y_c + Y_I - (t+\tau) + w\left(1 - e_c^* - e_I^*\right). \end{aligned}$$

The weight p is exogenous. This parameter allows the multilateral bargaining model to encompass two important solution concepts as special cases. Indeed, if $p = 0$, solving the Nash bargaining program amounts to maximize the utility of the dependant within the household $V(\mu_n, t_n, \tau_n)$. Two sources of inefficiencies subsist in this model: (i) a moral hazard in team problem that results in underprovision of labor on the collective field and, (ii) an imperfect commitment problem that affects insurance transfers. The case where $p = 0$, which corresponds to the situation of a benevolent principal, therefore yields a second-best outcome.[16] The other extreme case obtains when $p = 1$ and corresponds to a classical Principal-Agent (PA) approach. In our framework, the outcome of the PA approach is not second best. This important result derives from the fact that the premium τ is not incentive neutral. In other words, as is shown below, the principal is unable to extract the surplus without impacting behaviors. We develop this particular case (PA) because it helps us highlight an important intuition of the paper.

4 Individualization and the efficiency-risk sharing trade-off

4.1 Intuition behind the Principal-Agent situation

In a PA setting, the household head solves the following optimization program

$$\begin{aligned} \underset{\{\mu,t,\tau\}}{Max} \quad & \theta\tau \\ s.t. \quad \bar{V} &\leq V(\mu, t, \tau) & (6) \\ u(c_d) &\leq u(c_h) + \delta\left(V(\mu, t, \tau) - \bar{V}\right). & (7) \end{aligned}$$

The head maximizes the expected value of the surplus he extracts from the n^{th} dependant, subject to the ex ante (6) and ad interim (7) constraints. Contrary to the more general bargaining approach which includes the exit option in the threat point of the agent, in the PA setting the head makes a take-it-or-leave-it offer to the dependant. We must therefore take account of the dependant's willingness to accept the offer captured by the ex ante participation constraint (6). As Lemma 2 states, both constraints are binding in equilibrium.

Lemma 2 *In the PA setting, both the ex ante (6) and ad interim (7) participation constraints are binding in equilibrium.*

Proof. First, suppose the ex ante participation constraint is binding and the ad interim is not. The household head can then increase the insurance transfer t, thereby improving the level of risk-sharing achieved[17]. This causes an increase in V, which enables the head to extract a higher premium τ (this is possible since the ad

[16] The decision-maker cannot be called a social planner since the latter would have been able to implement the first-best outcome.

[17] As we show below, the relevant cases are characterized by imperfect insurance. It follows that an increase in t should always improve welfare.

interim constraint is still not binding). The initial situation was therefore not optimal. Second, suppose the ad interim participation constraint is binding and the ex ante is not. In this case, the household head can reduce the insurance transfer t, thereby relaxing the ad interim constraint, in order to increase the premium τ, until the ex ante constraint is binding. The initial situation was therefore not optimal. It can be concluded that both the ex ante and ad interim participation constraints are binding in equilibrium. ■

Let $\tilde{t}$ bind the ad interim participation constraint (7). If both constraints are binding, the ad interim constraint boils down to

$$c_d = c_h \iff \tilde{t} = \frac{1}{n} Y_c - w e_c^* - \tau. \tag{8}$$

It is interesting to note that, as soon as the ex ante participation constraint is binding, the terms related to the future disappear from expression (7). In classical works on mutual insurance transfers, such as in Coate & Ravallion (1993), it is precisely the threat of exclusion from the insurance group that deters deviation. In other words, the future cost alone acts as an incentive to abide by the insurance agreement. In the PA version of our theoretical framework, the fact that the whole insurance surplus is captured by the household head prevents exclusion from playing such a role. Indeed the dependant is always indifferent between staying in the household and the exit option. As equation (8) illustrates, it follows that collective production remains as the only instrument to deal with imperfect commitment. This equation describes the maximum amount of transfer that remains compatible with the ad interim constraint. The right hand side shows that the cost of deviation is equal to the dependant's share of collective output net of the cost of effort applied to the collective field. The direct implication of this relationship is that individualization of land tenure reduces the scope for insurance through transfers.

