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Abstract

The labor contract usually assigns significant authority to the employer (hierarchical governance). The threat of hold-up of the employee by the employer, caused by this asymmetric distribution of decision rights, can be mitigated by a preference for reciprocity on the part of the employer or by a balance of power, arising from the credible threat by the employee to retaliate if he is exploited. In this working paper we investigate the interaction and the evolution between the preferences for reciprocity of the employer and the feasibility and willingness to punish hostile behavior by the employee in an overlapping generations model where there is cultural transmission of preferences. We characterize the long-run behavior of this society, that is, the stable steady states of the dynamics. Our framework shows how and why different labor cultures or regimes can emerge in the long run. Our main result states that if the net gains from specific investment are high enough and the amount of feasible punishment (i.e., the worker's power) is also high, the economy will converge from any initial condition to an efficient cooperative equilibrium. If any of these conditions does not hold, the market will settle down in an inefficient equilibrium where not all types of workers make specific investment or, even if they do, there is surplus destruction because selfish firms offer low wages. Positive reciprocity on the part of the employer is not enough to achieve an efficient labor culture. There is also a need for a significant allocation of power to the workers in order to make the threat of punishment a powerful tool to enhance efficiency and cooperation.

Key words

Cultural transmission, trust and punishment, labor power, social preferences, specific investment.

Resumen

El contrato de trabajo generalmente asigna la mayor parte de la autoridad al empresario (gobernanza jerárquica). La amenaza del *hold-up* (oportunismo poscontractual, cesación del trabajo) del empleador al empleado, causada por esta distribución asimétrica de los derechos de decisión, se puede mitigar si existen preferencias por la reciprocidad por parte del empresario o se produce un equilibrio de poder, que surge de la amenaza por parte del empleado de emprender represalias si es explotado. En este documento de trabajo se investiga la evolución y la interacción entre las preferencias por reciprocidad del empresario y la posibilidad y el deseo de castigar un comportamiento hostil, por parte del empleado, en un modelo de generaciones solapadas donde existe transmisión cultural de preferencias. En concreto, se caracteriza el comportamiento a largo plazo de esta sociedad, es decir, los estados estacionarios estables de la dinámica. Este análisis muestra cómo y por qué pueden surgir diferentes culturas laborales en el mercado de trabajo. El resultado principal que se obtiene indica que si las ganancias netas por realizar inversión específica son lo suficientemente elevadas y la magnitud del castigo posible (p.ej., el poder del trabajador) también es alto, la economía convergerá desde cualquier condición inicial hacia un equilibrio cooperativo eficiente. Si cualquiera de estas condiciones no se cumple, el mercado convergerá hacia un equilibrio ineficiente, en el que, o bien, no todos los tipos de trabajadores hacen inversión específica o bien, aunque la elijan, existe destrucción del excedente porque las empresas egoístas ofrecerán salarios bajos y una proporción de trabajadores los rechazarán. La presencia de reciprocidad positiva por parte del empresario no es suficiente para conseguir una cultura laboral eficiente: también se necesita asignar a los trabajadores suficiente poder para que la amenaza de castigo sea un arma poderosa para promover la eficiencia y la cooperación.

Palabras clave

Transmisión cultural, confianza y castigo, poder del trabajador, preferencias sociales, inversión específica.

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CONTENTS

1. Introduction

MOST employment represents a long-term relationship between the employer and the employee. In many of these employment relations, both agents are increasingly *tied* to one another as they invest in relation-specific assets, weakening the discipline of market forces. The labor contract in these cases is highly incomplete, involves important implicit elements, and usually assigns significant authority to the employer (hierarchical governance).

However, the asymmetric distribution of authority puts the employee in danger of being exploited, leading to inefficiency if he refuses to invest, or simply refuses to cooperate, fearing that any such contribution will go unreciprocated.

The threat of hold-up of the employee by the employer can be mitigated by at least three means other than by law and contract provision: a preference for reciprocity on the part of the employer, a balance of power, arising from the credible threat by the employee to retaliate if he is exploited and finally, the desire of the employer to maintain a reputation among employees for not being exploitative (see, for instance, Baron and Kreps, 1999).

