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Hold up and intergenerational transmission of preferences

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Abstract

We present an overlapping generations model with cultural transmission of preferences in which players face in each period a simplified hold up problem. In our model, both the distribution of preferences in the population and the investment policies in the long run influence one another and are determined endogenously and simultaneously. In the stable steady state of the economy there is a mixed distribution of preferences where both selfish and other-regarding preferences are present in the population. Moreover, the presence of a significant fraction of individuals with other-regarding preferences alleviates post-contractual opportunism and improves efficiency in the investment decisions.

JEL classification: C78; D23; D63

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1. Introduction

The hold up problem in real-life economies is ubiquitous, potentially arising in the presence of relation-specific investments and incomplete contracts. Whenever these two features come together, there is room for post-contractual opportunism. When relation-specific investments are non-contractable, underinvestment may occur because of hold up (Williamson (1985)). That is, the specificity of the investments makes the investors vulnerable to ex post exploitation. As agents anticipate this, there is usually too little investment.

Nevertheless, a prime source of the hold up problem is also individuals' behaviour, namely, selfish or opportunistic behaviour on the side of the partners. Obviously, in a world

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of altruists there would not be a hold up problem, as nobody would be afraid of being exploited after the investments have been made. This is probably the reason why parents do not underinvest in their children.

However, in markets and economic organisations, pure altruism (such as parental altruism) is rather exceptional. Nevertheless, although there is little doubt that many agents conform to the selfishness assumption of conventional economics (and game theory), there is also overwhelming evidence indicating that a non-negligible proportion of the population cares not only about their own material payoffs but also about reciprocity and fairness. A more realistic assumption, therefore, would be that preferences in the population are heterogeneous, but even this treatment of preferences and their distribution is rather limited. The reason is that, as is the usual treatment by economists, the distribution of preferences is taken as given, and explaining its sources or how it may change is left aside in the analysis.

This paper focuses on the formation, evolution and stability of the distribution of preferences in the population and its relationship with the investment and bargaining strategies in a simplified hold up problem. More precisely, in our model a population of infinitely-lived players (say, for example, firms) with homogeneous selfish or self-regarding preferences is pair-wise matched at each period with a population of an equal size of short-lived players (say, for example, workers) with heterogeneous preferences. Both types of player play a two-stage game. In the first stage, they decide separately but simultaneously whether to make a general or a relation-specific investment. The latter type of investment is more efficient, that is, yields a higher surplus, but it entails a higher individual cost. Moreover, both of the current investments also determine the bargaining power of the partners in the second stage of the game when they negotiate the division of the surplus. If both players have made the same kind of investment they will have the same bargaining power, but if one has made a general investment while the other has made a specific investment, the former has all the bargaining power, although the surplus to be divided is smaller. Using this simplified game, we capture a stylized hold up situation. Players are afraid of making costly specific investment because they run the risk of being exploited if their partners make a general investment.

The preferences in the population of short-lived players are heterogeneous. In each period, there is a fraction of selfish players, but there is also a fraction of players motivated by reciprocal altruism. In particular, we use the concept of *inequity aversion* of Fehr and Schmidt (1999). More precisely, strongly inequity averse players behave very differently from selfish players in a negotiation. Namely, they reject very unfair offers when they are responders, and they are generous when they are proposers.

Any short-lived player lives for two periods in an overlapping generation situation. In the second period, as an adult, each one plays the investment game already described, but she also has a descendant and makes a costly decision on education effort, trying to transmit her own preferences. The reason for this behaviour is that they are altruistic towards their offspring but in a particular form of altruism called *imperfect empathy* (see Bisin and Verdier (1998)). Namely, parents evaluate their child's well-being through the filter of their own preferences. If this *vertical transmission* of preferences does not succeed, then children acquire preferences from the social environment (*oblique transmission*). The distribution of preferences in the population of workers will, therefore, evolve over time, depending on the education effort of both types of parents, which is determined itself by the actual distribution of preferences (since oblique transmission is a substitute for vertical transmission), and by their expectations about the firms' investment and negotiation policy. In turn, the firms' policy will depend on the distribution of preferences in the population of short-lived players, which is all the information the firms have.

We find that in any stable steady state of this economy there is a mixed stationary distribution of preferences where both types are present in the population of short-lived players. In general, the presence within the population of a fraction of strongly inequity averse players alleviates the post-contractual opportunism and improves the efficiency in the optimal long-run investment decisions.

The driving force for this improvement in efficiency is not any particular "compulsion" or tendency of the inequity averse players to make specific investments as compared to selfish players. In fact, it is the opposite in some cases: for instance, when there is a conflict between efficiency and risk-dominance in the investment game, inequity averse short-lived players make general investments while selfish players (long- and short-lived) make specific investments. The driving force of the model is that the presence of a significant fraction of inequity averse players in the population plays the role of a kind of "social capital" in the economy. In other words, it works as a good substitute for complete contracting, and this occurs basically because of their aversion to advantageous inequality. Strongly inequity averse players are rather generous and fair when they are at the top (i.e., proposers in the negotiation), and this works as a "credible promise" that they will not abuse their partners after investments have been made.

Our framework allows us to introduce many important qualifications on this general result depending on the particular strategic structure of the investment game. The steady state of the economy when making a general investment is the less risky strategy is characterized by a second-best result. Namely, the long-lived player and the selfish short-lived player make specific investments, while, paradoxically, the inequity averse player makes general investments. When the efficient equilibrium, with both players making specific investment, is also the risk dominant equilibrium, we get a first-best result on investments in the long run: all players make specific investments. Lastly, the case in which the investment game has the structure of a prisoner's dilemma is the only case in which the features of the steady state may depend crucially on the initial conditions of the dynamics (i.e., the initial distribution of preferences). When the initial proportion of selfish short-lived players is low enough and under some configuration of the parameters, the economy converges to a second-best result, but if this fraction is high, the economy can remain trapped in the long run in a very inefficient situation in which everybody makes general investments and nobody has incentives to socialize their children. In our model, only an exogenous shock on expectations might get the economy out of this trap.

The only strand of literature, to our knowledge, that analyses the hold up problem in an explicitly population dynamic context is a very recent evolutionary analysis on hold up. Ellingsen and Robles (2000) and Tröger (2000) have shown that when only one party makes a specific investment, followed by play of the Nash demand game, then all stochastically stable equilibria are efficient. Therefore, it would seem that evolution "solves" the hold up problem. However, Dawid and MacLeod (2001) show that these results do not extend to the case in which both parties can make relation-specific investments. An important difference compared to our work is that these authors do not consider the *fundamental* *transformation* (Williamson) of the players' ex post bargaining position due to the kind of investment (general or specific) and, instead, they assume as renegotiation protocol a symmetric Nash demand game.

The paper is organized as follows. Section 2 introduces the model, describing the specific investment game, the inequity averse preferences, and the mechanism of cultural transmission of preferences. Section 3 analyses the optimal education effort choice of the different types of short-lived players and its determinants. In Section 4, we characterize the optimal strategies on investment and bargaining of the infinitely-lived player. Section 5 presents the main results characterizing the steady state policies (investment and bargaining) and the distribution of preferences. This analysis is done for all the possible cases concerning the structure of the investment game. Finally, Section 6 concludes.

2. The model

We consider a dynamic random matching model where an infinitely-lived player (player 1) is matched, at each period, with a short-lived player (player 2), who only lives two periods. Both populations of players are a continuum, normalized to one. From the point of view of players 2, this is an overlapping generations model. Each player 2, in the first period, is a child and is educated in certain preferences; in the second period, when she is an adult, she is matched with a long-lived player 1 who is playing a coordination game in specific investments to be described later. Also, in this second period she has one offspring and makes a decision regarding her education, trying to transmit certain types of preferences. Notice that the population size remains constant.

2.1. The specific investment game: hold up and coordination failures

A long-lived player 1 and an adult short-lived player 2 are randomly paired in any one period and play the following sequential investment game. In a first stage, each player has to decide separately and simultaneously whether to make a specific investment (S) or a general investment (G). We will assume that specific investment is more individually costly than general investment. In particular, let $c > 0$ be the cost of specific investment, and we normalise the cost of general investment to zero.