Proposition 3 *If $p = 1$ (in the PA setting), individualization of land tenure always implies a reduction of the level of insurance transfers compatible with the ad interim participation constraint: $\partial \tilde{t}/\partial \mu < 0$. The risk faced by the household members therefore increases: $d\phi/d\mu > 0$. A tradeoff between risk-sharing and production efficiency therefore exists. The equilibrium institutional arrangement*[18] $\left(\tau^{PA}, \mu^{PA}, t^{PA}\right)$ *satisfies*

$$\begin{aligned} V\left(\tau^{PA}, \mu^{PA}, t^{PA}\right) - \bar{V} &= 0, & (9)\\ t^{PA} + \tau^{PA} - \frac{1}{n} Y_c + w e_c^* &= 0, & (10)\\ \frac{\partial Y}{\partial \mu} - n\left(\frac{\partial \phi}{\partial \mu} + \frac{\partial \phi}{\partial t}\frac{\partial \tilde{t}}{\partial \mu}\right) &= 0. & (11)\end{aligned}$$

Proof. First, the impact of individualization on the insurance transfer is given by

$$\frac{\partial \tilde{t}}{\partial \mu} = -L f_l^c + \theta f_e^c \frac{\partial e_c^*}{\partial \mu} - w \frac{\partial e_c^*}{\partial \mu} = -L f_l^c + w \frac{\partial e_c^*}{\partial \mu}(n\theta - 1) < 0,$$

where the second equality obtains by making use of (4).

Second, equations (9) and (10) are directly derived from Lemma 2.

Finally, let us solve the household head's optimization problem. By Lemma 2, both the ex ante and the ad interim constraints are binding. The following equation implicitly defines the maximal premium $\tilde{\tau}$ that the head can charge on the dependant:

$$\Omega = V\left(\tilde{\tau}, \mu, \tilde{t}\left(\tilde{\tau}, \mu\right)\right) - \bar{V} = 0, \tag{12}$$

[18] PA stands for Principal-Agent.

where $\tilde{t}(\mu, \tau)$ is the value of insurance transfer that binds the ad interim constraint. The household head maximizes $\theta\tau$ with respect to μ. The first order condition of this problem is $d\tau/d\mu = 0$. Recalling that

$$V = \theta u(c_h) + (1-\theta) u(c_0) = u\left(\frac{Y}{n} - \theta\tilde{\tau} - \phi\right),$$

and applying the implicit function theorem on (12), we get

$$\begin{aligned} \frac{d\tau}{d\mu} &= -\frac{\Omega_\mu}{\Omega_\tau} = 0 \iff \Omega_\mu = 0 \\ &\iff \frac{\partial Y}{\partial \mu} - n\left(\frac{\partial \phi}{\partial \mu} + \frac{\partial \phi}{\partial t}\frac{\partial \tilde{t}}{\partial \mu}\right) = 0. \end{aligned}$$

■

As already highlighted, the existence of the collective field entails efficiency losses caused by the moral hazard in team problem. Equation (11) states that there is a tradeoff between production efficiency and the level of risk-sharing achieved. Indeed, in the PA setting (see counter examples below), individualization of land tenure is always associated with a twofold increase in risk. On the one hand, as we have shown earlier, the direct impact of individualization on risk is positive since the size of collective output, that is shared equally among household members, is reduced. On the other hand, the amount of transfers such that the ad interim constraint remains satisifed decreases, which also constributes to the increase in risk. The equilibrium condition on μ can also be written as[19]

$$\frac{u'(c_h)}{u'(c_0)} = \frac{R_c^*/(1-\mu)}{R_I^*/\mu}. \tag{13}$$

Under risk aversion, marginal utility is decreasing. Since we always have that $c_0 \leq c_h$, the left hand side of (13) is lower than one. This ratio reflects the level of insurance achieved within the household: the less consumption is distorted across states of nature, the higher the ratio of marginal utilities. Besides, it can be shown that the right hand side of (13) does not depend on μ. This second term is the ratio of the rents per unit of land on the collective and individual parcels, respectively. Given that the rent is maximized on the individual parcels, this term is also always lower that one. It actually measures the extent of the moral hazard in team problem. If efficiency losses on the collective field are severe, this ratio tends to be low. Condition (13) illustrates that, in this case, the insurance level is accordingly low. Put differently, individualization of land tenure might be critically needed to deal with production inefficiencies, even though it causes a severe reduction in risk-sharing. This relationship highlights the tradeoff between insurance and production efficiency.

4.2 The general case

The PA approach developed in the preceding section is not fully satisfactory for at least two reasons. First, in the PA model, the Principal, as the first player of the game, is in a position to extract the whole surplus. As argued by Bell (1989), such a setting implicitly assumes that there is a perfectly elastic supply of agents. Otherwise, the Agent would have some power over the principal. In other words, in a PA framework an agent should be easily replaceable. In the context of a family, this assumption is very unrealistic. If the ex ante participation constraint of a household member is violated, this member leaves and the household size

[19] A proof is provided in Appendix.

is necessarily reduced. Moreover, a mutual insurance scheme, even under imperfect commitment, requires a minimal level of trust and needs to take place under repeated interaction. In this perspective, kinship is a decisive element, making replacement by another agent very unlikely. Second, in the particular case of this model, the PA setting artificially hides an important partial effect of individualization on risk. This effect appears with the use of the more general multilateral bargaining approach used in this section.