In this working paper we investigate the interaction and the evolution between the preferences for reciprocity of the employer and the feasibility and willingness to punish hostile behavior by the employee in an overlapping generations model where there is cultural transmission of preferences. More precisely, in our simplified labor market, each employment relation is characterized by the following sequence of events: the worker has to decide between making a general investment, or a specific or cooperative investment which results in a higher surplus. Next, the employer sets wages and thus, after observing the employee's investment, he can reward the cooperative action of the employee, paying a high wage, or abuse him, paying a low wage. Finally, the worker can engage in a costly punishing activity, destroying part of the surplus. Thus, players are facing a one-sided sequential prisoner's dilemma with a final punishment stage. We represent the asymmetric distribution of authority by assumming that the employer can exploit or hold up the worker by appropiating all the surplus derived from cooperation, while the worker lacks this capacity with respect to the employer. Notice that our notion of authority is different from other definitions used in literature (see, for instance, Simon, 1951 or Aghion and Tirole, 1997)[1]. On other hand, we represent the possible retaliatory power of the workers by means of a punishment stage: the feasibility to punish hostile behavior by destroying surplus *(money burning).* Notice that in order to make a credible threat of retaliation, is not enough; the willingness to punish hostile behavior it is also necessary that the rules of the game (the institutions) allow for a sufficient amount of costly punishment. In fact, our main interest in this work lies in the interaction between the evolution of the preferences for reciprocity and the institutional features that make possible the retaliatory power of employees.

If the above game is played by the usual selfish agents of conventional economic theory, it will result in an inefficient outcome: the employee chooses a general investment and a low surplus is obtained. A costly punishment is not a credible threat by a selfish worker. Therefore, the worker cannot trust any promises made by the selfish employer of being rewarded in case he makes the specific investment.

Obviously, reputation is a well-known solution to this inefficiency in a repeated scenario, even if the agents are selfish. Nevertheless, as we want to isolate the influence of fairness and the balance of power on the efficiency of employment relations; we will assume that the above game is played only once in any employment relation in order to eliminate any possible influence of the reputation motive.

It is well known that fairness concerns may have a decisive impact on the actual working of the labor markets (see Fehr and Gachter, 2000a, 2000b). Fair-minded agents will exhibit reciprocity in their observed behavior. By reciprocity we mean the willingness to reward friendly behavior and the willingness to punish hostile behavior. If the above employment game is played by fair-minded agents or, alternatively, there is a high proportion of this type of agent in both the populations of the employers and the employees, the resulting outcome would be the efficient one. That is, workers make specific investments and employers reciprocate with high (fair) wages. We want to analyze whether these preferences can survive in cultural competition with the conventional selfish preferences (i.e., agents who try to maximize their material payoffs).

1. H. Simon, 1951: "We will say that (the boss) exercises authority over (the worker) if (the worker) permits (the boss) to select *x* (a behavior, i.e., any element of the set of specific actions that the worker performs on the job..."

For this purpose, we work with a dynamic model of cultural transmission, where both the distribution of preferences in the population and the strategies in the labor market in the long run are determined endogenously and simultaneously.

Preferences in both the populations of the employers and the employees are heterogeneous. In each period there is a fraction of selfish agents, and there is also a fraction of agents motivated by reciprocal altruism. The distribution of preferences in the population evolves according to a process of cultural transmission which combines direct transmission from parents with oblique transmission from the society (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985). Parents make a costly decision on education effort trying to transmit their own preferences (Bisin and Verdier, 2001). If they do not succeed, children acquire preferences from the social environment. In contrast with other models, where oblique transmission takes place in society at large, we assume that economic agents are socialized exclusively within their parents' social class. Employers' children are socialized, either by their parents or by other adult employers. And the same assumption applies to employees. We denote this situation as a segmented or *classist* society.

We characterize the long-run behavior of this society, that is, the stable, steady states of the dynamics. As a first result we obtain that in any of these steady states there is a heterogenous distribution of preferences in the population of both social classes.

