AGRICULTURAL LAND RELATIONS IN TRANSITIONAL ECONOMIES: AN EVOLUTIONARY MODEL

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Abstract

This paper suggests an evolutionary model to account for the bargaining process in transitional economies leading to the emergence of formal and informal agreements between landowners who for whatever reason are not willing to farm and landless who are willing to cultivate land. In particular, each agent from each population presumes to be matched with an agent from the opponent population only once a period by assuming his opponent not to react instantaneously to the environment, he observes the strategy that better worked for agents of his population in the previous period, and he experiments with some probability towards an agrarian contract which is alternative to the prevailing one in the current period.

The bargaining process in East and Central European as well as in the former Soviet Union countries is referred to and an empirical validation based on data from a farm survey carried out in Romania is provided.

Keywords: land relations, transitional economies, bargaining process, evolutionary model

1. Introduction

Land privatization in East and Central European as well as in the former Soviet Union countries has evolved in several ways because of the several constraints faced by each government in the pursue of an efficient reform process (Swinnen and Mathijs, 1997): among them, the history of asset ownership, including its post-collectivization status; the ethnicity of pre-collectivization asset owners; and the equality of pre-collectivization asset distribution. Besides the comparison of different procedures implemented by different governments has lead to the conclusion that there is no an optimal strategy *per se* and a strategy turning out to be efficient in one country might not be efficient in another country (Brooks, Guash, Braverman and Csaki, 1991).

However two main approaches to restore property rights over land can be spotted (Brooks and Lerman, 1994): restitution to former owners and distribution to individual users. Under *restitution*, ownership rights before collectivization have been recognized: beneficiaries have received a physical plot of land and a registered title in some cases; a compensation with vouchers in other cases. Under *distribution*, beneficiaries have been named and the land divided into paper certificates of entitlement: in some cases, a physical plot of land has been identified and registered as well as the title documents issued; paper certificates have been issued, either to individuals or to profit centres, in other cases, only.

Two general statements can be made about the adoption of these procedures (Csaki and Lerman, 1994). First privatization of land in East and Central European countries (ECECs) has involved transfer of collective land to individual owners; by contrast, in the former Soviet Union countries (FSUCs) the land has been transferred by the state to collective ownership without designating the individual owner in a first stage, whereas in the second stage paper certificates of ownership and distinct plots of land have been distributed to individuals and shareholders, respectively. Second ECECs have followed the policy of reprivatization or restitution to former owners; by contrast, FSUCs have adopted the strategy of distribution to agricultural workers, both active and pensioners. Exceptions are Albania for ECECs and Baltic States for FSUCs.

Diversions from these general rules can also be observed. Because of considerations of social equity and justice, some ECECs have allocated land to farm workers who were not former landowners: for example Hungary. Due to the essential role recognized to social activities within the rural community (teachers, doctors, etc.), some FSUCs have distributed land to the rural population not employed in farming: for example Russia.

Therefore, although to a different extent in different countries, it can be observed the *coexistence of landless agents with farming capabilities and landowner agents without them* (Csaki and Lerman,

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1997). Consequentally, in each country, a process to enable landowners to sell or lease land to those who want to farm has been defined in order to avoid underutilization of land resources.

For historical and political reasons, almost all the countries have introduced several restrictions to land sales in order to prevent absentee ownerships and speculative transactions in land. For example, buying and selling of land is prohibited in Albania, whereas there is a moratorium in Romania; besides, even where buying and selling is allowed, land markets are still very thin for several reasons: land prices are usually exorbitantly high because land valuation is performed in a administratively base; the contracting parties must often belong to the same village; the transaction procedure must usually be supervised by state agencies; an official registry and titling system to record ownership rights and exchanges is often absent.

However transferability of ownership is not a prerequisite for tradebility of usership, and the above restrictions on ownership rights are not necessarily an obstacle to the emergence of an efficient agricultural structure based on market incentives. Indeed in the absence of land sales, land leases can well represent an effective alternative.

Some countries have introduced constraints to land use to observe conservation practices: for example, failure to farm the land for a specified period of time implies expropriation in Belarus, whereas use rights are completely non tradable in Turkmenistan. Some other countries have introduced laws to regulate transactions in usership: for example, the Leasing Law 16/1994 in Romania.

Therefore, although in different relative proportions in different countries, it can be observed the presence of formal and informal land agreements tracing back to the standard agrarian contracts: *fixed rent*, where the landless bears all the risk; *sharecropping*, where the contracting parts obtain a fraction of the outcome; *wage labor*, where the landowner bears all the risk.

The purpose of this paper is to provide a theoretical framework that allows to predict the land tenure system that is more likely to prevail in transitional economies. The analysis developed below will refer to East and Central European as well as in the former Soviet Union countries, but any transitional economy where the same conditions apply could have also been considered.

The choice among various land relations has been under intense investigation (Binswanger, Deininger and Feder, 1993), while a little effort has been devoted to study the process leading to an agreement between the contracting parties (Otsuka, Chuma and Hayami, 1992). Indeed the vast majority of papers assumes that there are many landless workers so that their reservation utility is exogenously given to each contracting party. It is clear that this is not the case of transitional economies depicted above where a relative small number of landless faces a relative small number of landowners.

Moreover, even when an inelastic supply of landless workers is assumed, the theory of bargaining has been applied (Binmore, Osborne and Rubinstein, 1992; Thomson, 1992): sometimes within a partial equilibrium analysis (Bell and Zusman, 1976; Bell, 1988), sometimes within a general equi-

librium analysis (Braverman and Stiglitz, 1982; Bell, 1988). It is obvious that this is not the case of transitional economies depicted above where the absence of previous experiences for both parties make them homogeneous to each other: searching effectively for the best potential use of land can be quite costly for a landowner who has low insights on its conditions because he has never been or is not anymore involved in agriculture activities; operating successfully a private farm may be quite risky for a landless who is uncertain on his skills because he has never faced similar tasks. In other words, the counterpart characteristics can not play an essential role in such an incomplete information context, and the problem is not so much to reach an agreement between two identified parties about a set of contractual clauses, but to find a counterpart who is willing to agree upon a given set of contractual statements.