On the other hand, specific investment is more efficient. Namely, the pair of investments decided by the players determines the size of the joint surplus that has to be divided between them at a second stage. That is, if both players make specific investments, the highest surplus $\bar{v}$ is obtained. If one of them makes a specific investment and the other makes a general investment, then they get a smaller but positive surplus $\underline{v}$. Finally, if both players make a general investment they get the lowest possible surplus, which we normalise to zero. We will assume $\bar{v} > \underline{v} > c > 0$.

Each particular pair of investments also determines the bargaining power of the players at the second stage, when the players have to negotiate the division of the surplus. The reason is very intuitive: when a subject makes a general investment, this investment will be valuable outside the relationship; that is, the player can bargain with another potential partner. Conversely, if he makes a specific investment, the player will be locked in the relationship because this kind of investment is not valuable outside. Therefore, in the former case, the player has a high bargaining power, and in the latter case he has a low bargaining power.

In order to simplify the analysis, we suppose that after observing the realized surplus, players bargain following an ultimatum game with the following characteristics depending on the pair of current investments. If both players make a specific investment, they have equal bargaining power; that is, both have equal probability of being the proposer. If one player makes a specific investment and the other makes a general investment, we assume that the latter has all the bargaining power; that is, he will be the proposer in the Ultimatum game. Finally, if both players make a general investment, there is no negotiation, and both receive a zero payoff.

2.2. Reciprocal fairness: inequity aversion

Standard economic theory assumes that all people are self-regarding in the sense that they are motivated only by their own monetary payoff. This may be true of some people but, obviously, it is not true of everybody. There are many well-controlled bilateral experiments (i.e., ultimatum game, public goods provision, dictator game, ...) that indicate that a significant fraction of the subjects does not care about material payoffs but rather relative payoffs. These experiments suggest that fairness and reciprocity motives affect the behaviour of many people.

In this paper we use the model of Fehr and Schmidt. In particular, we assume that in the population of short-lived players 2, in addition to purely self-interested people, there is a fraction of people who are also motivated by inequity aversion. A person exhibits inequity aversion if she dislikes being better off than relevant others and/or she dislikes being worse off than relevant others. In other words, these persons are willing to give up some material resources in order to reduce the inequity between them and relevant others, yet from several psychological studies the willingness to pay for a reduction in disadvantageous inequity is, in general, substantially higher than the willingness to pay for a reduction in advantageous inequity. That is, the inequity aversion is asymmetric.

In this work, we will assume that there are heterogeneous preferences only on the population of players 2. Let $x = (x_1, x_2)$ denote the vector of monetary payoffs for both players. The utility function of player 2 is given by:

$$U_2(x) = x_2 - \alpha \max\{x_1 - x_2, 0\} - \beta \max\{x_2 - x_1, 0\}, \tag{1}$$

where $\beta \leq \alpha$ and $0 \leq \beta < 1$.

The second term in (1) measures the utility loss from disadvantageous inequity, while the third term measures the loss from advantageous inequity. The assumption $\beta \leq \alpha$ implies that a player suffers more from inequity that is to her disadvantage.

In order to simplify the analysis we will assume that there are only two types of agents in the population of players 2. We call selfish players those with $\alpha = \beta = 0$ and strongly inequity averse players those with $(\alpha, \beta) > 0.5$. We also assume that the following condition holds for the inequity averse players:

$$\alpha \leq \frac{2\beta - 1}{2(1 - \beta)}. \tag{2}$$

This condition establishes an upper bound on the parameter α that is increasing with the parameter β. With this assumption we want to rule out non-realistic cases with extremely high values of α.[1]

In each period t there will be a proportion p_t of selfish players and, obviously, $1 - p_t$ of strongly inequity averse players. This distribution of preferences is endogenously determined in our model by the education decisions made by the adult players 2. Our main goal is to analyse the dynamic evolution of these preferences in the population and its relation with the investment policies of the long-lived players.

2.3. Payoff functions and optimal strategies under complete information

Long-lived players 1 do not know the true type of player 2 with whom they are matched in a period t. However, we will assume that they know the preferences distribution p_t in the population of players 2. Consequently, the optimal investment and bargaining strategies of player 1 will depend on this distribution. Nevertheless, it is convenient to study the payoffs and the strategies of both players, in case player 1 was sure of player 2's type.

Firstly, assume a player 1 is matched with a selfish player 2. According to conventional game theory, if we solve the game described in Section 2.1 by backward induction, we find that the players are facing the following simultaneous game in the first period:

	S	G
S	$\frac{1}{2}\bar{v}-c$, $\frac{1}{2}\bar{v}-c$	$-c$, $\underline{v}$
G	$\underline{v}$, $-c$	0 , 0

(M.1)

where player 1 is the row-player and player 2 is the column-player. We will assume that

$$\tfrac{1}{2}\underline{v} - c > 0, \tag{A.1}$$

$$\tfrac{1}{2}\bar{v} - \underline{v} > 0. \tag{A.2}$$

With assumption (A.1) we rule out the less interesting case in which the cost of investment is very high in relation to the low surplus $\underline{v}$. Assumption (A.2) makes it easier to obtain some results. Notice that under these two assumptions, (S, S) is the efficient allocation. Even under these assumptions, game (M.1) has quite different strategic structures depending on the particular relation between the parameters. Let us describe briefly all the possible cases, which are characterized by three alternative conditions:

$$2c > \tfrac{1}{2}\bar{v} - \underline{v} > c, \tag{C.1}$$

$$2c < \tfrac{1}{2}\bar{v} - \underline{v}, \tag{C.2}$$

$$\tfrac{1}{2}\bar{v} - \underline{v} < c. \tag{D}$$

Notice that under the condition $(1/2)\bar{v} - \underline{v} > c$, the investment game (M.1) has the structure of a coordination game with two Nash equilibria in pure strategies: (S, S) and (G, G), where

[1] The experimental evidence in the ultimatum game shows that the parameter α lies between 0 and 4 (see Fehr and Schmidt).

the first term in parentheses is the investment chosen by player 1 and the second term is the investment chosen by player 2. As we can observe, (S, S) is the Pareto-dominant equilibrium and (G, G) is an inefficient equilibrium. However, if condition (C.1) holds, the inefficient equilibrium (G, G) is the risk dominant equilibrium (Harsanyi and Selten (1988)).[2] In this case, there would be a conflict between payoff-dominance and risk-dominance and, therefore, there can potentially occur a coordination failure given that the less risky strategy is to make a general investment. However, under condition (C.2), the payoff dominant equilibrium (S, S) is also the risk-dominant equilibrium.

Lastly, under condition (D), the investment game (M.1) has the structure of a prisoner's dilemma where making a general investment is a dominant strategy for both players and therefore, (G, G) is the unique Nash equilibrium.

Next, assume a player 1 is matched with probability one with a strongly inequity averse player 2. Solving again the game by backward induction, we study first the negotiation stage. If the inequity averse player 2 is the proposer in the ultimatum game, it is easy to verify that it is a dominant strategy for her always to offer an equal split of the surplus.[3] This offer will obviously be accepted by player 1. On the other hand, if player 1 is the proposer, he cannot make too greedy an offer because it would be rejected by the inequity averse responder. Thus, the optimal strategy is to offer a share of the surplus that makes player 2 indifferent between accepting or rejecting. In order to calculate this acceptance threshold t^a of player 2, we equalize to zero the utility function (1) where, without loss of generality, we have normalized the surplus to one. Thus, $t^a - \alpha(1 - 2t^a) = 0$. Therefore, $t^a(\alpha) = \alpha/(1 + 2\alpha)$. Note that this threshold t^a is strictly less than one-half for any finite α.

Summarising, player 1 offers the inequity averse player 2 a proportion t^a of the current surplus and player 2 accepts, even though she gets a utility of zero. Backward induction yields the following simultaneous game in the first stage:

	S	G
S	$\frac{1}{2}(1-t^a)\bar{v} + \frac{1}{4}\bar{v} - c$, $\frac{1}{4}\bar{v} - c$	$\frac{1}{2}\underline{v} - c$, $\frac{1}{2}\underline{v}$
G	$(1-t^a)\underline{v}$, $-c$	0 , 0

(M.2)

Note that under assumptions (A.1) and (A.2) it is a dominant strategy for player 1 to make a specific investment, and under condition (C.1) as well as in the prisoner's dilemma case, it is a dominant strategy for the inequity averse player 2 to make a general investment. However, under condition (C.2), the inequity averse player 2 has no dominant strategy.