More interestingly, our framework shows how and why different labor cultures or regimes can arise in the long run. And also, in which cases there exists a multiplicity of steady states, the final outcome depending on the initial condition (the history) of the society. Namely, four labor regimes can persist in the long run. A very efficient one in which both types of workers and both types of employers cooperate in a *gift-exchange* (Akerlof) way. All workers make specific investment, all employers pay high wages and there is no surplus destruction. A second one, in which both types of workers make specific investments, but selfish employers pay low wages and are punished by fair-minded workers, while fair-minded employers offer high wages. A third regime in which only selfish workers make specific investment, while fair-minded workers choose to make general investment. And finally, the labor market can get trapped in the inefficient outcome in which both types of workers make general investments with a population with a very high proportion of selfish employers.

Our analysis shows that if the net gains from making specific investment are high enough and the workers' power, measured by the maximum amount of surplus they are able to destroy, is also sufficiently high, the economy will converge from any initial condition to the efficient Akerlof-type equilibrium. On the other hand, with high net gains from specific investment but low workers' power or a very high cost of punishment, the market will settle down in an inefficient equilibrium. In this equilibrium not all types of workers make specific investment or if they do, there is surplus destruction because selfish firms offer low wages. Only if both the net gains from cooperation and the workers' power are very low, the market will get trapped in the very inefficient equilibrium in which both types of workers make general investment.

Positive reciprocity (rewarding) on the side of the employers is not enough to achieve an efficient labor culture. Trust and gift exchange operates in the market only if there is a balance of power. Or, in other words, under the shadow of a credible threat of a significant punishment. A sufficient allocation of retaliatory power to the workers is needed in order to make the threat of punishment a powerful tool to enhance efficiency and cooperation.

There are some works related to our paper. Herold (2004) presents an indirect evolutionary approach to analyze a game in which a player chooses between cooperation or defection and a second player can either reward or not reward his cooperation and can punish or not punish his defection. This author studies the evolution of reciprocity preferences for rewarding and preferences for punishing in competition with purely self-interested preferences. Our approach is different. On the one hand, Herold's evolutionary dynamics is payoff monotonic as is usual in an evolutionary model. In our model, the cultural dynamics is not necessarily payoff monotonic because it is biased by the cultural intolerance of the parents. On the other hand, the structure of our game is different: in our case cooperation can be rewarded or not by the employer and then, non-rewarding can be punished or not by the employee. We think that our sequence of events is much more well-suited as a representation of a hierarchical labor relationship, in which there is a balance of power. Fehr, Klein and Schmidt (2007) present robust experimental evidence showing that contracts that offer a voluntary bonus for satisfactory performance provide superior incentives to explicit incentive contracts and also to trust (Akerlof) contracts. In a bonus contract, both players can mutually reciprocate: the firm pays a wage upfront, the worker exerts effort and the firm can reward him paying an unenforceable bonus. So this game represents a natural benchmark for making a comparison between the power of punishment and the power of mutual reciprocity in order to enhance efficiency. It turns out that punishment is a more powerful tool. In their model, full efficiency is not reachable: selfish employers will not pay a bonus and, anticipating this, fair-minded employees provide low effort. In our model, provided the feasibility of engaging in costly punishment of the workers is high enough, full efficiency is reached. All workers make specific investment and all firms pay high wages, given the credible threat of punishment.

There is a lot of empirical work analyzing the economic impact of workers power (unions, legal rights, labor standards and so on). Freeman and Medoff (1984) in a classic work show, among other things, how on average unions create a bigger pie to be split between the workers and the owners of the firms. However, there is contradictory evidence on these issues (see Menezes, 1997). There also exist a few theoretical approaches as, for instance, Altman (2000). In this work, the author shows, using a static behavioral model, how an increase in labor power can be welfare enhancing in a market economy.

The rest of the working paper is organized as follows. Section 2 presents the employment relationship. Section 3 introduces the inequity aversion preferences and analyzes the behavior of inequity averse agents. Section 4 studies the employment game with heterogeneous preferences in both populations. Section 5 summarizes the mechanism of cultural transmission of preferences. Section 6 analyzes the dynamics of the segmented or two-class society. In section 7, we characterize the steady states or long-run labor cultures under the cultural dynamics and their basins of attraction. Finally, we conclude in section 8.