Several procedures to solve the *coordination problem* should have been suggested in a general context, while only a few are plausible when conditions prevailing in transitional economies are taken into account.

The existence of uncertainty due to never experimented circumstances and the presence of adjustment costs due to possible miscoordinations lead to depict agents assuming that their opponents will not react instantaneously to their environment. The *inertia hypothesis* is made.

The existence of only a small fraction of agents changing their strategy simultaneously and the prevalence of local agreements suggest to represent agents assuming that strategies proved to be effective in previous periods are likely to remain effective for some future periods and spotting the better strategy by observing which one better worked for other people from their own population. The *myopia hypothesis* is made.

The coexistence of agents that take their action by simply mimic the most successful strategy and other agents that take their action by challenging it leads to assume that both populations consist of conservative and progressive agents, where the former take the contract that better worked for other people from his own population in the previous period as the best one, while the latter experiment with an exogenously fixed probability towards any alternative contract. The *experimentation hypothesis* is made.

Therefore in this paper we consider an agrarian context where landless with farming capabilities and landowners without them form two distinct populations that want to agree upon a contract for land utilization. Actions are taken in discrete time. Both populations know that an agreement can be reached by signing either the fixed rent or the sharecropping or the wage labor contract and realize that not agreeing upon a contract forces them to resort to activities other than agriculture. Each agent on one side is matched to at most one agent on the other side at a time. Both populations consist of conservative and progressive agents, they observe the contract that better worked for them, and they assume their opponents not to react instantaneously to the environment.

It will be shown that, from the assumptions above, an evolutionary model that predicts the land tenure system that is more likely to prevail in transitional economies emerges *only* in terms of the relative preferences of landless and landowners with respect to the alternative land relations. In particular under the assumption of risk neutrality of landless and landowners, it can be easily tested by observing the returns expected from the alternative contracts for both populations, even if a detailed survey assessing the relative preferences of landless and landowners may not be required under the assumption of risk neutrality of at least a contracting party.

The structure of the paper is as follow. In section 2 the evolutionary model on agrarian contracts is developed. An empirical validation is discussed in section 3. Section 4 draws some conclusions.

2. The evolutionary model

The purpose of this section is to analyze the issue introduced above by developing the model suggested by Kandori, Mailath and Rob (1993) [1].

The presence of landless with farming capabilities and landowners without them leads to consider an agrarian context where two distinct populations want to agree upon a contract for land utilization.

Without loss of generality we assume that the number of plots that landowners are willing to bargain over equals the number of landless who are willing to farm them and that the number of landowners equals the number of plots. Let n the number of landless and N the number of landowner. In other words n and N denote the number of times agents play the role of landless and landowner, respectively.

Notice that the results obtained below do not depend on the absolute values of n and N, but on their relative values only. Moreover n equals N *ex-post*. Finally the predictions obtained below apply whenever n and N are sufficiently large. Thus the assumptions above do not compromise the generality of our analysis.

For the sake of simplicity we assume that the number of agents does not depend on the contract that is going to prevail in equilibrium.

Analysis could be carried out for any given number of formal and informal agreements observed. Without loss of generality we assume that both populations know that an agreement can be reached by signing one out of the following three available agrarian contracts: fixed rent (F), sharecropping (S) and wage labor (W) contracts. Let lower (f, s and w) and upper (F, S and W) case letters represent payoffs for landless and landowners, respectively, when an agreement on an agrarian contract is reached.

[1] When the first draft of this paper was completed, we became aware of the work by Young (1998). His paper is entirely theoretically and differ from our work in three main respects. It assumes a utility of zero to the unattached state for each player, but asymmetries may be essential in some cases: we take $r \neq R$. It assumes that agents stick to their previous choice with a fixed probability only so that the best reply may not be reasonable in the next period: our assumption that agents take their opponents not to change their previous choice seems to better sustain the myopia hypothesis. It considers a uniform experimentation rate among individuals, but asymmetries may be essential in some cases: we take $k \neq K$.

Notice that a representative agent for each population is focused on only so that the representative preferences for each population are considered only. Moreover notice that whenever there are no agricultural traditions driving agents to adopt a specific agrarian contract without taking into account the current economic conditions, payoffs amount to preferences for expected returns and represent the characteristics of the representative agent taking the decision as well as the characteristics he expects to be present in his representative counterpart: think of attitudes towards risk or of specific factors endowments. In a general case, a proper questionnaire must be developed in order to assess payoffs for each population; however, for risk neutral agents, payoffs coincide with expected returns, and a simple survey measuring observable values is required only in this case. Thus the assumptions above do not compromise the generality of our analysis.

We assume that both populations know that not agreeing upon a contract forces them to resort to activities other than agriculture. Let r and R represent the preferences of landless and landowners, respectively, for the circumstance occurring when none of these contracts is agreed upon.

Notice that r refers to the case where landless are employed in sectors other than agriculture: think of them offering work in a nearby firm, while R refers to the case where landowners employ land in uses alternative to cultivation: think of them selling their plots. In other words phenomena such as the existence of industrial opportunities for landless or the damage of abandoned land for landowners can easily be depicted by properly calibrating the values of r and R.

When a landless and a landowner accept to sign the same contract there is agreement, whereas there is no agreement otherwise. Thus, if a landless wants to agree upon the fixed rent contract (c_F), he gets a payoff of f if he manages to meet a landowner willing to sign the same contract (C_F) and r otherwise. The same reasoning can be made when landless choose the sharecropping and the wage labor contracts. Analogously for landowners.

The payoffs that landless and landowners obtain from signing one of the three available agrarian contracts can be represented by the Matrix 1.

		landless		
		c_F	c_S	c_W
Landowners	C_F	F, f	R, r	R, r
	C_S	R, r	S, s	R, r
	C_W	R, r	R, r	W, w

Matrix 1: Payoffs for landless and landowners

Notice that analysis can be carried out for any payoffs values for both landless and landowners.

Actions are taken in discrete time in such a way that at the beginning of each period t each agent chooses his (pure) strategy for the period so that actions are fixed within the period. The economic interpretation of this assumption is that when an agent declares himself to be willing to sign a contract, he waits for a reply before turning to an alternative one.