The important feature in this case is that making a specific investment is a dominant strategy for player 1, provided that he is facing an inequity averse player 2. The intuition is quite straightforward: as strong inequity averse players are very generous proposers, player 1 does not fear exploitation in the negotiation stage when he makes a specific investment.

[2] Notice that only if condition (C.1) holds, then making a general investment is the best reply if a player expects that his opponent plays each strategy with equal probability.

[3] The utility function (1) where the surplus is normalized to one and when player 2 makes an offer $t \leq 0.5$ can be written as $U_2 = (1 - t) - \beta(1 - 2t)$. If $\beta > 0.5$ this utility is strictly increasing in t for all $t \leq 0.5$.

2.4. The cultural transmission of preferences

Preferences among short-lived agents are influenced by a socialization process. We will draw from the model of cultural transmission of preferences of Bisin and Verdier (1998). Children acquire preferences through observation, imitation and learning of cultural models prevailing in their social and cultural environment. First, offspring learn from their family (vertical transmission), and second, offspring acquire preferences from the social environment (oblique transmission). A crucial assumption of the model is that parents care about their children and want to maximize their child's well-being. Nevertheless, given that parents do not know what is best for their child, they evaluate their child's well-being through their own preferences; that is, they use their own utility function. This particular form of myopia, called imperfect empathy by Bisin and Verdier (1998), implies that parents always try to socialize their children to their own preferences.

Let $\tau^i \in [0, 1]$ be the educational effort made by a parent of type i with $i \in \{e, a\}$, where e denotes selfish and a denotes strongly inequity averse. With probability τ^i the education will be successful and the child adopts her parent's preferences, but with probability $1 - \tau^i$, the education will not be successful and the child adopts the preferences of some other adult she is randomly matched with.

Let P^{ij} denote the probability that a child of a parent with preferences i is socialized to preferences j. The socialization mechanism just introduced is then characterized by the following transition probabilities:

$$P_t^{ee} = \tau_t^e + (1 - \tau_t^e) p_t, \tag{3}$$

$$P_t^{ea} = (1 - \tau_t^e)(1 - p_t), \tag{4}$$

$$P_t^{aa} = \tau_t^a + (1 - \tau_t^a)(1 - p_t), \tag{5}$$

$$P_t^{ae} = (1 - \tau_t^a) p_t. \tag{6}$$

Given these transition probabilities it is easy to characterize the dynamic behaviour of p_t:

$$p_{t+1} = [p_t P_t^{ee} + (1 - p_t) P_t^{ae}]. \tag{7}$$

Substituting (3)–(6) we obtain

$$p_{t+1} = p_t + p_t(1 - p_t)[\tau_t^e - \tau_t^a]. \tag{8}$$

3. The education effort choice

Parents are altruistic and try to maximize their offspring's welfare by transmitting the more valuable preferences through education, but education effort involves some direct and indirect costs: education is time-consuming, it conditions the parent's choice of neighbourhood and school in order to affect the social-cultural environment where their children grow up, and so on. Let $C(\tau^i)$ denote the cost of the education effort τ^i, $i \in \{e, a\}$. While it is possible to obtain similar results with any increasing and convex cost function, we will assume, for simplicity, the following quadratic form $C(\tau^i) = (\tau^i)^2/2k$, where $k > 0$. Therefore, a parent of type i chooses the education effort $\tau^i \in [0, 1]$ at time t, that maximizes

$$P_t^{ii}(\tau^i, p_t)U^{ii}(\sigma_{t+1}) + P_t^{ij}(\tau^i, p_t)U^{ij}(\sigma_{t+1}) - \frac{(\tau^i)^2}{2k} \tag{9}$$

where P^{ij} are the transition probabilities and U^{ij} is the utility to a parent with preferences i if her child is of type j. Notice that the utility U^{ij} depends on σ_{t+1}, which denotes the policy of the long-lived players in $t+1$. This policy has two components $\{\sigma_1, \sigma_N\}$ where the first component denotes the investment policy of the long-lived players and the second denotes their negotiation policy. It is assumed that parents have perfect foresight, equivalent to rational expectations in this deterministic context. Namely, parents in period t have an expectation on the preferences distribution in the next period $t+1$, p_{t+1}^{E}. As we will see in the next section the policy of the long-lived players in period $t+1$ depends on p_{t+1}. In this paper we will analyze perfect foresight paths of preferences, that is, $p_{t+1}^{\mathrm{E}} = p_{t+1}$. Hence, parents know σ_{t+1}.

According to the imperfect empathy notion a parent of type i uses her own utility function in order to assess U^{ij}. Thus, parents obtain a higher utility if their children share their preferences. As a consequence, $U^{ee} \geq U^{ea}$ and $U^{aa} \geq U^{ae}$.

Maximizing (9) with respect to τ^i, $i \in \{e, a\}$ we get the following first order conditions:

$$\frac{\mathrm{d}P_t^{ii}(\tau^i, p_t)}{\mathrm{d}\tau^i}U^{ii}(\sigma_{t+1}) + \frac{\mathrm{d}P_t^{ij}(\tau^i, p_t)}{\mathrm{d}\tau^i}U^{ij}(\sigma_{t+1}) = \frac{\tau^i}{k}. \tag{10}$$

Substituting (3)–(6), we obtain the optimal effort levels:

$$\hat{\tau}^e(p_t, \sigma_{t+1}) = k\Delta U^e(\sigma_{t+1})(1 - p_t), \tag{11}$$

$$\hat{\tau}^a(p_t, \sigma_{t+1}) = k\Delta U^a(\sigma_{t+1})p_t. \tag{12}$$

Here $\Delta U^e(\sigma_{t+1}) = U^{ee}(\sigma_{t+1}) - U^{ea}(\sigma_{t+1}))$ and $\Delta U^a(\sigma_{t+1}) = U^{aa}(\sigma_{t+1}) - U^{ae}(\sigma_{t+1})$. That is, ΔU^i is the net gain from socializing your child to your own preferences. In order to have interior solutions the parameter k must be chosen small enough so that in equilibrium $\tau^i < 1$.

Differentiation of the first order conditions with respect to p_t yields

$$\frac{\mathrm{d}\tau^e(p_t, \sigma_{t+1})}{\mathrm{d}p_t} = -k\Delta U^e(\sigma_{t+1}) < 0, \tag{13}$$

$$\frac{\mathrm{d}\tau^a(p_t, \sigma_{t+1})}{\mathrm{d}p_t} = k\Delta U^a(\sigma_{t+1}) > 0. \tag{14}$$

Note that the education effort $\tau^e(\cdot)$ of a selfish parent decreases with the proportion of selfish individuals in the population. The reason is very intuitive: the larger p_t is, the better children are socialized to the selfish preferences in the social environment. On the contrary, the educational effort chosen by the inequity averse players 2 $\tau^a(\cdot)$ increases with p_t; that is, the greater the proportion of selfish players in the population, the bigger the socialization effort of the former parents in order to offset the pressure of the environment if they want their children to share their own preferences. In other words, oblique transmission acts as a substitute for vertical transmission. Bisin and Verdier (2000a,b) refer to this feature of educational effort as "the cultural substitution property." It holds in our model because of the particular cost function we have assumed. For example, if the cost function of any type of parent depends not only on τ but also negatively on the proportion of this type in the population, this property will not hold and the result would change.

The other determinant of the optimal educational effort is the relative profits ΔU^i to a parent of type i from transmitting her own cultural traits, which depends on the policy σ_{t+1} of the long-lived players in the next period. The next section is devoted to the analysis of the optimal policies of these latter players.

4. The optimal policy of infinitely-lived players

If an infinitely-lived player is the proposer in the negotiation stage, his optimal offer will depend on the distribution of preferences in the population of players 2. Namely, if he offers zero, only the selfish type of player 2 will accept. Therefore his expected payoff will be p_t (where we have normalized the surplus to one). However, if he offers the inequity averse player's acceptance threshold $t^a > 0$, both types of player 2 will accept, and player 1 will get a payoff of $1-t^a$. Summarising, if $p_t > 1-t^a$ the infinitely-lived player 1 offers zero to his opponent, and if $p_t \leq 1-t^a$, he offers the acceptance threshold t^a. That is, $\sigma_N \in \{0, t^a\}$.