Let us write again the Nash bargaining program

$$\begin{aligned} \underset{\{\mu_n, t_n, \tau_n\}}{Max} \quad & \Phi(\mu_n, t_n, \tau_n) = p \ln(\theta \tau_n) + (1-p) \ln\left(V(\mu_n, t_n, \tau_n) - \bar{V}\right) \\ s.t. \quad & u(c_d) \leq u(c_h) + \delta\left(V(\mu_n, t_n, \tau_n) - \bar{V}\right), \end{aligned}$$

where p is now assumed to be strictly lower than one. Let $\tilde{t}(\mu_n, \tau_n)$ bind the ad interim participation constraint, so that $\tilde{t}$ is implicitly given by

$$\psi = u(c_d) - u(c_h) - \delta\left(\theta u(c_h) + (1-\theta) u(c_0) - \bar{V}\right) = 0. \tag{14}$$

Contrary to the PA setting in which $c_d = c_h$, we have $c_d > c_h$. This is due to the fact that, if $p < 1$, the ex ante participation constraint should not be binding since the dependant should be strictly better off than at his exit option: $V > \bar{V}$.

Proposition 4 *If $p < 1$, the impact of individualization of land tenure on the level of insurance transfer compatible with the ad interim participation constraint $\partial\tilde{t}/\partial\mu$ is ambiguous.*

Proof. Applying the implicit function theorem to equation (14), we obtain

$$\frac{\partial \tilde{t}}{\partial \mu_n} = -\frac{\psi_{\mu_n}}{\psi_{t_n}},$$

where

$$\begin{aligned} \psi_{t_n} &= u'(c_h) - \delta\theta\left[u'(c_0) - u'(c_h)\right] > 0 \\ \iff & \frac{u'(c_h)}{u'(c_0)} > \frac{\delta\theta}{1+\delta\theta}. \end{aligned} \tag{15}$$

Condition (15) states that an increase in t tightens the ad interim constraint provided that the initial insurance level is sufficiently high (the ratio of marginal utilities is monotonically related to the insurance level). This means that, if this condition is not satisfied, it is possible to increase the insurance transfer while relaxing the ad interim constraint. It is obviously profitable to do so. At some point however, condition (15) will be violated and ψ will increase until the ad interim constraint is binding (the ad interim constraint is satisfied iff $\psi \leq 0$). It can be concluded that, if $\psi = 0$, then $\psi_{t_n} > 0$. It follows that $\partial\tilde{t}/\partial\mu_n < 0 \iff \psi_{\mu_n} > 0$, with

$$\psi_{\mu_n} = u'(c_d)\frac{\partial c_d}{\partial \mu_n} - (1+\delta\theta) u'(c_h)\frac{\partial c_h}{\partial \mu_n} - \delta(1-\theta) u'(c_0)\frac{\partial c_0}{\partial \mu_n},$$

which cannot be signed unambiguously since

$$\frac{\partial c_d}{\partial \mu_n} = f_e^I \frac{\partial e_I^*}{\partial \mu_n} + f_l^I L - w\frac{\partial e_I^*}{\partial \mu_n} = f_l^I L > 0; \frac{\partial c_0}{\partial \mu_n} < 0; \frac{\partial c_h}{\partial \mu_n} > 0.$$

■

Proposition 4 is worth discussing. It suggests that, individualization of land tenure may possibly improve the incentives to abide by the insurance agreement, thereby allowing higher insurance transfers. This is because, contrary to the PA setting, household membership generates a strictly positive surplus $\left(V-\bar{V}>0\right)$. Since production efficiency within the household improves with individualization, there is a partial effect by which this surplus $\left(V-\bar{V}\right)$ increases, thereby increasing the opportunity cost of reneging on the transfer t, namely the cost of exclusion. The sign of the impact of μ on $\tilde{t}$ is, indeed, given by the sign of

$$\psi_{\mu}=u'\left(c_{d}\right)\frac{\partial c_{d}}{\partial\mu}-u'\left(c_{h}\right)\frac{\partial c_{h}}{\partial\mu}-\delta\frac{\partial V}{\partial\mu},$$

where $\partial Y/\partial\mu>0$ appears in $\partial V/\partial\mu$.