At the beginning of each period t everyone in a population is matched with someone from the opponent population, where each matching has a positive probability over all periods. Notice that the probability distribution of matching does not affect the long-run equilibrium, but the waiting time until the process reaches that outcome only. For $n = N$ sufficiently large, this amounts to say that each agent presumes to be matched with an agent from the opponent population only once. The economic intuition behind this assumption is that when an agent does not reach an agreement with an agent from the other population in period t, he looks for a new counterpart at the beginning of period $t + 1$ rather than changing his mind on the contract he wants to agree upon.

Let l_t^F, $l_t^S$and $l_t^W$the fraction of landless adopting strategy c_F, c_S and c_W at time t, respectively, and L_t^F, $L_t^S$and $L_t^W$the fraction of landowners adopting strategy C_F, C_S and C_W at time t, respectively. Thus if a landless is willing to sign the fixed rent contract (c_F), he obtains f when he meets a landowner who wants to agree upon the same contract and r otherwise, where the former circumstance occurs in a L^F and the latter in a $(1 - L^F)$ fraction of times.

The existence of uncertainty due to never experimented circumstances leads to depict agents assuming their opponents not to react instantaneously to their environment within the period. The *inertia hypothesis* is made. Moreover, the prevalence of local agreements suggests that agents are in a position to learn which strategy is better by observing which one better worked for other people from their own population in previous periods. The *myopia hypothesis* is made. In other words the assumptions above state that at the same time when agents are learning, they are not taking into account the long-run implications of their strategy choices, but their optimal action in the short-run only.

Notice that a similar issue has been tackled by Wolinsky (1987) and Chikte and Deshmukh (1987), even if they assume agents maximizing their expected utilities.

These hypothesis have two consequences.

First, on the basis of what has been observed at time $t-1$, the expected payoffs for landless choosing strategy c_F, c_S and c_W at time t are given respectively by:

$$\pi_t^F(L_{t-1}^F) = fL_{t-1}^F + r(1 - L_{t-1}^F)$$

$$\pi_t^S(L_{t-1}^S) = sL_{t-1}^S + r(1 - L_{t-1}^S)$$

$$\pi_t^W(L_{t-1}^W) = wL_{t-1}^W + r(1 - L_{t-1}^W)$$

Analogously for landowners.

Second, all landless will choose the contract c at the beginning of period t if the payoff obtained from it in period $t - 1$ is greater than the payoffs got from the alternative ones $\bar{c}$; landless will be indifferent at time t between the contract c and the alternative one $\bar{c}$ that gave the same payoff in period $t - 1$ so that they will choose among them according to a fixed probability distribution that has

full support; no landless will choose the contract c at the beginning of period t if an alternative one $\bar{c}$ ensured a greater payoff in period $t-1$. Thus the fraction of landless choosing the contract c at time t is given by:

$$l_t^c = b_t(L_{t-1}^F, L_{t-1}^S, L_{t-1}^W) \equiv \begin{cases} 1 & \text{if} \quad \nexists \bar{c} \quad | \quad \pi_{t-1}^c(.) < \pi_{t-1}^{\bar{c}}(.) \\ l_t^c & \text{if} \quad \exists\, \bar{c} \quad | \quad \pi_{t-1}^c(.) = \pi_{t-1}^{\bar{c}}(.) \\ 0 & \text{if} \quad \exists\, \bar{c} \quad | \quad \pi_{t-1}^c(.) < \pi_{t-1}^{\bar{c}}(.) \end{cases}$$

Analogously $B_t(l_{t-1}^F, l_{t-1}^S, l_{t-1}^W)$ for landowners.

The existence of some agents trying to change the *status quo* by choosing an agrarian contract which was not to be the best response in the previous period leads to assume that each agent experiments with an exogenously fixed probability. Let k and K the probability for landless and landowners, respectively. The *experimentation hypothesis* is made. In other words this assumption says that agents sometimes observe the other agents' performance and simply mimic the most successfully strategy, while sometimes they challenge the previous status and choose an alternative strategy to the most successful one.

The availability of three agrarian contracts implies that there are two alternative contracts to the prevailing one. Thus a fraction of the population experiments with the exogenously fixed probability towards the first and the complementary fraction towards the second alternative. For the sake of simplicity we assume that $n/2$ and $N/2$ are the fractions of landless and landowners experimenting respectively towards each agrarian contract other than the prevailing one.

Notice that the half-and-half specification is implicit if agents are assumed to choose the contract at random with a uniform experimentation rate.

These assumptions yield three non-linear stochastic difference equations:

$$\widetilde{l}_t^c = l_t^c - \frac{v_{c\bar{c}}}{n} - \frac{v_{c\underline{c}}}{n} + \frac{v_{\bar{c}c}}{n} + \frac{v_{\underline{c}c}}{n} \tag{1}$$

where $v_{c\bar{c}}$ depicts the fraction of landless moving from contract c to contract $\bar{c}$ so that:

$$\widetilde{l}_t^F = b_t(L_{t-1}^F, L_{t-1}^S, L_{t-1}^W) - \frac{v_{FS}}{n} - \frac{v_{FW}}{n} + \frac{v_{SF}}{n} + \frac{v_{WF}}{n}$$

$$\widetilde{l}_t^S = b_t(L_{t-1}^F, L_{t-1}^S, L_{t-1}^W) - \frac{v_{SF}}{n} - \frac{v_{SW}}{n} + \frac{v_{FS}}{n} + \frac{v_{WS}}{n}$$

$$\widetilde{l}_t^W = b_t(L_{t-1}^F, L_{t-1}^S, L_{t-1}^W) - \frac{v_{WF}}{n} - \frac{v_{WS}}{n} + \frac{v_{FW}}{n} + \frac{v_{SW}}{n}$$

Thus, the fraction of landless choosing at time t the fixed rent contract $\widetilde{l}_t^F$ is given by the sum of a deterministic item due to the best reply dynamics $b_t(L_{t-1}^F, L_{t-1}^S, L_{t-1}^W)$ and of the stochastic elements depicting the fraction of landless who choose to be willing to sign the sharecropping and the wage labor rather than the fixed rent contract (v_{FS} and v_{FW}, respectively) and those willing to agree upon the fixed rent rather than the sharecropping and the wage labor contract (v_{SF} and v_{WF}, respectively).