Player 1 has two kinds of policy or strategy in the repeated investment game. Let σ^{G} be the G-pooling strategy consisting of making general investments in all periods. Also assume rational expectations. In this case, if the inequity averse player 2 makes a specific investment, the selfish player 1 will be the proposer and, as we have just obtained, he offers either zero or the inequity averse players' acceptance threshold. In both cases, the utility to the inequity averse player is $-c$. If instead the inequity averse player 2 makes a general investment, her expected payoff is zero, so the inequity averse player 2 will make a general investment when she anticipates σ^G. As a consequence, if player 1 observes the specific investment of his opponent, he will conclude that this decision comes from the selfish player 2, and he will offer zero to her, resulting in the latter expected payoff of $-c$. However, if the selfish player 2 makes a general investment, she obtains a zero payoff; therefore, the selfish player 2 makes a general investment too. Summarising, the expected payoff to a selfish player 1 if he follows a G-pooling strategy is zero because both types of short-lived players will reply with general investment.

Let σ^{S} be the S-pooling strategy consisting of making specific investments in all periods. Let us assume again that player 2 correctly anticipates this strategy. In this case, the minimum payoff obtained by a selfish player 2 if she makes a specific investment is given by $(1/2)\bar{v}-c$,[4] whereas if she makes a general investment, she obtains v. In the coordination case, that is, if conditions (C.1) or (C.2) hold, a selfish player 2 will choose specific investment. On the other hand, the payoff obtained by the inequity averse player 2 if she makes a specific investment will be $(1/4)\bar{v}-c$.[5] On the contrary, by making a general investment she obtains

[4] Note that, with probability 1/2, player 1 is the proposer and his optimal offer is either zero or the inequity averse player's acceptance threshold and that, with probability 1/2, the selfish player 2 is the proposer and claims all the surplus.

[5] Recall that if she is the proposer, she offers half of the surplus $\bar{v}$, but if she is the responder, irrespective of the offer of player 1, she obtains a utility of zero.

$(1/2)\underline{v}$. Depending on conditions (C.1) or (C.2), the inequity averse player 2 makes general investment or specific investment, respectively. Therefore, the expected payoff per period for a long-lived player 1 if he follows an S-pooling strategy is given by

$$p_t\left(\frac{1}{2}\bar{v}-c\right)+(1-p_t)\left(\frac{1}{2}\underline{v}-c\right)$$

whenever condition (C.1) is satisfied and

$$p_t\left(\frac{1}{2}\bar{v}-c\right)+(1-p_t)\left(\frac{1}{4}\bar{v}-c\right), \quad \text{if } p_t > 1-t^a$$

$$p_t\left(\frac{1}{2}(1-t^a)\bar{v}-c\right)+(1-p_t)\left(\frac{1}{2}(1-t^a)\bar{v}+\frac{1}{4}\bar{v}-c\right), \quad \text{if } p_t \le 1-t^a$$

whenever condition (C.2) is satisfied.

It is straightforward to check that in all cases these payoffs are strictly positive. Consequently, the optimal strategy of player 1 under condition (C.1) or (C.2) is the S-pooling strategy. We summarise all the previous analysis in the following two results:

Result 1: Under condition (C.1) or (C.2) on the investment coordination game (M.1), the long-lived player 1 always makes a specific investment (S-pooling strategy), the selfish type of player 2 also makes a specific investment, and the inequity averse type of player 2 makes a general investment under condition (C.1) and a specific investment under condition (C.2).

Result 2: Under condition (C.1), the long-lived player 1 always offers zero if he is the proposer. When condition (C.2) holds, player 1, as a proposer in the bargaining stage, either offers zero if $p_t > 1-t^a$ or offers the threshold t^a if $p_t \le 1-t^a$.

If the investment game has the structure of a prisoner's dilemma (condition (D)), then if player 1 follows a *G-pooling strategy* his expected payoff is zero. Instead, if player 1 follows an *S-pooling strategy*, his expected payoff will be $p_t(-c)+(1-p_t)((1/2)\underline{v}-c)$, as making a general investment is a dominant strategy for both types of player 2. Comparing these payoffs, the optimal strategy of player 1 under condition (D) is:

- the S-pooling strategy σ^{S} if $p_t \le p' = ((1/2)\underline{v}-c)/(1/2)\underline{v}$.
- the G-pooling strategy σ^{G} if $p_t > p' = ((1/2)\underline{v}-c)/(1/2)\underline{v}$.

It follows from all the previous results that the strategy $\sigma_t = \{\sigma_I, \sigma_N\}$, where $\sigma_I \in \{\sigma^{\mathrm{G}}, \sigma^{\mathrm{S}}\}$ and $\sigma_N \in \{0, t^a\}$, is a function of p_t (where the form of the function depends on the case). Thus, from here on, σ_t can be replaced by $\sigma_t = \sigma(p_t)$.

5. Investment and preference distribution in the long run

In this section we will characterise the steady states of the economy in all possible cases, that is, depending on the particular structure of the investment game.

5.1. Case (C.1): an investment coordination game with a conflict between risk-dominance and Pareto-efficiency

In this case, the selfish player 2 makes a specific investment while the inequity averse player 2 makes a general investment. The long-lived player 1 makes a specific investment and offers always zero at the negotiation stage. Therefore, the expected policy $\sigma(p_{t+1})$is fixed for all p_{t+1}. We will denote this policy as $\hat{\sigma} = \{\sigma^S, 0\}$.

The utilities U^{ij} are given by:

$$U^{ee} = \frac{1}{2}\bar{v} - c, \qquad U^{aa} = \frac{1}{2}\underline{v}$$

$$U^{ea} = \frac{1}{2}\underline{v}, \qquad U^{ae} = \frac{1}{2}\bar{v}(1-\alpha-\beta) - c$$

Notice that in order to assess U^{ij} we use the imperfect empathy notion. That is, a parent of type *i* evaluates her child's well-being using her own utility function. For instance, U^{ae} is the utility to an inequity averse parent if her child is selfish. The child makes a specific investment and with probability one-half she will be the proposer in the bargaining stage and will claim all the surplus $\bar{v}$. Evaluating this payoff through the parent's utility function, the parent obtains $\bar{v}(1-\beta)$. With probability one-half, the child acts as a responder in the negotiation stage and receives a zero payoff. Evaluating this payoff through the parent's preferences, the parent obtains $-\alpha\bar{v}$. Consequently, $\frac{1}{2}\bar{v}(1-\alpha-\beta) - c$ is the utility to an inequity averse parent if her child is selfish (notice that this quantity is negative since $\alpha+\beta > 1$). Therefore, the net gains from socialization are given by $\Delta U^e = (1/2)\bar{v} - c - (1/2)\underline{v}$ and $\Delta U^a = (1/2)\underline{v} - ((1/2)\bar{v}(1-\alpha-\beta) - c)$.

The dynamic behaviour of the distribution of preferences in the population of the short-lived players 2 is given by the equation in differences:

$$p_{t+1} = p_t + p_t(1-p_t)[k\Delta U^e(1-p_t) - k\Delta U^a p_t]. \tag{15}$$

The next proposition characterises the globally stable steady state of the economy.

Proposition 1. *Under* (*C*.1) *for all* $p_0 \in (0,1)$, p_t *converges to* $= \bar{p} = ((1/2)\bar{v} - c - (1/2)\underline{v})/((1/2)\bar{v}(\alpha+\beta))$, *where* $\bar{p}$ *is such that* $\tau^e(\bar{p},\hat{\sigma}) = \tau^a(\bar{p},\hat{\sigma})$.

Proof. See Appendix A available on Elsevier website. □

Therefore, the steady state of the society when there is a conflict between risk-dominance and payoff-dominance in the investment coordination game is characterized, on the one hand, by a heterogeneous stationary distribution of preferences in the population of short-lived players and, on the other hand, by the following investment policies: the selfish players, that is, player 1 and the selfish type of player 2, make a specific investment, and the inequity averse player 2 makes a general investment. Recall that if we had assumed homogeneous selfish preferences in the population, there may potentially occur a coordination failure given that the less risky strategy is to make a general investment. By contrast, in the dynamic and heterogeneous preferences model we obtain a second-best result. Therefore, the presence of a proportion of inequity averse agents in the population of players 2 yields a significant improvement in efficiency.