2. The Employment Relationship

WE consider overlapping generations of agents who only live two periods (as a youth and as an adult). The agents can be workers or owners of firms (employers), and we assume that each type of agent belongs to a *social class* or group. In the first period, the agent is a child and is educated in certain preferences, and in the second period, the agent (as an adult with well-defined preferences), is randomly matched with an adult player from the other *class* or group, to play the stage game to be described later. In this second period, any adult player has one offspring and has to make a (costly) decision regarding his/her child's education, trying to transmit his/her own preferences.

As is customary in this class of models, we will assume that an adult has just one child independently of the payoffs in the stage game, and thus the population remains constant. It is also assumed that reproduction is asexual, with a parent per child.

2.1. The stage game

Two adult players drawn from each *social class* are randomly matched to play the following sequential game. The worker (he, player 1) has to decide whether to make specific investment *(S)* or general investment *(G)*. If he chooses general investment, a nonnegative surplus of size $2l$ is obtained, where for simplicity, we assume that it is divided equally between the employer (she, player 2) and the worker, and the game ends.

If the worker chooses to make specific investment, it is produced a total surplus of H, higher than $2l$. Next, the firm sets wages. Therefore, after observing S, it has to decide which proportion $b \in [0,1]$ of H it is willing to pay to the worker. In order to simplify the analysis, it is assumed that the offer $b = 0$ covers the cost for the worker of making specific investment. The worker, after observing b, has the option of punishing the firm, destroying a proportion λ of $H(1 - b)$ at some unitary cost z. If he decides not to punish, the firm gets a payoff of $H(1 - b)$ and the worker a payoff of bH. If he decides to punish, the firm obtains a payoff of $H(1 - b - \lambda\ (1 - b))$ and the worker gets a payoff of $H(b - z\lambda\ (1 - \mathrm{b}))$.

We denote λ^* as the maximum punishment that the worker can inflict on the employer. For example, if $\lambda^* = 1$, the worker can destroy the entire surplus of the firm. We denote this parameter as the strength or the power of the workers. It depends on the workers' ability for money burning (sabotage, strikes...) which in turn might depend on the workers' degree of unionization, their ability to organize collectively, their legal rights in the society... It also differs across different types of jobs depending on the strategic position of the worker in the production process. On the other hand, the cost of this activity of money burning (unitary cost z) varies with the firms capability of finding out and sanctioning this activity in case of sabotage or with the difficulty of coordination and organization in case of strikes. However, in this working paper we will assume the same parameters λ^* and z for all workers. We also assume that this maximum punishment has to satisfy the restriction $1/2 \leq \lambda^* \leq 1$. This assumption on the lower bound will be justified later on.

With this stage game we want to model a situation that reflects, on the one hand, that the worker runs the risk of being held up, in case the firm does not reward his cooperative action, and on the other hand, the balance of power captured by the punishment option or threatened damage that the worker can inflict on the firm.

Suppose now that all players have self-regarding preferences and there is complete information. We can obtain the subgame perfect equilibrium solving the game by backward induction. In the last subgame, selfish workers do not punish because it is costly and does not increase their payoff. Given that the firm will not be punished, it will offer a proportion $b = 0$ to the worker and therefore the optimal action for him will be to make general investment at the beginning of the game. This is an inefficient outcome in which both players obtain the same payoff, i.e., l. In this sequential stage game, both the promise of rewarding by the firm and the threat of punishment by the worker are not credible.

In this working paper we will assume that there is heterogeneity of preferences, and that in addition to self-regarding people there is also a significant fraction of the population that exhibits social preferences, that is, they are also concerned about relative payoffs. In the next section we will introduce this type of preferences.

3. Social Preferences: Inequity Aversion

THERE is nowadays an overwhelming evidence from experimental data showing that a significant fraction of the subjects does not care only about material payoffs but rather relative payoffs. These experiments and also everyday experience suggest that fairness and reciprocity motives affect the behavior of many people.

In our working paper the distribution of preferences in both populations of economic agents in each period is endogenously determined by the decision made by adult players. In each *social* class or group, there is a certain proportion of people with selfish preferences and the remaining proportion with reciprocal preferences. In particular, in the workers' (firms') population there is a proportion x_t (y_t) of self-interested agents in period t who are motivated exclusively by their own monetary payoffs and a proportion $1 - x_t$ $(1 - y_t)$ of agents who exhibit reciprocity in their observed behavior.