The same reasoning can be made for the fraction of landless choosing at time t the sharecropping $\widetilde{l}_t^S$ and the wage labor $\widetilde{l}_t^W$ contracts. Analogously for landowners.

The dynamical system (1) defines a Markov chain on the finite state space $M = \{FF, FS, FW, SF, SS, SW, WF, WS, WW\}$ where the transition probabilities are given by $p_{ij} = \Pr[m_{t+1} = j \mid m_t = i]$ and the 9×9 Markov matrix $P = [p_{ij}]$ is presented in Appendix I.

Thus the probability that an agreement is reached at time t with landless choosing c and landowners choosing C when at time $t-1$ they chose $\overline{c}$ and $\overline{C}$ is given by the transition probability $p_{(C,c),(\overline{C},\overline{c})}$.

Notice that the following two features are accounted for. First, agents can be affected by bounded rationality in their choices over contracts: think of agents preferring a contract because of the ignorance of income patterns arising from alternative ones or liking it better because of its widespread acceptance in the economy. This phenomenon is depicted by the preference ordering for each population. Second, only some agents may be affected by bounded rationality so that some of them always play the action that turned out to be the best in the short-run, and some others accept short-run losses to achieve the optimal contract in the long-run: the relative size of these groups is depicted by the exogenous fixed probability of innovation.

The probability that a number x out of the population of $n/2$ landless that should choose a contract c according to the best reply dynamics but that actually wants to sign an alternative contract $\overline{c}$ depends on the magnitude of the number x, the population size n and the innovation rate characterizing it k. This leads to assume that the fraction of landless moving from contact c to contract $\overline{c}$ have a binomial distribution. Appendix II presents the distribution of the stochastic elements.

Notice that if the best reply dynamics at time t suggests all landless choosing the fixed rent contract so that $l_t^F = 1$, one gets:

$$v_{SW} = v_{WS} = v_{SF} = v_{WF} = 0$$

Moreover, when $l_t^S = 1$ one obtains:

$$v_{WF} = v_{FS} = v_{FW} = v_{WS} = 0$$

Finally, when $l_t^W = 1$ one gets:

$$v_{SF} = v_{FS} = v_{FW} = v_{SW} = 0$$

The economic intuition behind the first set of stochastic elements is as follows.

When at time t the best reply dynamics suggests that all landless should choose the fixed rent contract c_F, the following reasoning holds. The probability that half the landless chooses the alternative contract c_S (v_{FS}) and half the alternative contract c_W (v_{FW}) at time t positively depends on the number of landless that actually choose c_F according to the best reply dynamics ($n/2$) and on the innovation rate (k). Moreover, the probability that half the landless chooses the alternative contract c_S (v_{SW}) and

the alternative contract c_W (v_{WS}) at time t positively depends on the number of landless who do not choose the fixed rent contract c_F according to the best reply dynamics (0) and on the innovation rate (k). Finally, the probability that half the landless chooses F at time t positively depends on the number of landless that choose the alternative contracts c_S (v_{SF}) and the alternative contract c_W (v_{WF}) according to the best reply dynamics (0) and on the innovation rate k. The same reasoning can be made when at time t the best reply dynamics suggests all landless choosing the sharecropping and the wage labor contracts. Analogously for landowners.

Notice that the smaller the innovation rates ($k < 1$ and $K < 1$), the closer is the matrix P to the diagonal matrix. In other words, the probability of each state is more likely to be constant in time.

Let $\Delta_3^l \equiv \{\mathbf{l} \in R^3 | l^c \geq 0 \, for \, c = c_F, c_S, c_W \, and \, \sum_c l^c = 1\}$ be the 3-dimensions simplex where l^c is the proportion of landless playing strategy c. Let $\Delta_3^L \equiv \{\mathbf{L} \in R^3 | L^C \geq 0 \, for \, C = C_F, C_S, C_W \, and \, \sum_C L^C = 1\}$ be the 3-dimensions simplex where L^C is the proportion of landowners playing strategy C. Therefore $\Delta_3^2 \equiv \{(\mathbf{l}, \mathbf{L}) \in R^3 \times R^3 | l^c \geq 0 \, L^C \geq 0$ for $c = c_F, c_S, c_W$ and $C = C_F, C_S, C_W; \sum_c l^c = 1$ and $\sum_C L^C = 1\}$ specifies the pairs of proportions playing a particular pair of strategies (c, C).

Let the basin of attraction of the contract c for landless the subset of the 3-dimensions simplex Δ_3^l such that $\widetilde{l}_{t+1}^c > \widetilde{l}_t^c$. Let the basin of attraction of the contract C for landowners the subset of the 3-dimensions simplex Δ_3^L such that $\widetilde{L}_{t+1}^c > \widetilde{L}_t^c$. Therefore the subset of Δ_3^2 such that $\widetilde{l}_{t+1}^c > \widetilde{l}_t^c$ and such that $\widetilde{L}_{t+1}^c > \widetilde{L}_t^c$ specifies the pairs of proportions playing a particular pair of strategies (c, C) that strengthen over time.

Under the assumptions made above, all elements in the matrix P are strictly positive. This has three main consequences.

First, the Markov chain has a unique stationary distribution $\mu = (\mu_{FF}, \mu_{FS}, \mu_{FW}, \mu_{SF}, \mu_{SS}, \mu_{SW}, \mu_{WF}, \mu_{WS}, \mu_{WW}) \in \Delta_3^2$ satisfying $\mu P = \mu$ (Freidlin and Wentzell, 1984).

Second, the stochastic process is ergodic, i.e. each $\mu_{i,j}$ with $i = F, S, W$ and $j = F, S, W$ can be interpreted as the proportion of time spent on state i, j (Karlin and Taylor, 1975).