It is now evident that there exists three different sources of interaction between production efficiency and risk-sharing. First, the equal sharing of the collective output, by distributing income from the good to the bad state of the world, acts as an insurance device. Through this first partial effect, individualization of land tenure decreases the level of risk-sharing. Second, individualization of land tenure enhances the value of the ad interim exit option. This second partial effect increases the incentives to renege on the insurance agreement, thereby reducing the scope for risk-sharing through transfers. Taken together, these two first partial effects are the source of a potential tradeoff between production efficiency and risk-sharing. However, a third effect goes in opposite direction: since production efficiency increases with individualization, the value of household membership increases. This tends to improve the incentives to abide by the insurance contract.

We have thus shown that increase individualization of family land doe snot necessarily have the effect of reducing the members' ability to share risks. If the implicit transfers involved in the equal sharing of collective output diminish with the size of the collective field, reciprocal transfers between lucky and unlucky members may actually increase. If the latter effect outweighs the former, we reach the somewhat paradoxical conclusion that land privatization is not automatically adverse to risk sharing when collective farming exists in the initial situation.

5 Family size, discount rate and privatization

In this section, we discuss the effects of family size and discount rate on privatization. Regarding family size, we show that large enough families choose to fully privatize. We establish first this results for a level of taxation τ exogenously set and we then argue that since the result holds for all τ, there exits a $\bar{n}$, such that any family greater than $\bar{n}$ choose full privatization $\mu=1$. The following proposition summarizes our results:

Proposition 5 *There exists $\bar{n}\in R^{+}$ such that families with size greater than $\bar{n}$ choose to fully privatize their production: $\mu=1$. Families with $n<\bar{n}$ face a trade-off between efficiency and risk-sharing at their optimal level of privatization.*

Proof. To prove this result it is useful to write the first order condition for the optimal level of μ. The objective function of the general problem is:

$$\begin{array}{ll}\underset{\{\mu_n,t_n,\tau_n\}}{Max} & \Phi\left(\mu_{n},t_{n},\tau_{n}\right)=p\ln\left(\theta\tau_{n}\right)+\left(1-p\right)\ln\left[\theta u\left(c_{1}\right)+\left(1-\theta\right)u\left(c_{0}\right)-\left(1-\delta\right)\bar{U}_{EA}\right]\\ s.t. & u\left\{Y_{i}\left(e_{I}^{*}\right)+w\left(1-e_{I}^{*}\right)\right\}+\delta\bar{U}_{EA}\leq u\left(c_{1}\right)+\dfrac{\delta}{1-\delta}\left[\theta u\left(c_{1}\right)+\left(1-\theta\right)u\left(c_{0}\right)\right]\end{array}$$

The first order condition with respect to μ is:

$$\frac{d\Phi}{d\mu_{n}}=0\iff\frac{dEU_{m}}{d\mu}=0\iff\frac{d\tilde{c}}{d\mu}=0$$

where

$$\tilde{c} = \frac{Y}{n} - \phi\left(c_0, c_1; \theta\right)$$

is the certainty equivalent of consumption within the household. For an interior solution, the first order condition writes

$$\frac{d\tilde{c}}{d\mu} = \frac{1}{n}\frac{\partial Y}{\partial \mu} - \left(\frac{\partial \phi}{\partial \mu} + \frac{\partial \phi}{\partial t}\frac{\partial \tilde{t}}{\partial \mu}\right) = 0$$

Note that the first term $\frac{1}{n}\frac{\partial Y}{\partial \mu}$ is positive as established by Lemma 1. If the second term is negative $\left(\frac{\partial \phi}{\partial \mu} + \frac{\partial \phi}{\partial t}\frac{\partial \tilde{t}}{\partial \mu}\right)$, then privatization increases both efficiency and risk sharing, so that the solution is at a corner $\mu = 0$. The proof uses this first order condition and proceeds in four step. First, for a given level of taxation τ, we show that if n tends to $+\infty$, the risk premium θ is decreasing with privatization so that both side of the first order condition above are positive and there is no trade-off efficiency-risk-sharing. Privatization is then a win-win situation which increases both total production and insurance. When n tends to $+\infty$, the land is thus fully privatized. Second, we show that when n tends to 1, the trade-off exists, since the risk premium increases when privatization increases. Third, we show that when n goes from 1 to $+\infty$, the impact of privatization on the risk premium is monotonically decreasing. Step 4 concludes.