A number of theoretical models have been developed in literature to obtain reciprocal behavior. Well-known examples include Fehr and Schmidt (1999) and Bolton and Ockenfel's (2000) models of inequity aversion, Charness and Rabin's (2002) model of quasi-maximin preferences, Rabin (1993) and Dufwenberg and Kirchsteiger's (2004) models of intention-based reciprocity. These models can lead to different predictions in some particular games, but in our sequential prisoner's dilemma they all deliver reciprocal behavior. For tractability reasons, we choose in this work the inequity aversion preferences model of Fehr and Schmidt (1999) but the results would not change qualitatively with any other type of efficiency-enhancing social preferences as those previously mentioned.

Let $m = (m_1, m_2)$ denote the vector of monetary payoffs for both players. The utility function of an inequity averse player i is given by:

$U_i(m) = m_i - \alpha \max\{m_j - m_i, 0\} - \beta \max\{m_i - m_j, 0\}$, $j \neq i$, where $\beta \leq \alpha$ and $1 > \beta \geq 0$.

Inequity averse agents are willing to give up some material payoff to move in the direction of more equitable outcomes. The second term in the above expression 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 his disadvantage, that is, the inequity aversion is asymmetric. We also assume that $\beta > 0.5$ and denote this type of players as strongly inequity averse players.

Strongly inequity averse players have very different policies as compared to those of selfish players, in particular the rewarding policy of the employers and the punishing policy of workers. The inequity averse employers compensate generously the cooperative action of the workers and the inequity averse workers are willing to punish a low rewarding policy by the firms, provided that the unit cost of punishment is low enough. Let us prove these policies in turn.

3.1. Punishing policy of strongly inequity averse workers

In contrast to the behavior of selfish workers, the threat of punishment is credible in the case of inequity averse workers, provided that the unit cost of punishing z is smaller than a critical value which is increasing in α, the parameter that captures his degree of disadvantageous inequity aversion.

Lemma 1. *Assume* $z \leq \frac{\alpha}{1+\alpha}$, *if the inequity averse worker is offered a reward* $b \geq 1/2$ *by the firm, he will not punish it. If the firm offers a reward* $b < 1/2$, *the worker will punish it with a punishment that depends inversely on the compensation offered by the firm.*

In particular, if the worker is offered a reward of b, *where* $0 \leq b \leq b^* = \frac{1-\lambda^*+\lambda z}{2-\lambda^*+\lambda z}$, *he will punish the firm choosing* λ^*, *the maximum possible punishment.*

If the worker gets an offer b, *where* $b^* < b < 1/2$, *he will punish the firm choosing* $\lambda = \frac{1-2b}{(1-z)\,(1-b)} < \lambda^*$.

Proof. See appendix.

The intuition behind this result is that by punishing, the inequity averse worker reduces inequality against him and this positive effect more than compensates the diminution in his material payoffs. Notice that in principle, the inequity averse worker will punish his opponent until an egalitarian payoff vector is obtained. But if the wage offer of the employer is very small, an egalitarian payoff is not feasible because there is a limit in the amount of punishment λ^*. And in this case, the worker punishes until this limit is reached.

3.2. Rewarding policy of strongly inequity averse employers

A strongly inequity averse firm has a dominant strategy which is to offer half of the surplus ($b = 1/2$) to the worker. This strategy implies that neither of the two types of worker will punish it. Notice that starting in an unequal advantageous distribution for it to give one monetary unit to the worker reduces its material payoff in one unit and consequently its utility. But, it also reduces the inequity in two units. Therefore, as $\beta > 0.5$, its utility increases in more than one unit. The total effect is an increase in its utility. We relegate to the appendix a more formal proof.

3.3. Changes in the behavior of selfish agents

The presence of inequity averse agents in the population induces changes in the behavior of selfish agents. For instance, a selfish worker who faces an inequity averse firm with probability one will choose to make specific investment, because he knows that the firm will offer an equitable reward.