Third, the Markov chain is aperiodic and irreducible so that, independent of initial conditions, μ satisfying $\mu P = \mu$ is asymptotically and globally stable. In principle we could calculate the limit distribution for each ε by solving the equation $\mu P = \mu$ with respect to μ, but the procedure is rather complicated. However under the assumptions made above the equilibrium prevailing in the long run depends on the relative magnitude of the basins of attractions only (Kandori, Mailath and Rob, 1993). Indeed, at each time t each agent can choose the best response independently with a certain probability (k for landless and K for landowners) so that the long-run equilibrium is identified by the basin of attraction that is characterized by the less efficient escape routes along its edges.

Under the assumptions made above, all the three basins we deal with have two edges. The superposition of the 3-dimensions simplex for landless and for landowners yields Figure 1.

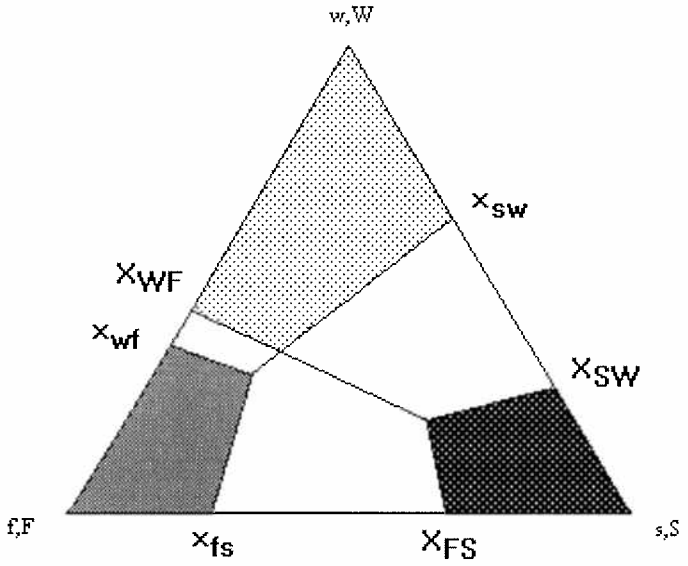

Figure 1. The 3-dimensions simplex for landless and landowners, where $X_{WF} = (W-R)/(F+W-2R)$, $X_{FS} = (S-R)/(F+S-2R)$, $X_{SW} = (S-R)/(S+W-2R)$, $x_{wf} = (f-r)/(f+w-2r)$, $x_{fs} = (f-r)/(f+s-2r)$ and $x_{sw} = (w-r)/(s+w-2r)$.

Figure 1 should be read as follows. In order to escape the fixed rent contract, one out of the two following circumstances must occur. First a fraction $(f-r)/(f+s-2r)$ of landless or a fraction $(S-R)/(F+S-2R)$ of landowners mutates its strategy towards the sharecropping contract, where the former or the latter case applies when $(f-r)/(f+s-2r) < (S-R)/(F+S-2R)$ or $(f-r)/(f+s-2r) > (S-R)/(F+S-2R)$, respectively. Second a fraction $(f-r)/(f+w-2r)$ of landless or a fraction $(W-R)/(F+W-2R)$ of landowners mutates its strategy towards the wage labor contract, where the former or the latter case applies when $(f-r)/(f+w-2r) < (W-R)/(F+W-2R)$ or $(f-r)/(f+w-2r) > (W-R)/(F+W-2R)$, respectively. This will bring the state outside the region around F. The same reasoning can be made in order to escape the sharecropping and the wage labor contracts.

Notice that the escape route to move from one contract is measured by the number of mutations in terms of a fraction of landless or a fraction of landowners provided rounding issues are ignored. Thus the number of landless n must be proportional of the number of landowners N. Moreover notice that the borders of the basins of attractions meet the following conditions:

$$(w-r)/(s+w-2r) = 1-(s-r)/(s+w-2r)$$

$$(f-r)/(f+s-2r) = 1-(s-r)/(s+s-2r)$$

$$(f-r)/(f+w-2r) = 1-(w-r)/(f+w-2r)$$

$$(S-R)/(S+W-2R) = 1-(W-R)/(S+W-2R)$$

$$(S-R)/(F+S-2R) = 1-(F-R)/(F+S-2R)$$

$$(W-R)/(F+W-2R) = 1-(F-R)/(F+W-2R)$$

Finally notice that the sizes of edges are independent of the scale of preferences.

In order to identify the contract prevailing in equilibrium, one must consider the shortest edge for each basin of attraction relative to each contract and compare them to each other: the largest edge will belong to the largest basin. Because of the large number of parameters involved, a widespread analysis can not be developed.

The next section will refer to the case of a specific country.

3. Some empirical evidence

The purpose of this section is to provide some empirical evidence to test the evolutionary model introduced in the previous section: we will refer to a country where the hypothesis on which it is based on can be assumed to hold. In particular the following minimal features must be present:

- ownership rights before collectivization have been recognized: this ensures the existence of some landless in a position to cultivate facing landowners unwilling to farm
- beneficiaries have received a physical plot of land: this allows landowners to take decisions on land allocation
- usership rights are transferable: this ensures the existence of alternative land employments

Notice that private ownership is not a prerequisite for tradebility of land so that transferability of usership rather than of ownership has been considered as an essential feature.

Romania, where the land privatization process has almost been completed and a favorable institutional and legal context has been developed, is one country that is characterized by all these features. Indeed, land has been quickly restored to former owners, user certificates have been distributed and the right to lease privately owned land is accepted: we will refer to this country hereafter.

However alternative contexts might be under investigation later on. Within countries where restitution to former owners have been chosen as method of land reform, East Germany, Baltic States, Chech Republic and Slovak Republic will also represent potential countries where the model developed in the previous section can be falsified when the moratorium on transferability of usership rights ceases. Notice that this will never be the case for Bulgaria, where substitutions have been applied, and for Hungary, where restitutions through compensation vouchers have been used. Within countries where distribution to individual users have been chosen as method of land reform, Albania and Armenia will also represent potential countries where the model obtained in the previous section can be verified. In-

deed in these countries land was divided and distributed directly to employees by disbanded previous collective farms, and farm members and workers have received ownership of land and usership of land in Albania and in Armenia, respectively. Thus the scenario arising in case future generations would prefer to undertake activities other than agriculture could be well depicted by the model introduced above.