The result that only the inequity averse player 2 makes a general investment may seem paradoxical at first, but, in fact, it is rather intuitive. The presence of this type of player, who always offers half of the surplus in the negotiation stage, provides strong incentives for the selfish players (1 and 2) to make specific investments, but the presence of selfish long-lived players induces the inequity averse short-lived agent to make a general investment because he anticipates that he will receive very greedy offers.[6]

Under condition (C.1), the equilibrium fraction $\bar{p}$ of selfish individuals is always less than one-half. This occurs because $\Delta U^a > \Delta U^e$; inequity averse parents have stronger incentives than selfish parents to transmit their preferences to their children. This steady state proportion $\bar{p}$ is decreasing with the degree of inequity aversion (either the disadvantageous inequity aversion α or the advantageous inequity aversion β). The reason is very intuitive: the greater α or β, the greater the utility loss to an inequity averse parent if her child is selfish and the greater the educational effort will be in order to avoid this; that is, the socialization function τ^a shifts upwards for all p, but ΔU^e is not affected. Therefore, the socialization function τ^e does not change. As a result, $\bar{p}$ diminishes. This has another implication: given that the expected surplus for each match in the steady state is $\overrightarrow{p}\ \bar{v} + (1-\bar{p})\underline{v}$, the aggregate efficiency of the economy diminishes. Paradoxically, the long-lived players 1 need, as we have seen, the presence in the population of short-lived inequity averse potential partners in order to have the right incentives to invest efficiently, but, nevertheless, they prefer the lowest possible degree of inequity aversion in these partners.

The steady state proportion $\bar{p}$ also diminishes if the cost of the specific investment c or the low surplus v increases (provided condition (C.1) still holds). In both cases ΔU^a increases and ΔU^e decreases. As a consequence, for any p_t, the optimal socialization function τ^a of the inequity averse players shifts upwards and the corresponding function τ^e for the selfish type shifts downwards. Lastly, if the high surplus $\bar{v}$ increases, the optimal socialization function of both types shifts upwards. However, it can be proved that the net effect is an increment in the steady state proportion $\bar{p}$ of selfish players.

5.2. Case (C.2): an investment coordination game without a conflict between risk-dominance and Pareto-efficiency

In this case, both types of players 2 make specific investments and the long-lived player 1 follows an S-pooling strategy. Nevertheless, the negotiation strategy of player 1 depends on the distribution of preferences in the population of players 2. Namely, if $p_{t+1} > 1 - t^a$, the infinitely-lived player 1 offers zero to his opponent, and if $p_{t+1} \leq 1 - t^a$, he offers the acceptance threshold t^a. Therefore, we will denote the policy of the long-lived players in $t+1$ as $\sigma(p_{t+1}) = \hat{\sigma} = \{\sigma^{\mathrm{S}}, 0\}$ if $p_{t+1} > 1 - t^a$ and $\sigma(p_{t+1}) = \sigma' = \{\sigma^{\mathrm{S}}, t^a\}$ if $p_{t+1} \leq 1 - t^a$. Consequently, the net gains from socialization ΔU^i will depend on the expected distribution of preferences in the next period p^{E}_{t+1}.

- If $p^{\mathrm{E}}_{t+1} > 1 - t^a$

$$U^{ee} = \tfrac{1}{2}\bar{v} - c \quad U^{aa} = \tfrac{1}{4}\bar{v} - c$$
$$U^{ea} = \tfrac{1}{4}\bar{v} - c \quad U^{ae} = \tfrac{1}{2}\bar{v}(1-\alpha-\beta) - c$$

[6] This kind of paradoxical result is also obtained by Fehr and Schmidt (2000) in a different model: a static principal-agent model. The presence of fair principals induces the selfish agents to perform, and the presence of selfish principals induces fair agents to defect under implicit contract because they are afraid of being cheated by the selfish principals.

Therefore, $\Delta U^e = (1/4)\bar{v}$ and $\Delta U^a = (1/2)\bar{v}(\alpha + \beta - (1/2))$.

- If $p^{\mathrm{E}}_{t+1} \leq 1 - t^a$

$$U^{ee} = \tfrac{1}{2}\bar{v}(1 + t^a) - c \quad U^{aa} = \tfrac{1}{4}\bar{v} - c$$
$$U^{ea} = \tfrac{1}{4}\bar{v} + \tfrac{1}{2}\bar{v}t^a - c \quad U^{ae} = \tfrac{1}{2}\bar{v}(1 - \beta) - c$$

Therefore, $\Delta U^e = (1/4)\bar{v}$ and $\Delta U^a = (1/2)\bar{v}(\beta - (1/2))$.

The two possibilities $p^{\mathrm{E}}_{t+1} > 1 - t^a$ and $p^{\mathrm{E}}_{t+1} \leq 1 - t^a$ lead to a two-branch dynamics:

$$p_{t+1} = p_t \left[1 + \tfrac{1}{4}k\bar{v}(1 - p_t)(1 - 2(\alpha + \beta)p_t\right], \quad \text{if } p_{t+1} > 1 - t^a; \tag{A}$$

$$p_{t+1} = p_t \left[1 + \tfrac{1}{4}k\bar{v}(1 - p_t)(1 - 2\beta p_t)\right], \quad \text{if } p_{t+1} \leq 1 - t^a. \tag{B}$$

The equations come from (8) in Section 2.4. In the "if" condition, p^{E}_{t+1} has been replaced by p_{t+1} under the perfect foresight assumption. Notice that there is a discontinuity in $p = 1 - t^a = (1 + \alpha)/(1 + 2\alpha)$. To explain (A) and (B) as a single dynamics, suppose we have a value for p_t. How do we get p_{t+1}? First plug p_t into the equation in (A) to get a potential value for p_{t+1}. If this potential p_{t+1} satisfies $p_{t+1} > 1 - t^a$, then it is a legitimate value for p_{t+1}. Next plug p_t into the equation in (B) to get another provisional value for p_{t+1}. If this p_{t+1} satisfies $p_{t+1} < 1 - t^a$, it is a legitimate value for p_{t+1}. These two steps will yield either no value for p_{t+1}, a unique p_{t+1}, or two values of p_{t+1}.

It follows that there are three possibilities to consider in constructing a complete perfect foresight path $\{p_0, p_1, \ldots, p_t, p_{t+1}, \ldots\}$. Possibility (i): A perfect foresight path does not exist. Starting from p_0, the dynamics may come to a step p_t on the partial path $\{p_0, p_1, \ldots, p_t\}$ for which (A) and (B) yield no value of p_{t+1}. The dynamics then breaks down; there is no perfect foresight path. Possibility (ii): There is a unique perfect foresight path. Starting from p_0, (A) and (B) may yield exactly one p_{t+1} for each p_t. Possibility (iii): There is more than one perfect foresight path. Starting from p_0, the dynamics may come to a step p_t for which (A) and (B) both yield a value for p_{t+1}. Thus, two paths split off. Then there are at least two perfect foresight paths, and there may be more since other splits may occur.

The phase diagram in Fig. 1 shows which possibilities apply for Case (C.2). Fig. 1 is qualitatively correct for all admissible parameter values.

Notice that $\breve{p}_{\mathrm{B}}$ is such that $F_{\mathrm{B}}(\breve{p}_{\mathrm{B}}) = 1 - t^a$ and $\breve{p}_{\mathrm{A}}$ is such that $F_{\mathrm{A}}(\breve{p}_{\mathrm{A}}) = 1 - t^a$. In general, for any particular values of the parameters in case C.2, $\breve{p}_{\mathrm{A}}$ is always greater than $\breve{p}_{\mathrm{B}}$, because $\alpha > 0$ (just compare the general formulas of dynamics (A) and (B)).