Step 1: We show that $\frac{d\phi}{d\mu}$ is negative when n tends to $+\infty$.

$$\begin{aligned}
\frac{d\phi}{d\mu} &= \frac{\partial \phi}{\partial \mu} + \frac{\partial \phi}{\partial t}\frac{\partial \tilde{t}}{\partial \mu} \\
&= \frac{\theta\left(1-\theta\right)\left[u'\left(c_0\right) - u'\left(c_1\right)\right]\left[\frac{\partial c_1}{\partial \mu} - \frac{\partial c_0}{\partial \mu}\right]}{\theta u'\left(c_1\right) + \left(1-\theta\right)u'\left(c_0\right)} \\
&\quad + \frac{\theta\left[u'\left(c_0\right) - u'\left(c_1\right)\right]}{\theta u'\left(c_1\right) + \left(1-\theta\right)u'\left(c_0\right)} \frac{u'\left(c_d\right) f_l^I L - \left(1+\theta\delta\right)u'\left(c_1\right)\frac{\partial c_1}{\partial \mu_n} - \delta\left(1-\theta\right)u'\left(c_0\right)\frac{\partial c_0}{\partial \mu_n}}{\left[1+\theta\delta\right]u'\left(c_1\right) - \theta\delta u'\left(c_0\right)} \\
&= \frac{\theta\left[u'\left(c_0\right) - u'\left(c_1\right)\right]}{\theta u'\left(c_1\right) + \left(1-\theta\right)u'\left(c_0\right)}\left[\left(1-\theta\right)\left[\frac{\partial c_1}{\partial \mu} - \frac{\partial c_0}{\partial \mu}\right] + \frac{u'\left(c_d\right) f_l^I L - \left(1+\theta\delta\right)u'\left(c_1\right)\frac{\partial c_1}{\partial \mu_n} - \delta\left(1-\theta\right)u'\left(c_0\right)\frac{\partial c_0}{\partial \mu_n}}{\left[1+\theta\delta\right]u'\left(c_1\right) - \theta\delta u'\left(c_0\right)}\right] \\
&= \frac{\theta\left[u'\left(c_0\right) - u'\left(c_1\right)\right]}{\theta u'\left(c_1\right) + \left(1-\theta\right)u'\left(c_0\right)}\frac{1}{\left[1+\theta\delta\right]u'\left(c_1\right) - \theta\delta u'\left(c_0\right)} \\
&\quad * \left[\left[\left[1+\theta\delta\right]u'\left(c_1\right) - \theta\delta u'\left(c_0\right)\right]\left(1-\theta\right)\left[\frac{\partial c_1}{\partial \mu} - \frac{\partial c_0}{\partial \mu}\right] + u'\left(c_d\right) f_l^I L - \left(1+\theta\delta\right)u'\left(c_1\right)\frac{\partial c_1}{\partial \mu_n} - \delta\left(1-\theta\right)u'\left(c_0\right)\frac{\partial c_0}{\partial \mu_n}\right]
\end{aligned}$$

The two terms multiplying the term in brackets in the above expression are unambiguously positive, therefore the sign of $\frac{d\phi}{d\mu}$ is the sign of the term in brackets. Let's call it $\Lambda(n,\delta)$