The behavior of a selfish employer will also depend crucially on the type of worker that it faces. We already know that when a selfish firm faces with probability one a selfish worker, it will offer no reward anticipating that this type of player does not punish. But when a selfish firm faces a strongly inequity averse player with certainty, its rewarding policy will change substantially. In particular, it will offer $b = 1/2$, because it anticipates that he will punish it if it does not offer an equitable reward.This result is stated in the following lemma.

Lemma 2. *A selfish employer faced with probability one with an inequity averse worker, will offer a wage of* $b = 1/2$.

Proof. See appendix.

As a consequence, the inequity averse worker, anticipating this behavior of the employer, will choose to make specific investment, yielding the efficient outcome, a surplus of size *H*.

Notice that this lemma only holds for $\lambda^* \geq 1/2$. If the workers' strength λ^* is smaller than $1/2$, that is, the workers can only destroy at most less than half of the surplus, the optimal behavior of a selfish employer is to offer $b = 0$. Thus, its behavior would be the same as in absence of the punishment option. This explains our assumption on the lower bound on λ^*.

Summarizing, if it is common knowledge that both, or at least one of the agents is inequity averse, then the worker makes specific investment and the employer rewards him with a high wage. Both the firm and the worker will get a payoff of $H/2$.

The intuition behind these results is the following. When the firm is an inequity averse player it behaves generously in its reward policy offering $b = 1/2$. Then, the selfish worker does not fear being exploited. On the other hand, as inequity averse workers are willing to punish any offer below $b = 1/2$, selfish firms, anticipating this behavior, will behave also generously offering half of the surplus. Therefore, the inequity averse player will choose at the start of the game to make specific investment, achieving the efficient outcome.

But note that players do not know the true type of the player with whom they are matched with in period t. However, we will assume that they know the preferences distribution x_t or y_t in both social *classes* or groups.

We will study this incomplete information game in the next section.

4. Trust and Punishment with Heterogeneous Preferences

IN this section, we characterize the Perfect Bayesian Equilibrium (PBE) of the incomplete information sequential game played in each period. That is, neither player knows the true type of player that he is randomly matched with but they know the distribution of preferences of the population from which a player is drawn. This distribution of preferences will be endogenously determined in our model by the education decisions made by adult players.

Notice, first, that the rewarding policy of an inequity averse firm does not change when there is incomplete information. However, the rewarding policy of a selfish firm is indeed affected by the existence of a fraction of inequity averse workers.

To compute the optimal rewarding policy of selfish employers, note that the particular decision made by the worker might also change its beliefs about the worker's type. We will denote by $\mu_t\,(e/S)$ the updated probability in period t which the firm assigns to the worker being selfish after observing the action S. Then, the selfish firm has three options: 1) to offer a low wage b, such that $0 \leq b < b^*$, 2) to offer an intermediate wage b, such that $b^* \leq b < 1/2$ or, finally, 3) to offer a generous reward, $b = 1/2$.

We show in the appendix that the second option is dominated by the other two. It is easy to see that if the firm wishes to offer a low wage, the best option is to set $b = 0$. Thus, we have to compare whether the firm prefers to offer $b = 0$ or $b = 1/2$. The answer obviously depends on the beliefs about the proportion of selfish workers in the population. In the following lemma we state this result:

Lemma 3. *A selfish employer will use the following rewarding policy:*

I) *Offer* $b = 0$ *if* $\mu_t > \frac{\lambda^* - 1/2}{\lambda^*}$.

II) *Offer* $b = 1/2$ *if* $\mu_t \leq \frac{\lambda^* - 1/2}{\lambda^*}$.

Proof. See appendix.

Now we are ready to obtain the set of PBE of this incomplete information game. Firstly, we will check the existence of separating equilibria in which the two types of workers choose different kinds of investments.

Lemma 4. *Separating equilibrium* e^{sep}.

For every x_t *and* $y_t \in [y'', \tilde{y}]$ *where* $y'' = \frac{H-2l}{H(1+2(z\lambda^*(1+\alpha)+\alpha(1-\lambda^*))}$ *and* $\tilde{y} = \frac{H-2l}{H}$, *there exists a PBE in which the selfish worker chooses to make specific investment (S) and the inequity averse worker chooses to make general investment (G). The selfish firm offers* $b = 0$ *and the inequity averse firm offers* $b = 1/2$. *The equilibrium payoff of the selfish worker is* $(1 - y)\ H/2$, *for the inequity averse worker is* l, *for the selfish firm is* $xH + (1 - x)\, l$ *and for the inequity averse firm is* $x\frac{H}{2} + (1 - x)\, l$.