If p_0 is in the interval $(0, \breve{p}_{\mathrm{B}}]$ it follows from inspection that a unique p_t path results with p_t converging to $\tilde{p} = 1/(2\beta)$. If p_0 is in the interval $(\breve{p}_{\mathrm{B}}, \breve{p}_{\mathrm{A}})$ there is no p_1 and thus no perfect foresight path. What happens for $p_0 \in [\breve{p}_{\mathrm{A}}, 1)$? We show formally in the Appendix A that for a subset of initial conditions in this interval the dynamics will eventually reach the interval $(\breve{p}_{\mathrm{B}}, \breve{p}_{\mathrm{A}})$ and therefore there will be no perfect foresight path, but for the rest of initial conditions the dynamics will jump over the latter interval, landing in interval

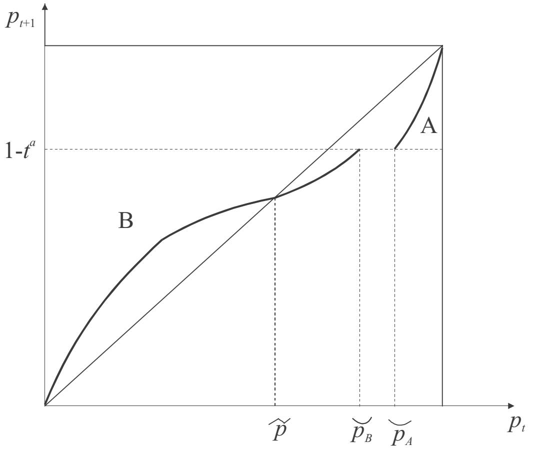

Fig. 1. Preferences dynamics in case (C.2).

$(0, \breve{p}_{\mathrm{B}}]$ and leading to a unique path that converges to $\tilde{p}$. Since the (A) and (B) branches do not overlap, there is no possibility of more than one perfect foresight path for a given p_0.[7]

The complete and formal analysis of these possibilities is relegated to the Appendix A. The next proposition only states the major conclusion.

Proposition 2. *In case* (*C*.2) *and* $C''(\tau) = 1/k \geq ((\alpha + \beta)\bar{v})/6$, *a perfect foresight path will exist for some initial values* p_0 *and not for others*. *When a perfect foresight path exists, it is unique, with* p_t *converging to* $\tilde{p} = 1/(2\beta)$ *where* $\tilde{p}$ *is such that* $\tau^e(\tilde{p}, \sigma') = \tau^a(\tilde{p}, \sigma')$.

Proof. See Appendix A available on Elsevier website. □

Therefore, the steady state of the economy when there is no conflict between risk- and Pareto-dominance in the investment coordination game is characterized by the fact that all players make specific investments. That is, there is no coordination failure and the first-best result is achieved.

Regarding the preferences distribution in the population of players 2, notice that there will be a greater fraction of selfish than inequity averse types in the population. This occurs because $\Delta U^e > \Delta U^a$. That is, the incentives to socialize their offspring derived from the benefits of transmitting their own preferences are greater for the selfish parents. Nevertheless, in the steady state of the economy, the long-lived players follow policy σ', implying that when they are proposers in the negotiation stage, they offer a positive share of the surplus t^a. In other words, there is also efficiency in the negotiation stage.

[7] It easy to check that there will exist a perfect foresight path for all p_0 if players 2 had backward looking expectations, believing that the long-lived players 1 will follow today's policy in the next period.

5.3. Case (D): an investment game with the structure of a prisoner's dilemma

In this case, the long-lived player 1 follows an S-pooling strategy if $p_{t+1} \leq p' = ((1/2)\underline{v}-c)/(1/2)\underline{v}$. Otherwise, he follows a G-pooling strategy. Moreover, it is a dominant strategy for both types of player 2 to make general investments. Notice that player 1 will never act as a proposer. Therefore, we have only to take into account the investment policies σ^{S} and σ^{G}.

Assume that $p_{t+1}^{\mathrm{E}} \leq ((1/2)\underline{v} - c)/(1/2)\underline{v}$, the utilities U^{ij} are given by:

$$\begin{array}{ll} U^{ee} = \underline{v} & U^{aa} = \frac{1}{2}\underline{v} \\ U^{ea} = \frac{1}{2}\underline{v} & U^{ae} = \underline{v}(1-\beta) \end{array}$$

Therefore, $\Delta U^e = (1/2)\underline{v}$ and $\Delta U^a = \underline{v}(\beta - (1/2))$.

On the other hand, when $p_{t+1}^{\mathrm{E}} > ((1/2)\underline{v}-c)/(1/2)\underline{v}$, it follows that $U^{ee} = U^{ea} = U^{aa} = U^{ae} = 0$. Obviously $\Delta U^e = \Delta U^a = 0$ and therefore, $\tau^e(p_t, \sigma^{\mathrm{G}}) = \tau^a(p_t, \sigma^{\mathrm{G}}) = 0$.

The two possibilities, $p_{t+1}^{\mathrm{E}} \leq p'$ and $p_{t+1}^{\mathrm{E}} > p'$, lead again to a two-branch dynamics:

$$p_{t+1} = p_t + p_t(1-p_t)[k\tfrac{1}{2}\underline{v}(1-p_t) - k\underline{v}(\beta - \tfrac{1}{2})p_t], \quad \text{if } p_{t+1} \leq p' \tag{A}$$

$$p_{t+1} = p_t, \quad \text{if } p_{t+1} > p' \tag{B}$$

where the "if" condition, p_{t+1}^{E} has been replaced by p_{t+1} under the perfect foresight assumption. In the next proposition we characterise the steady states of the perfect foresight paths of preferences in this system. Notice that $\tilde{p} = 1/(2\beta)$ is the preferences distribution for which $\tau^e(\tilde{p}, \sigma^{\mathrm{S}}) = \tau^a(\tilde{p}, \sigma^{\mathrm{S}})$.

Proposition 3. *Under (D) and $C''(\tau) = 1/k \geq (\beta\underline{v})/3$,*

1. *If $p' < \tilde{p}$, whenever $p_0 > p'$, $p_t = p_0$ for all t.*
2. *If $p' \geq \tilde{p}$, whenever $p_0 \leq p'$, p_t converges to $\tilde{p} = 1/(2\beta)$ and whenever $p_0 > p'$, there exists a $\breve{p} \in (p', 1)$, such that for $p_0 > \breve{p}$, $p_t = p_0$ for all t and for p_0 such that $p' < p_0 \leq \breve{p}$, p_t either converges to $\tilde{p}$ or remains in p_0 for all t.*

Proof. See Appendix A available on Elsevier website. □

Hence, the steady state of the society when the investment game has the structure of a prisoner's dilemma depends on the relationship between the parameters β, and $\underline{v}$ and c, which determines the values of $\tilde{p}$ and p', respectively.

When $p' < \tilde{p}$ and $p_0 > p'$, the economy would remain locked in a very inefficient situation where all agents make general investments. The reason is that if the initial proportion of selfish types in the population of players 2 is sufficiently high, the long-lived players 1 prefer to make general investments. If both types of short-lived agents expect that the preferences distribution will not change in the next period and, therefore, expect the previously mentioned policy of player 1, they will have no incentive at all to socialize their children, so the preferences distribution will not change. This self-confirms the initial expectations.

Notice that in case 1 of Proposition 3, for $p_0 \leq p'$, there is not a perfect foresight path of preferences. The reason is the following. When the expected preferences distribution for

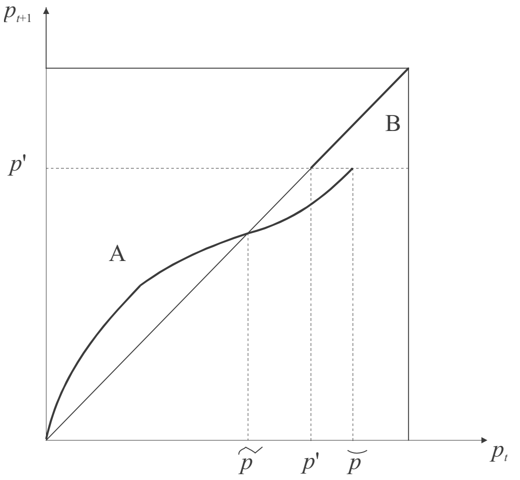

Fig. 2. Preferences dynamics in case (D) when $p' \geq \tilde{p}$.

the next period is smaller than p', the long-lived player 1 is expected to follow an S-pooling strategy and the proportion of selfish short-lived players increases over time. Eventually, one generation will expect a next period preferences distribution greater than p'. Therefore, the expected policy of the long-lived player will be the G-pooling strategy, and parents will not exert effort in socializing their children. As a consequence, the preference distribution will not change (i.e., $p_{t+1} = p_t$), but this contradicts the initial expectation.

If players 2 had backward looking expectations, believing that the long-lived players 1 will follow today's policy in the next period, then whenever $p_0 \leq p'$, the economy converges to a $p_t > p'$. That is, the steady state is again a very inefficient situation where all agents make general investments.[8]

The phase diagram of the two-branch dynamics, when $p' \geq \tilde{p}$, is shown in Fig. 2.