$$\begin{aligned}
\Lambda(n,\delta) &= [1+\theta\delta]\,u'(c_1)(1-\theta)\frac{\partial c_1}{\partial\mu} - \theta\delta u'(c_0)(1-\theta)\frac{\partial c_1}{\partial\mu} - [[1+\theta\delta]\,u'(c_1) - \theta\delta u'(c_0)](1-\theta)\frac{\partial c_0}{\partial\mu} \\
&\quad + u'(c_d)\,f_l^I L - (1+\theta\delta)\,u'(c_1)\frac{\partial c_1}{\partial\mu_n} - \delta(1-\theta)\,u'(c_0)\frac{\partial c_0}{\partial\mu_n} \\
&= -[1+\theta\delta]\,u'(c_1)\,\theta\frac{\partial c_1}{\partial\mu} - \theta\delta u'(c_0)(1-\theta)\frac{\partial c_1}{\partial\mu} - [[1+\theta\delta]\,u'(c_1) - \theta\delta u'(c_0)](1-\theta)\frac{\partial c_0}{\partial\mu} \\
&\quad + u'(c_d)\,f_l^I L - \delta(1-\theta)\,u'(c_0)\frac{\partial c_0}{\partial\mu_n} \\
&= u'(c_d)\,f_l^I L - [1+\theta\delta]\,u'(c_1)\,\theta\frac{\partial c_1}{\partial\mu} - \theta\delta u'(c_0)(1-\theta)\frac{\partial c_1}{\partial\mu} - [[1+\theta\delta]\,u'(c_1) - \theta\delta u'(c_0)](1-\theta)\frac{\partial c_0}{\partial\mu} \\
&\quad - \delta(1-\theta)\,u'(c_0)\frac{\partial c_0}{\partial\mu_n} \\
&= [1+\theta\delta]\,u'(c_1)\left[-\theta\frac{\partial c_1}{\partial\mu} - (1-\theta)\frac{\partial c_0}{\partial\mu}\right] + u'(c_d)\,f_l^I L - \theta\delta u'(c_0)(1-\theta)\frac{\partial c_1}{\partial\mu} - \delta u'(c_0)(1-\theta)^2\frac{\partial c_0}{\partial\mu} \\
&= -[1+\theta\delta]\,u'(c_1)\left[\theta\frac{\partial c_1}{\partial\mu} + (1-\theta)\frac{\partial c_0}{\partial\mu}\right] + u'(c_d)\,f_l^I L + \left[\theta\frac{\partial c_1}{\partial\mu} + (1-\theta)\frac{\partial c_0}{\partial\mu}\right](1-\theta)(-\delta u'(c_0)) \\
&= -[1+\theta\delta]\,u'(c_1)\left[\theta\frac{\partial c_1}{\partial\mu} + (1-\theta)\frac{\partial c_0}{\partial\mu}\right] + u'(c_d)\,f_l^I L + \frac{1}{n}\frac{\partial Y}{\partial\mu}(1-\theta)(-\delta u'(c_0)) \\
&= u'(c_d)\,f_l^I L - \frac{1}{n}\frac{\partial Y}{\partial\mu}\{[1+\theta\delta]\,u'(c_1) + (1-\theta)\,\delta u'(c_0)\} \\
&= u'(c_h)f_l^I L\left[\frac{u'(c_d)}{u'(c_h)} - \frac{1}{n}\frac{\partial Y}{\partial\mu}(f_l^I L)^{-1}\left[1+\delta\theta+\delta(1-\theta)\frac{u'(c_0)}{u'(c_h)}\right]\right]
\end{aligned}$$

where $\frac{1}{n}\frac{\partial Y}{\partial\mu} = \frac{1}{n}\frac{R_I^*}{\mu} - \frac{1}{n}\frac{R_C^*}{1-\mu}$ and

$$f_l^I = \frac{Y_I - e_I^* w}{\mu\frac{L}{\theta}} = \frac{R_I^*}{\mu n L} \iff f_l^I L = \frac{R_I^*}{\mu n}.$$

Thus:

$$\Lambda(n,\delta) = u'(c_h)f_l^I L\left[\frac{u'(c_d)}{u'(c_h)} - \left(1 - \frac{\mu R_C^*}{(1-\mu)R_I^*}\right)\left(1+\delta\theta+\delta(1-\theta)\frac{u'(c_0)}{u'(c_h)}\right)\right]$$

The first term in this expression is always positive. Furthermore we have $\frac{u'(c_d)}{u'(c_h)} < 1$ since $c_h \le c_d$ so that if $\left(1 - \frac{\mu R_C^*}{(1-\mu)R_I^*}\right)\left(1+\delta\theta+\delta(1-\theta)\frac{u'(c_0)}{u'(c_h)}\right) < 1$, we have $\Lambda(n,\delta) < 0$. When n tends to $+\infty$, this is the case, since the the rent from the collective field tends to zero, so that that $\frac{\mu R_C^*}{(1-\mu)R_I^*}$ tends to 1. We thus conclude that when n tends to $+\infty$, $\Lambda(n,\delta) < 0$ which implies $\frac{d\phi}{d\mu} < 0$.

Step 2: We show that $\frac{d\phi}{d\mu}$ is positive when n tends to 1^+.

Consider the above expression for $\Lambda(n,\delta)$. When n is equal to 1, there is no moral-hazard-in-team problem and no difference between collective and individual productivity. Thus when n tends to 1^+, $\frac{\mu R_C^*}{(1-\mu)R_I^*}$ tends to 1 and $\Lambda(n,\delta)$ tends to $u'(c_h)f_l^I L\frac{u'(c_d)}{u'(c_h)}$ which is unambiguously positive.