Proof. See appendix.

Note that, paradoxically, in this inefficient equilibrium, selfish workers make specific investment and strongly inequity averse workers make general investment. The reason is that the former play cooperatively because of the presence of a significant fraction of fair-minded employers who pay high wages. And the latter choose general investment because of the presence of a significant fraction of selfish employers who pay low wages. As the punishment is costly, if the number of selfish firms is high enough, it is not worthwile for the inequity averse worker to make specific investment[2]. This explains that this equilibrium only exists for an intermediate range of $y \in [y'', \tilde{y}]$. That is, if there were too few fair-minded employers, selfish workers would not find it profitable to make specific investment and if there were too many fair-minded employers, then inequity averse workers would make specific investment.

Note also that there is no separating equilibrium in which a selfish worker chooses G and an inequity averse worker chooses S. In this case, employers would offer high wages ($b = 1/2$), and selfish workers would deviate, imitating the behavior of their inequity averse mates.

Next, we will show several lemmas that characterize the pooling equilibria of this game in which both types of workers choose the same type of investment. We begin with equilibria in which there is specific investment.

2. A similar result is obtained in Fehr, Klein and Schmidt (2007) in a principal agent model. The presence of fair principals induces selfish agents to choose high effort levels, while the presence of selfish principals induces the fair agents to provide low effort levels.

Lemma 5. *Pooling equilibrium e^{p1}.*

For every y_t and $x_t \in [0, \hat{x}]$, where $\hat{x} = \frac{\lambda^* - 1/2}{\lambda^*}$, there exists a PBE in which both types of workers choose to make specific investment (S) and both types of firms choose to offer $b = 1/2$. The equilibrium payoff for all players is $H/2$.

Proof. See appendix.

This is the efficient equilibrium of the game. All types of workers make specific investment and all types of employers pay high (fair) wages and therefore, there is no surplus destruction. A relatively high fraction of inequity averse workers is needed for the existence of this equilibrium. This type of workers credibly punishes the unfair behavior of employers. Thus, if its proportion is high enough, selfish employers are better off offering high wages and avoiding punishment. Notice that the critical fraction of selfish workers $\hat{x}$ depends positively on the workers' power λ^* and can take values between 0 and 1/2.

But there is also a second pooling equilibrium in which both types of workers also make specific investment but the selfish employer is not so generous, as is stated in the following lemma:

Lemma 6. *Pooling equilibrium e^{p2}.*

For $x_t \in [\hat{x}, 1]$ and $y_t \in [0, y']$, there exists a PBE in which both types of workers choose to make specific investment (S), the selfish firm offers $b = 0$ and the inequity averse firm offers $b = 1/2$. The equilibrium payoff of the selfish worker is $(1 - y) H/2$, for the inequity averse worker is $(1 - y)\ H/2 + y\ (-z\lambda^*H - \alpha\ (H - \lambda^*H + z\lambda^*H))$ (while his material payoff is $(1 - y)\ H/2 + y\ (-z\lambda^*H))$, for the selfish firm is $xH + (1 - x)(H - \lambda^*H)$ and for the inequity averse firm is $\frac{H}{2}$.

Proof. See appendix.

Notice that this is an inefficient equilibrium because fair-minded workers punish the low wages offered by selfish employers destroying the maximal possible amount of surplus. This equilibrium exists in a labor market with a high proportion of selfish workers and a low proportion of selfish employers. A high proportion of selfish workers is needed for selfish firms to offer low wages and a low proportion of selfish firms is needed for inequity averse workers to make specific investment, given that punishment is costly.

Finally, there is also a very inefficient equilibrium in which both types of workers make general investment.

Lemma 7. *Pooling equilibrium e^{pg}.*

For every x_t and $y_t \in [\tilde{y}, 1]$, where $\tilde{y} = \frac{H - 2l}{H}$, there exists a PBE in which both types of worker choose to make general investment (G). The off-equilibrium beliefs that support this equilibrium are $\mu_t\ (\mathrm{e/S}) > \hat{x}$. The equilibrium payoff for all players is l.