Notice that $\breve{p}$ is such that $F_{\mathrm{A}}(\breve{p}) = p'$. If p_0 is in the interval $(0, p']$ it follows from inspection that a unique p_t path results with p_t converging to $\tilde{p}$. Therefore when the proportion of inequity averse players is high enough, the steady state of the economy is characterized by the following investment policies: the long-lived player 1 makes a specific investment and both types of player 2 make a general investment. Recall that with homogeneous selfish preferences, under the same condition, the inefficient outcome, where every player makes a general investment, will be the only possible result. By contrast, in the dynamic and heterogeneous preferences model, a second-best result is achieved.

If p_0 is in the interval $(\breve{p}, 1)$, $p_t = p_0$ for all t. That is, the economy remains locked in the inefficient situation where all agents make general investments. However, if p_0 is in the interval $(p', \breve{p}]$, there are two perfect foresight paths; that is, we have two different equilibria with self-fulfilling expectations since the (A) and (B) branches overlap. In the first p_t path, equation (B) holds. This means that all agents are "pessimistic" concerning the next period

[8] It is easy to check that all the other results of the paper hold with backward looking expectations.

distribution of preferences, and they will have no incentives at all to socialize their children. This in turn implies that the composition of the population of players 2 will not change in the next period. This obviously self-confirms the initial expectations, and the society will remain locked in at the inefficient result. In the second perfect foresight path, Eq. (A) holds. Players 2 are "optimistic" and believe that in the next generation there will be enough inequity averse players 2 so that they expect that players 1 will make specific investments. Then, the socialization effort of inequity averse players would be stronger than the effort of selfish players. When the proportion p_0 is smaller than $\breve{p}$ this socialization effort is strong enough to shift the dynamics to a distribution p_1 smaller than p', which again self-confirms the initial expectations. The economy will reach a second best scenario in which player 1 makes a specific investment. This result of multiplicity of perfect foresight path is quite interesting, because it implies that there is room for exogenous shocks on the expectations that will move the economy from an inefficient situation to a more efficient one.

The second best result is more likely whenever the distance between the low surplus $\underline{v}$ and the cost of specific investment c is sufficiently high. In particular, even for a β very close to 1, we need that $\underline{v} > 4c$, and this critical value on this distance increases for smaller β. In summary, in a society with a high aversion to the advantageous inequity and if the low surplus is sufficiently high with respect to c, the economy will reach a second best result.

6. Conclusions

Most of the economic literature has assumed self-regarding preferences. Nevertheless, there is substantial experimental evidence suggesting that fairness and reciprocity motives affect the behaviour of many people (for example, on the hold up problem, see Ellingsen and Johannesson (2000)). Therefore, a more realistic assumption would be that preferences in the population are heterogeneous. This paper, based on the evolutionary anthropology and cultural transmission literature, goes beyond and concentrates on issues related to the formation and stability of preferences in the population. Particularly, an overlapping generation and random matching model has been postulated in order to provide a dynamic analysis of the hold up problem.

We have shown that in the stable steady state of the economy there is a mixed distribution of preferences. The presence in the population of a significant fraction of individuals with other-regarding preferences considerably alleviates post-contractual opportunism and improves efficiency in investment decisions. Our framework also illustrates how some important features of the steady state of the economy depend crucially on the particular strategic structure adopted by the investment game, which in turn depends on the primitives of the economy: high and low surplus and the cost of the investments.

Our paper is, certainly, only a first-step in the analysis of the hold up problem in a context in which the distribution of preferences is determined endogenously, in particular, through a cultural transmission process. There are several future extensions. The first one consists of removing the extreme assumption of completely short-lived workers who only live as adults for one period. That is, we will keep the distinction between more patient players (firms) and less patient players (workers), but the latter will have a positive probability of playing the hold up game again. Moreover, in this new context, it seems natural to suppose that firms have access to some imperfect information on the past performance of active workers. Another possible future extension of our analysis is to allow for heterogeneous preferences and cultural transmission on both sides: firms and workers.

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Appendix A

A.1. Proof of Proposition 1

Obviously, $p = 0$ and $p = 1$ are stationary states of (15), as well as all p that solve

$$k\Delta U^e(1-p_t) - k\Delta U^a p_t = 0.$$

This equation has a unique solution

$$\bar{p} = \frac{\Delta U^e}{\Delta U^e + \Delta U^a} = \frac{(1/2)\bar{v} - c - (1/2)\underline{v}}{(1/2)\bar{v}(\alpha+\beta)}.$$

Next, we show that $p = 0$ and $p = 1$ are locally unstable. It is sufficient to prove that the following conditions are verified:

$$\frac{\mathrm{d}p_{t+1}}{\mathrm{d}p_t}|_{pt=pt+1=0} > 1 \quad \frac{\mathrm{d}p_{t+1}}{\mathrm{d}p_t}|_{pt=pt+1=1} > 1.$$

We will denote p_{t+1} as $F(p)$, suppressing the time subscripts. Therefore, we have the dynamic behaviour of p_t:

$$F(p) = p + p(1-p)[k\Delta U^e(1-p) - k\Delta U^a p].$$

We get that

$$F'(p) = 1 + (1-2p)[k\Delta U^e(1-p) - k\Delta U^a p] - p(1-p)[k\Delta U^e + k\Delta U^a].$$

Evaluating $F'(p)$ in the steady states $p = 0$ and $p = 1$, we obtain that

$$F'(0) = 1 + k\Delta U^e$$

$$F'(1) = 1 + k\Delta U^a.$$

As $k\Delta U^e > 0$ and $k\Delta U^a > 0$, then $F'(0) > 1$ and $F'(1) > 1$.

We turn now to the global stability of $\bar{p}$. Assume $p_t > \bar{p}$, if $\bar{p} < p^{\mathrm{E}}_{t+1} < p_t$ then, $\tau^e(p_t, \hat{\sigma}) < \tau^a(p_t, \hat{\sigma})$. Therefore, $p^{\mathrm{E}}_{t+1} = p_{t+1} < p_t$. Assume $p_t < \bar{p}$, if $p_t < p^{\mathrm{E}}_{t+1} < \bar{p}$ then, $\tau^e(p_t, \hat{\sigma}) > \tau^a(p_t, \hat{\sigma})$. Therefore, $p^{\mathrm{E}}_{t+1} = p_{t+1} > p_t$. Evaluating $F'(p)$ in $\bar{p}$ we obtain

$$F'(\bar{p}) = 1 - \bar{p}(1 - \bar{p})[k\Delta U^e + k\Delta U^a].$$

Denote $\bar{\tau} = \tau^e(\bar{p}) = \tau^a(\bar{p}) = k(\Delta U^e \Delta U^a/(\Delta U^e + \Delta U^a))$, then $F'(\bar{p}) = 1 - \bar{\tau}$. As $\bar{\tau} \in (0, 1)$, then $F'(\bar{p}) \in (0, 1)$. Given that the Eq. (15) is a polynomial of third degree and that $F'(0) > 1$, $F'(1) > 1$ and $F'(\bar{p}) \in (0, 1)$ there are two possible situations. First, $F'(p) > 0$ for all $p \in (0, 1)$. This is a sufficient condition for global stability because the function $F(p)$ does not reach either a maximum or a minimum in (0,1). Alternatively, if $F(p)$ has interior maximum and minimum, $F'(\bar{p}) \in (0, 1)$ implies that $\bar{p}$ cannot be within the maximum and the minimum. That is, $\bar{p}$ is either before the maximum or after the minimum. In both cases, we obtain global stability.

A.2. Proof of Proposition 2

Dynamics A has an interior steady state $\hat{p} = 1/(2(\alpha+\beta))$ and dynamics B has an interior steady state $\tilde{p} = 1/(2\beta)$. Notice that $\tilde{p} = 1/(2\beta) > 1/2$ because $\beta \in (0.5, 1)$; $1-t^a > 1/2$ and $\hat{p} = 1/(2(\alpha+\beta)) < 1/2$ because $\alpha \geq \beta$.