Step 3: We show that $\frac{\partial\Lambda(n,\delta)}{\partial n} < 0$

$$\frac{\partial\Lambda(n,\delta)}{\partial n} = \frac{1}{(1-\mu)}\left(\frac{\left(f_e^c\theta n\frac{\partial e_c^*}{\partial n}+f_e^c\theta e_c^*+f_l^c(1-\mu)L\right)n-Y_c}{n^2}-\theta w\frac{\partial e_c^*}{\partial n}\right)\left[u'(c_1)+\delta\left[\theta u'(c_1)+(1-\theta)u'(c_0)\right]\right]$$
$$-\left[\frac{1}{n}\frac{\partial Y}{\partial\mu}\right]\frac{\partial}{\partial n}\left[u'(c_1)+\delta\left[\theta u'(c_1)+(1-\theta)u'(c_0)\right]\right]$$

where

$$\begin{aligned}\frac{\left(f_e^c\theta n\frac{\partial e_c^*}{\partial n}+f_e^c\theta e_c^*+f_l^c(1-\mu)L\right)n-Y_c}{n^2}-\theta w\frac{\partial e_c^*}{\partial n} &= \frac{f_e^c\theta n^2\frac{\partial e_c^*}{\partial n}+Y_c-Y_c}{n^2}-\theta w\frac{\partial e_c^*}{\partial n}\\ &= f_e^c\theta\frac{\partial e_c^*}{\partial n}-\theta w\frac{\partial e_c^*}{\partial n}\\ &= (n-1)\,\theta w\frac{\partial e_c^*}{\partial n}<0\end{aligned}$$

therefore, we have

$$\frac{\partial\Lambda(n,\delta)}{\partial n}=\frac{n-1}{1-\mu}\theta w\frac{\partial e_c^*}{\partial n}\left[u'(c_1)+\delta\left[\theta u'(c_1)+(1-\theta)u'(c_0)\right]\right]-\left[\frac{1}{n}\frac{\partial Y}{\partial\mu}\right]\frac{\partial}{\partial n}\left[u'(c_1)+\delta\left[\theta u'(c_1)+(1-\theta)u'(c_0)\right]\right]$$

where

$$\begin{aligned}\frac{\partial}{\partial n}\left[u'(c_1)+\delta\left[\theta u'(c_1)+(1-\theta)u'(c_0)\right]\right] &= \frac{\partial}{\partial n}\left[(1+\delta\theta)u'(c_1)+\delta(1-\theta)u'(c_0)\right]\\ &= \left[(1+\delta\theta)u''(c_1)\frac{\partial c_1}{\partial n}+\delta(1-\theta)u''(c_0)\frac{\partial c_0}{\partial n}\right]\end{aligned}$$

where

$$\begin{aligned}\frac{\partial c_1}{\partial n} &= \frac{\partial}{\partial n}\left(\frac{Y_c}{n}\right)-w\frac{\partial e_c^*}{\partial n}\\ &= (n\theta-1)\,w\frac{\partial e_c^*}{\partial n}\end{aligned}$$
$$\frac{\partial c_0}{\partial n}=n\theta w\frac{\partial e_c^*}{\partial n}$$

we end up with

$$\frac{\partial\Lambda}{\partial n}=\frac{n-1}{1-\mu}\theta w\frac{\partial e_c^*}{\partial n}\left[u'(c_1)+\delta\left[\theta u'(c_1)+(1-\theta)u'(c_0)\right]\right]-\left[\frac{1}{n}\frac{\partial Y}{\partial\mu}\right]\frac{\partial}{\partial n}\left[u'(c_1)+\delta\left[\theta u'(c_1)+(1-\theta)u'(c_0)\right]\right]$$

This expression is unambiguously negative since effort on the collective field is decreasing in n, $\frac{\partial e_c^*}{\partial n}<0$.

Step 4 We have shown that $\frac{d\phi}{d\mu}$ is negative when n tends to $+\infty$ and positive when n tends to 1^+. Furthermore, $\frac{d\phi}{d\mu}$ is monotonically decreasing in n. As a result, for each exogenously set τ, there is a unique $\bar{n}(\tau)$ such that $\frac{d\phi}{d\mu}=0$. We can thus conclude that for any family size n greater $\bar{n}=\max_\tau\bar{n}(\tau)$, privatization always increases simultaneously efficiency and risk sharing and will therefore be complete. Conversely for $n<\bar{n}$ a trade-off exists and it privatization may or may not take place, and may be partial or complete.

■

Let us now turn to the effect of the level of impatience (discount) rate on privatization. Our main result is that patience favor privatization in the sense that above a given level of the discount rate δ, full privatization is optimal since the trade-off efficiency risk sharing disappears. Proposition 6 states this findings.

Proposition 6 *There exists $\bar{\delta} \in R^+$ such that households whose members have a discount rate greater than $\bar{\delta}$ choose to fully privatize their production: $\mu = 1$. Families with $\delta < \bar{\delta}$ face a trade-off between efficiency and risk-sharing at their optimal level of privatization.*

Proof. The proof follows the exact same steps as the proof for proposition 5.