Gordon et Al. (1998), the most recent and comprehensive survey carried out in Romania, provides baseline information on private farm resources and activities as well as accurate information on the interaction between farms and markets, private and state institutions in order to reveal which are the constraints to be overcome to allow a competitive agriculture market to emerge. We will refer to this survey from now on.

The first question to be answered is who leases land out and why.

Farmers prefer to keep a limited area for their own needs, the rest being cultivated by formal or informal associations: 37% of land originally distributed to private farmers is now in various associations. This phenomenon is easily explained by taking into account the limited resources individual farms can rely on: they are low wealth households and they have low non-agriculture incomes so that they depend in all instances from outside sources of mechanical and other services. *Elderly and absentee landowners* have no working capital to operate the land on their own so that their land is cultivated by other farmers: 49% of land distributed to people aged over 65 is leased out and at least 16% of landowners all over the country lives in cities and leases their land out.

Indeed Gordon et Al. (1998) shows that there is a positive correlation between being membership in formal or informal association (as well as leasing land out) and the size holding and the average age characterizing the household, while there is a negative correlation between leasing land out and the amount of incomes from non agricultural sources and the set of modern equipment characterizing the household.

Within the model developed above this feature can be depicted as follows:

$$W = 0$$

Besides, no alternatives are available to these landowners due to the absence of a land market. Transactions in land are unfeasible because of the lack of titling and of an appropriate registry system: up to December 1996, more than 48% of the farmers have received only users certificates for the land. Moreover individuals that have received their definitive land title still can not freely dispose of their land situated outside the village due to a moratorium imposed under Law 18/1991.

Indeed Gordon et Al. (1998) shows that the larger the size holding and the higher the average age characterizing the household, the larger is the propensity to sell land.

Within the model developed above this feature can be depicted as follows:

$$R = 0$$

The second point to put forward is who leases land in and how.

Private households of relatives and non relatives cultivate 39%, while *formal and informal associations* cultivate 56% of land given to users. Private household of relatives and formal associations are the preferred partners for leasing transactions. Moreover formal leasing is generally avoided: 55% of all agreements of giving land for use are verbal agreements, only 29% of them involves a leasing contract in accordance with the Law 16/1994, while 16% of them are not registered written agreements. In particular the *sharecropping* contract is dominant as an informal tenancy system.

The third question to be answered is whether the observed pattern of land tenure is efficient.

Formal and informal associations are well connected to the input markets: 93%, 57% and 62% of them bought certified seeds, fertilizer and insecticide or pesticide in 1996, respectively, while 50%, 43% and 22% of them obtained fuel, agricultural machinery spare parts and repair services from the market, respectively; they reached the input subsidies; 39% of them bought inputs on integrator contracts or on credit; they sold their production on a formal contract to state agencies and processing units. On the contrary *private households of relatives and non relatives* less often bought certified seeds (42%), fertilizer (32%) or plant protection chemicals (21%), not to say fuel (5%), agricultural machinery spare parts (3%) or repair services (1%); they hardly reached input subsidies; 90% of them bought inputs in cash; they sold on contract a small fraction of their production.

The theories developed in the literature suggest that the fixed rent contract should be chosen where tenants are risk neutral and are not constrained by imperfections in credit and insurance markets, while the sharecropping contract should be adopted otherwise. Indeed in the first case the loss resulting from the absence of proper work incentives are overcome, while the benefit from a suitable risk sharing are obtained in the second case.

Hence, according to the features characterizing Romania as sketched above, the sharecropping and the fixed rent contract should prevail where private households of relatives or non relatives and where formal or informal associations are involved, respectively. Indeed private households bear greater risks than associations; moreover farmers and elderly and absentee landowners are reasonably thought as risk averse to a similar extent with respect to the former and to a greater extent with respect to the latter; finally private households have worse access to credit and insurance markets than associations.

However, as highlighted above, the sharecropping contract is the dominant one in Romania. Thus the models developed in the literature seem to be inadequate to explain the contractual form chosen in a transitional economy and the assumption of an infinitely elastic supply of tenants within the

information theory and the assumption of an heterogeneous supply of tenants within the bargaining theory seem to be challenged.

Notice that the selection of farmers by landowners has not be focused on. However taking this into account and allowing for asymmetric information effects would differentiate the cases where private households and associations are involved to a greater extent because landowners are expected to sort farms out in the former case only. Moreover notice that the contract choice has not been considered under a multiperiod context because of the instability of the institutional framework that characterizes a transitional economy. Anyway recasting the problem in this context and allowing for reputation effects should make the fixed rent contract to dominate to a greater extent.

Within the framework introduced above, the sharecropping contract (C_S, c_S) will prevail whenever the following set of conditions holds:

$$\min[\min[\frac{s-r}{f+s-2r}, \frac{S-R}{F+S-2R}], \min[\frac{s-r}{s+w-2r}, \frac{S-R}{S+W-2R}]]$$

$$> \tag{2}$$

$$\min[\min[\frac{w-r}{s+w-2r}, \frac{W-R}{S+W-2R}], \min[\frac{w-r}{f+w-2r}, \frac{W-R}{F+W-2R}]]$$

and

$$\min[\min[\frac{s-r}{f+s-2r}, \frac{S-R}{F+S-2R}], \min[\frac{s-r}{s+w-2r}, \frac{S-R}{S+W-2R}]]$$

$$> \tag{3}$$

$$\min[\min[\frac{f-r}{f+w-2r}, \frac{F-R}{F+W-2R}], \min[\frac{f-r}{f+s-2r}, \frac{F-R}{F+S-2R}]]$$

Substituting $W = 0$ and $R = 0$ into inequalities (2) and (3) yields:

$$\min[\min[\frac{S}{F+S}, \frac{s-r}{f+s-2r}], \min[1, \frac{s-r}{s+w-2r}]]$$

$$> \tag{4}$$

$$\min[\min[0, \frac{w-r}{s+w-2r}], \min[0, \frac{w-r}{f+w-2r}]]$$

and

$$\min[\min[\frac{S}{F+S}, \frac{s-r}{f+s-2r}], \min[1, \frac{s-r}{s+w-2r}]]$$

$$> \tag{5}$$

$$\min[\min[1, \frac{f-r}{f+w-2r}], \min[\frac{F}{F+S}, \frac{f-r}{f+s-2r}]]$$

Formal and informal associations bear almost no risk so that their can be assumed to take their decisions by referring to returns expected from the alternative contracts. Let $f = y-c-F$, $S = (1/2)y$ and $s = (1/2)y - c$, where y and c are revenues and costs of production, respectively. Notice that assuming $S = (1/2)y-c$ and $s = (1/2)y$ or, alternatively, $S = (1/2)(y-c)$ and $s = (1/2)(y-c)$ does not change the results obtained below. Moreover there are no data to evaluate the relative propensities to innovate towards alternative contracts by landless and landowners so that their are assumed to challenge the *status quo* to the same extent.