Under assumption (2), then $\tilde{p} \leq 1 - t^a$ and the dynamics of preferences has three rest points: $p = 0$, $p = 1$ and $p = \tilde{p}$. Following the same arguments as in Proposition 1, it is easy to check that $p = 0$ and $p = 1$ are unstable. Recall that $\breve{p}_{\mathrm{B}} > 1 - t^a$ is such that $F_{\mathrm{B}}(\breve{p}_{\mathrm{B}}) = 1 - t^a$ and $\breve{p}_{\mathrm{A}} > 1 - t^a$ is such that $F_{\mathrm{A}}(\breve{p}_{\mathrm{A}}) = 1 - t^a$. In general, for any particular values of the parameters in case C.2, $\breve{p}_{\mathrm{A}}$ is always greater than $\breve{p}_{\mathrm{B}}$ because $\alpha > 0$. The existence and uniqueness of $\breve{p}_{\mathrm{B}}$ and $\breve{p}_{\mathrm{A}}$ is shown below.

We first show that for all $p_0 \in (0, \breve{p}_B]$, there is a perfect foresight path of preferences that converges to the steady state $\tilde{p} = 1/(2\beta)$:

(a) Assume $p_t < \tilde{p}$. If $p_t < p^{\mathrm{E}}_{t+1} < \tilde{p}$, the relevant dynamics is (B) and $\tau^e(p_t, \sigma') > \tau^a(p_t, \sigma')$. Therefore, $p^{\mathrm{E}}_{t+1} = p_{t+1} > p_t$.
(b) Assume $\tilde{p} < p_t < 1 - t^a$. If $\tilde{p} < p^{\mathrm{E}}_{t+1} < p_t$, the relevant dynamics is (B) and $\tau^e(p_t, \sigma') < \tau^a(p_t, \sigma')$. Therefore, $p^{\mathrm{E}}_{t+1} = p_{t+1} < p_t$.
(c) Assume $1 - t^a < p_t \leq \breve{p}_{\mathrm{B}}$. If $p^{\mathrm{E}}_{t+1} \leq 1 - t^a$, the relevant dynamics is (B) and $\tau^e(p_t, \sigma') < \tau^a(p_t, \sigma')$. By definition of $\breve{p}_{\mathrm{B}}$, $p_{t+1} \leq 1 - t^a$, and therefore we return to case (b).

Next, we characterize the set $\Omega \subset (\breve{p}_{\mathrm{B}}, 1)$ such that for any $p_0 \in \Omega$ there is convergence to $\tilde{p} = 1/(2\beta)$. Define p^*_{A} such that $F_{\mathrm{A}}(p^*_{\mathrm{A}}) = \breve{p}_{\mathrm{B}}$. Given that $\breve{p}_{\mathrm{B}} > 1-t^a$, then $p^*_{\mathrm{A}} > \breve{p}_{\mathrm{A}}$. For any $p_0 \in [\breve{p}_{\mathrm{A}}, p^*_{\mathrm{A}}]$ there is a perfect foresight path that converges to $\tilde{p}$. Notice that, by construction, $[F_{\mathrm{A}}(p_0) = p_1 \in [1 - t^a, \breve{p}_{\mathrm{B}}]$. The perfect foresight path is the following: in period $t = 0$, players 2 expect $p_1 = F_{\mathrm{A}}(p_0) \geq 1 - t^a$. Therefore, dynamics (A) holds and the expectation is fulfilled. In period $t = 1$, players 2 expect $p_2 = F_{\mathrm{B}}(p_1) < 1 - t^a$

(because $p_1 < \breve{p}_{\mathrm{B}}$) and the expectation is fulfilled. From here on, dynamics (B) holds, and the path converges to $\tilde{p} = 1/(2\beta)$.

Denote $\breve{p}_{\mathrm{A}}$ as $\breve{p}_{\mathrm{A}}^{1}$ and p_{A}^{*} as p_{A}^{*1}. We can apply recursively the operator F_{A}; that is, $\breve{p}_{\mathrm{A}}^{2}$ is such that $F_{\mathrm{A}}(\breve{p}_{\mathrm{A}}^{2}) = \breve{p}_{\mathrm{A}}^{1}$, and p_{A}^{*2} is such that $F_{\mathrm{A}}(p_{\mathrm{A}}^{*2}) = p_{\mathrm{A}}^{*1}$, and so on. In this way, we obtain a collection Ω of closed intervals of preferences distributions such that if the initial condition belongs to one of these intervals, there will be a preferences path that converges to $\tilde{p} = 1/(2\beta)$. Obviously, this succession of closed intervals never reaches $p = 1$, as $F_{\mathrm{A}}(1) = 1$, but for any $\varepsilon > 0$ sufficiently small, there will be a finite "n", such that there are "n" closed intervals as explained above in the interval $(\breve{p}_{\mathrm{B}}, 1-\varepsilon)$. Obviously, for all p_0 not included in this collection of closed intervals, there will be no perfect foresight path of preferences.

A sufficient condition for global stability of $\tilde{p}$ is that $F'_{\mathrm{A}}(p) > 0$ and $F'_{\mathrm{B}}(p) > 0$ for all $p \in (0, 1)$. When $C(\tau)$ is convex enough, in particular, $C''(\tau) = 1/k \geq ((\alpha+\beta)\bar{v})/6$ the above sufficient condition holds. Notice also that $F'_{\mathrm{B}}(p) > 0$ for all $p \in (0, 1)$, $F_{\mathrm{B}}(1-t^a) < 1-t^a$ and $F_{\mathrm{B}}(1) = 1$, implying that there exists a unique $\breve{p}_{\mathrm{B}} \in (1-t^a, 1)$, such that $F_{\mathrm{B}}(\breve{p}_{\mathrm{B}}) = 1-t^a$. A similar argument applies for $\breve{p}_{\mathrm{A}}$.

A.3. Proof of Proposition 3

1. We start by assuming that $p' < \tilde{p}$. If the initial proportion of selfish players in the economy is $p_0 > p'$ and $p_1^{\mathrm{E}} = p_0$, players 1 are expected to follow a G-pooling strategy and $\tau^e(p_0, \sigma^{\mathrm{G}}) = \tau^a(p_0, \sigma^{\mathrm{G}}) = 0$. Therefore, $p_t = p_0$ for all t.
2. Now, we assume that $\tilde{p} \leq p'$. Suppose that $p_t < \tilde{p}$, if $p_t < p_{t+1}^{\mathrm{E}} < \tilde{p}$ player 1 follows a S-pooling strategy and $\tau^e(p_t, \sigma^{\mathrm{S}}) > \tau^a(p_t, \sigma^{\mathrm{S}})$ and then, $p_{t+1}^{\mathrm{E}} = p_{t+1} > p_t$.

Suppose next $\tilde{p} < p_t < p'$, if $\tilde{p} < p_{t+1}^{\mathrm{E}} < p_t$, $\tau^e(p_t, \sigma^{\mathrm{S}}) < \tau^a(p_t, \sigma^{\mathrm{S}})$ and, as a result, $p_{t+1}^{\mathrm{E}} = p_{t+1} < p_t$. A sufficient condition for the stability of $\tilde{p}$ is that $F'_{\mathrm{A}}(p) > 0$ for all $p \in (0, p']$. When $C(\tau)$ is convex enough, in particular, $C''(\tau) = 1/k \geq (\beta\underline{v})/3$, this sufficient condition holds.

If $p_0 > p'$, then there exists a unique $\breve{p} \in (p', 1)$ such that $F_{\mathrm{A}}(\breve{p}) = p'$. This result holds because $F_{\mathrm{A}}(1) = 1$, $F_{\mathrm{A}}(p') < p'$ and, provided the above condition on the convexity of $C(\tau)$ is satisfied, $F'_{\mathrm{A}}(p) > 0$ for $p \in (p', 1)$.

Assume $p_0 > \breve{p}$, then $p_t = p_0$ for all t for the same reasons as in case 1. Now, assume $p' < p_0 \leq \breve{p}$. Then, if $\tilde{p} < p_1^{\mathrm{E}} \leq p'$, $\tau^e(p_0, \sigma^{\mathrm{S}}) < \tau^a(p_0, \sigma^{\mathrm{S}})$ and $p_1^{\mathrm{E}} = p_1 < p'$, and by definition of $\breve{p}$, this path of preferences converges to $\tilde{p}$. However if $p_1^{\mathrm{E}} = p_0$, then $\tau^e(p_0, \sigma^{\mathrm{G}}) = \tau^a(p_0, \sigma^{\mathrm{G}}) = 0$ and $p_t = p_0$ for all t. Therefore, the claims made on (2) of Proposition 3 follow.

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