Step 1: We show that $\frac{d\phi}{d\mu}$ is negative when δ tends to $+\infty$. Consider again the following expression, which has the sign of $\frac{d\theta}{d\mu}$:

$$\Lambda(n,\delta) = u'(c_h) f_l^I L \left[\frac{u'(c_d)}{u'(c_h)} - \left(1 - \frac{\mu R_C^*}{(1-\mu) R_I^*}\right) \left(1 + \delta\theta + \delta(1-\theta)\frac{u'(c_0)}{u'(c_h)}\right)\right]$$

It is clear from this expression that when δ tends to $+\infty$, $\Lambda(n,\delta)$ tends to $-\infty$ and is thus negative.

Step 2: We show that $\frac{d\phi}{d\mu}$ is positive when δ tends to $0+$. If we evaluate $\Lambda(n,\delta)$ in zero, we obtain:

$$\Lambda(n,0) = u'(c_h) f_l^I L \left[\frac{u'(c_d)}{u'(c_h)} - \left(1 - \frac{\mu R_C^*}{(1-\mu) R_I^*}\right)\right]$$

Furthermore, when $\delta = 0$, $c_h = c_d$. Indeed, in this situation the future has no value for the member, so that to enforce transfers, his consumption in the good state have to be no lower than his consumption if he deviates. As a result $\frac{u'(c_d)}{u'(c_h)} = 1$ and $\Lambda(n,0) > 0$

Step 3: We show that $\frac{\partial \Lambda(n,\delta)}{\partial \delta} < 0$

$$\frac{\partial \Lambda}{\partial \delta} = -u'(c_h) f_l^I L \left(1 - \frac{\mu R_C^*}{(1-\mu) R_I^*}\right) \left(\theta + (1-\theta)\frac{u'(c_0)}{u'(c_h)}\right)$$

This expression is unambiguously negative.

Step 4 We have shown that $\frac{d\phi}{d\mu}$ is negative when δ tends to $+\infty$ and positive when n tends to 0^+. Furthermore, $\frac{d\phi}{d\mu}$ is monotonically decreasing in δ. As a result, for each exogenously set τ, there is a unique $\bar{\delta}(\tau)$ such that $\frac{d\phi}{d\mu} = 0$. We can thus conclude that for level of patience δ greater $\bar{\delta} = \max_\tau \bar{\delta}(\tau)$, privatization always increases simultaneously efficiency and risk sharing and will therefore be complete. Conversely for $\delta < \bar{\delta}$ a trade-off exists and it privatization may or may not take place, and may be partial or complete.

■

6 Conclusion

When a risk-pooling, collective mechanism is available side by side with a private activity where efficiency is comparatively high but no insurance possibility exists, we expect an efficiency-insurance trade-off to arise. Removal of the collective mechanism in the context of incomplete (insurance and credit) markets would therefore be suboptimal as has been illustrated in the case of agricultural producer cooperatives.

If, on the other hand, private transfers are feasible yet returns to effort are higher in the collective activity, the collective mechanism may coexist in equilibrium with the private activity even though there may be no trade-off between efficiency and insurance. Such a conclusion has been reached in the particular case where the collective mechanism of risk pooling is a common property resource, implying that returns to effort are higher in the commons (since average rather than marginal productivity of effort is equated to its opportunity cost) than in the private activity. The superiority of the collective mechanism in terms of returns to effort is nevertheless obtained at the cost of rent dissipation and, possibly, resource degradation over the long term so that the collective mechanisms may not be sustainable as an insurance mechanism. Another situation in which one may hypothesize that insurance transfers under private property cannot ex ante Pareto dominate allocations under the collective activity obtains when, as suggested by Putterman (2006), altruism and reciprocity play an important role as incentives to provide effort in teamwork cooperative contexts.

What happens when incentive problems plague collective production yet not private production (because it is difficult or costly to measure individual contributions), and when private income transfers are feasible, is a priori unclear. Like in the first setup above, an efficiency-insurance trade-off exists, but now only potentially. Indeed, to the extent that risk can be shouldered through voluntary, reciprocal transfers, we cannot rule out the possibility that further privatization will enhance both insurance and efficiency, thus creating a win-win outcome. This paper has precisely shown that, indeed, the trade-off between efficiency and insurance can disappear when agents are allowed to make income transfers. Complete privatization may thus become optimal when some conditions are satisfied. Among these conditions is a sufficiently large size of the social unit managing the collective mechanism (in our particular set-up, the patriarchal, family farm) so that the moral-hazard-in-team problem impedes collective production enough. The central lesson from our theoretical foray is the following: it cannot be assumed that collective production is justified as soon as insurance markets are incomplete and agents are risk averse. When private transfers are possible, the efficiency-insurance trade-off is no more certain to exist, and land tenure individualization might bring both efficiency and insurance benefits.

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