Therefore the analysis of inequalities (4) and (5) allows to state:

The sharecropping contract will prevail in equilibrium provided one out of the following two conditions hold:

i)

$$f < s < w$$

ii)

$$f < \frac{y + r - c - \sqrt{(c+r)^2 + y(y - 2w - 2c)}}{2} < w < \frac{2c(w-r) + y(r-2w)}{2(r-w) - y} < s$$

Proof. See Appendix III.

Therefore, according to the features characterizing Romania as summarized by $W = 0$ and $R = 0$, the evolutionary model introduced above predicts that the sharecropping contract will be using by almost everybody in equilibrium provided experimentation rates are small, whenever the preferences of landowners with respect to the fixed rent contract are small enough with respect to the alternative contracts.

Notice that the conditions above ensuring that the sharecropping contract will prevail are sufficient only. In case landless could be assumed to show a greater propensity to innovate than landowners ($k > K$), the left hand sides of inequalities (4) and (5) should be replaced by $\min[\max[.,.], \max[.,.]]$.

Indeed, as highlighted above, the sharecropping contract is the dominant one in Romania. Unfortunately Gordon et Al. (1998) does not provide data on (expected) returns from alternative land tenure contracts so that, even the assumption of risk neutrality of both landless and landowners, does not allow us to assess their preferences. However the predictions above seem to well depict the case of land tenure in Romania. Indeed lease rates are typically linked to land taxes so that F is plausibly high (Csaki and Lerman, 1997); moreover f is likely to be lower than s because of the inefficiencies in the production process (Csaki and Lerman, 1994); finally, the law states that the landowner's share under a sharecropping contract is 30% so that s is plausibly high (Sarris and Gavrilescu, 1997). In other words the data seem to confirm that the relative bargaining power of contracting parties plays an essential role in transitional economies.

Therefore two main conclusions can be drawn from the analysis developed herein [2]: first, neither part is in a position to put the other part to its reservation contract; second, among the remaining contracts, the part characterized by the largest bargaining power manages to make the best preferred contract be agreed upon. The first result highlights the weak plausibility of the assumption that the reservation utility is exogenously given to each contracting party; the second result stresses the strong explanatory power of the assumption that the contracting parties mainly face a coordination problem.

Needless to say that in order to obtain a reliable test of the evolutionary model developed above several further field researches should be carried out in other ECECs or FSUCs where similar conditions apply.

4. Concluding remarks

The bargaining process between populations of landless and landowners leading a specific agrarian contract to prevail in transitional economies is depicted by an evolutionary model. In particular, each agent from each population presumes to be matched with an agent from the opponent population only once a period by assuming his opponents not to react instantaneously to the environment, he observes the strategy that gave the highest return to his population in the previous period, and he experiments with some probability towards an agrarian contract alternative to the prevailing one in the current period. The analysis refers to transitional economies in East and Central European as well as in the former Soviet Union countries, but any economy where the above conditions apply could have been considered.

Several undeveloped potentials of the model can be highlighted. Indeed the version developed here consider three preconceived contracts only, but their number can be expanded straightforwardly; it can account for the coexistence of several agreements; it refers to preferences with respect to contracts, even if returns expected from each of them can be applied where the assumption of risk neutrality can be made.

Moreover several inherent limitations of the model have been shown to vanish when transitional economies are referred to. Indeed agents are assumed to react to the entire distribution of choices by other agents in the previous period, but this can be grounded on the prevalence of local agreements; the length of time it takes the process to tip from one contract into another may be short if periods are assumed to be identified by the two successive times people enter into relationships with one another; changes in behaviors are assumed to be uncorrelated, but this has been taken because of the lack of evidence supporting an experimentation rate for landless different from that for landowners.

Therefore two main conclusions can be drawn. From a theoretical point of view, the evolutionary model developed here could show a better explanatory power in a context where alternative theories

[2] Similar results are obtained by Young (1998) for the pure coordination game.

disregarding the bargaining process could turn out to be unsatisfactory. This seems to be supported by the test based on data from Romania. From an empirical point of view, the evolutionary model presented here could be more easily validated in a context where alternative theories assuming risk neutrality could come out to be inadequate. This should lead to collect data on further transitional countries other than Romania.

Appendix I

The 9×9 matrix P is given by $P = [P_F, P_S, P_W]$ with:

$$P_F = \begin{bmatrix} (1-2a)(1-2A) & (1-2a)A & (1-2a)A \\ (1-2a)A & (1-2a)(1-2A) & (1-2a)A \\ (1-2a)A & (1-2a)A & (1-2a)(1-2A) \\ a(1-2A) & aA & aA \\ aA & a(1-2A) & aA \\ aA & aA & a(1-2A) \\ a(1-2A) & aA & aA \\ aA & a(1-2A) & aA \\ aA & aA & a(1-2A) \end{bmatrix}$$

$$P_S = \begin{bmatrix} a(1-2A) & aA & aA \\ aA & a(1-2A) & aA \\ aA & aA & a(1-2A) \\ (1-2a)(1-2A) & (1-2a)A & (1-2a)A \\ (1-2a)A & (1-2a)(1-2A) & (1-2a)A \\ (1-2a)A & (1-2a)A & (1-2a)(1-2A) \\ a(1-2A) & aA & aA \\ aA & a(1-2A) & aA \\ aA & aA & a(1-2A) \end{bmatrix}$$

$$P_W = \begin{bmatrix} a(1-2A) & aA & aA \\ aA & a(1-2A) & aA \\ aA & aA & a(1-2A) \\ a(1-2A) & aA & aA \\ aA & a(1-2A) & aA \\ aA & aA & a(1-2A) \\ (1-2a)(1-2A) & (1-2a)A & (1-2a)A \\ (1-2a)A & (1-2a)(1-2A) & (1-2a)A \\ (1-2a)A & (1-2a)A & (1-2a)(1-2A) \end{bmatrix}$$

where $a = k^{n/2}$ and $A = K^{N/2}$ and columns and rows represent from and to, respectively.

Appendix II

$$v_{FS} = v_{FW} \tilde{} Bin\{\frac{n}{2}[b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{SW} = v_{WS} \tilde{} Bin\{\frac{n}{2}[1 - b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{SF} = v_{WF} \tilde{} Bin\{\frac{n}{2}[1 - b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{SF} \tilde{} Bin\{\frac{n}{2}[b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{SW} \tilde{} Bin\{\frac{n}{2}[b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{WF} \tilde{} Bin\{\frac{n}{2}[1 - b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{FS} = v_{FW} = v_{WS} \tilde{} Bin\{\frac{n}{2}[1 - b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{WF} \tilde{} Bin\{\frac{n}{2}[b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{WS} \tilde{} Bin\{\frac{n}{2}[b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{SF} \tilde{} Bin\{\frac{n}{2}[1 - b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

$$v_{FS} = v_{FW} = v_{SW} \tilde{} Bin\{\frac{n}{2}[1 - b_t(L^F_{t-1}, L^S_{t-1}, L^W_{t-1})], k\}$$

Appendix III

It is easy to check that the inequality (4) is always met provided $S > 0$ and $s > r$. Let us apply the following notation:

$$a_{11} = \frac{S}{F+S}, a_{12} = \frac{s-r}{f+s-2r}, a_{13} = 1, a_{14} = \frac{s-r}{s+w-2r}$$

$$a_{21} = 1, a_{22} = \frac{f-r}{f+w-2r}, a_{23} = \frac{F}{F+S}, a_{24} = \frac{f-r}{f+s-2r}$$

Let us consider the case $f > s$. It is easy to obtain that:

$$\min[a_{12}, a_{14}] = \begin{cases} a_{12} & \text{if} \quad f > w \\ a_{14} & \text{if} \quad f < w \end{cases}$$

$$\min[a_{22}, a_{24}] = \begin{cases} a_{22} & \text{if} \quad s < w \\ a_{24} & \text{if} \quad s > w \end{cases}$$

Thus the comparison between a_{14} prevailing if $w > f > s$ with a_{24} prevailing if $f > s > w$ never occurs. Moreover it is immediate to show that:

$$\max[a_{12}, a_{22}] = a_{12} \text{ if } f < r + \sqrt{\frac{(w-r)(y-2c-2r)}{2}} \tag{III.1}$$

$$\max[a_{12}, a_{24}] = a_{12} \text{ if } f < s \tag{III.2}$$

$$\max[a_{14}, a_{22}] = a_{14} \text{ if } f < s \tag{III.3}$$

Thus cases (III.2) and (III.3) never apply. Finally it is straightforward to get that:

$$r + \sqrt{\frac{(w-r)(y-2c-2r)}{2}} > s \Rightarrow r + \sqrt{\frac{(w-r)(y-2c-2r)}{2}} < w$$

Thus also case (III.1) never applies. Therefore the sharecropping contract will never prevail if $f > s$.

Let us consider the case $f < s$. It is easy to obtain that:

$$\min[a_{11}, a_{14}] = \begin{cases} a_{11} & \text{if} \quad f < z_{14} \\ a_{14} & \text{if} \quad f > z_{14} \end{cases}$$

$$\min[a_{22}, a_{23}] = \begin{cases} a_{22} & \text{if} \quad f < z_{23} \\ a_{24} & \text{if} \quad f > z_{23} \end{cases}$$

where

$$z_{14} = \frac{y(3c + r + w - y) - 2c(c + r)}{2(c + r) - y}$$

$$z_{23} = \frac{2c(w - r) + y(r - 2w)}{2(r - w) - y}$$

Moreover it is immediate to show that:

$$\max[a_{11}, a_{22}] = a_{11} \text{ if } f > z_{12}^{+} \text{ or } f < z_{12}^{-} \tag{III.4}$$

$$\max[a_{11}, a_{23}] = a_{11} \text{ if } f > s \tag{III.5}$$

$$\max[a_{14}, a_{22}] = a_{14} \text{ if } f < s \tag{III.6}$$

$$\max[a_{14}, a_{23}] = a_{14} \text{ if } f > z_{43} \tag{III.7}$$

where

$$z_{12}^{+} = \frac{y + r + c + \sqrt{(c + r)^2 + y(y - 2w - 2c)}}{2}$$

$$z_{12}^{-} = \frac{y + r + c - \sqrt{(c + r)^2 + y(y - 2w - 2c)}}{2}$$

$$z_{43} = \frac{4c(w - r) - y(y - 4w + 2r - 2c)}{4(w - r)}$$

Thus the case (III.5) never applies. Finally by rewriting cases (III.4) (III.6) and (III.7) it is straightforward to obtain that:

$$\max[a_{11}, a_{22}] = a_{11} \text{ if } f < \min[s, z_{14}, z_{23}, z_{12}^{-}] = \begin{cases} s & \text{if} \quad s < w \\ z_{12}^{-} & \text{if} \quad s > w \end{cases}$$

$$\max[a_{14}, a_{22}] = a_{14} \text{ if } z_{14} < f < \min[s, z_{23}] = \begin{cases} s & \text{if} \quad s < w \\ z_{23} & \text{if} \quad s > w \end{cases}$$

$$\max[a_{14}, a_{23}] = a_{14} \text{ if } s > f > \max[z_{14}, z_{23}, z_{43}] = \begin{cases} z_{14} & \text{if} \quad s > w \\ z_{14} & \text{if} \quad s < w \text{ and } y < 2(c+r) \\ z_{43} & \text{if} \quad s < w \text{ and } y > 2(c+r) \end{cases}$$

Thus case (III.6) collapses in case (III.4) and case (III.7) never applies. ■

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