Proof. See appendix.

Notice that this equilibrium arises in a labor market with a very high proportion of selfish employers. The critical value $\tilde{y}$ depends on the net gains of efficiency derived from making specific investment. The greater these gains are the higher the critical value. The employers' beliefs in this equilibrium are such that if they observe specific investment they will infer that this action is more likely to come from a selfish worker.

5. The Socialization Process and the Education Effort by Parents in a Segmented Society

HUMAN behavior is governed by preferences that are transmitted through generations and acquired by learning and other ways of social interaction. The transmission of preferences which is the result of social interaction between generations is called cultural transmission. We will draw from the model of cultural transmission of Cavalli-Sforza and Feldman (1981) and Bisin and Verdier (2001).

Parents' purposeful and costly socialization determines the distribution of preferences in both the populations of employers and employees. Children acquire preferences through observation, imitation and learning of cultural models prevailing in their social and cultural environment, that is, in their family and in their social group.

Let $\tau_j^i \in [0, 1]$ be the educational effort made by a parent of class j of type i where $j \in \{1, 2\}$, 1 denotes worker and 2 employer and where $i \in \{e, a\}$, e denotes selfish and a denotes strongly inequity averse.

The socialization mechanism works as follows. Consider a parent with i preferences. His child is first directly exposed to the parent's preferences and is socialized to this preferences with probability τ_j^i chosen by the parent (vertical transmission); if this direct socialization is not successful, with probability $1 - \tau_j^i$, he is socialized to the preferences of a role model picked at random in a population composed exclusively of members of the same *social class* (oblique transmission). In this latter aspect we depart from the usual approach in which oblique transmission takes place in society at large. We call this process the socialization process in a segmented or *classist* society.

Let P_j^{ik} denote the probability that a child of a parent of a social class j with preferences i is socialized to preferences k. The socialization mechanism in class j is then characterized by the following transition probabilities where v_t is the proportion of selfish types in this social class (v_t is x_t for workers and y_t for employers):

$$P_{jt}^{ee} = \tau_{jt}^{e} + (1 - \tau_{jt}^{e})\, v_t,$$
$$P_{jt}^{ea} = (1 - \tau_{jt}^{e})\ (1 - v_t),$$
$$P_{jt}^{aa} = \tau_{jt}^{a} + (1 - \tau_{jt}^{a})\ (1 - v_t),$$
$$P_{jt}^{ae} = (1 - \tau_{jt}^{a})\ v_t.$$

Given these transition probabilities it is easy to characterize the dynamic behavior of v_t:

$$v_{t+1} = [v_t\, P_{jt}^{ee} + (1 - v_t)\ P_{jt}^{ae}\ ].$$

Substituting, we obtain the following equation on differences:

$$v_{t+1} = v_t + v_t\,(1 - v_t)\ [\tau_{jt}^{e} - \tau_{jt}^{a}\ ].$$

Note that this cultural transmission mechanism combines direct purposeful transmission with oblique transmission. Direct transmission is justified because parents are altruistic towards their children. But, an important feature is that they have some kind of imperfect altruism: their socialization decisions are not based on the purely material payoff expected for their children but on the payoff as perceived by their parents according to their own preferences. This particular form of myopia is called imperfect empathy (Bisin and Verdier, 2001). As a consequence, the cultural dynamics is not necessarily payoff-monotonic.

Direct transmission is also costly. Let $C(\tau_j^i)$ denote the cost of the education effort τ_j^i, $j \in \{1, 2\}$ and $i \in \{e, a\}$. While it is possible to obtain similar results with any increasing and convex cost function we will assume, for simplicity, the following quadratic form $C(\tau_j^i) = (\tau_j^i)^2/2q$, with $q > 0$. Therefore, a parent from class j of type i chooses the education effort $\tau_j^i \in \{0, 1\}$ at time t, which maximizes

$$P_{jt}^{ii}\ (\tau_j^i\,,\, v_t)\ V_j^{ii}\,(v_{t+1}^E) + P_{jt}^{ik}\,(\tau_j^i\,,\, v_t)\ V_j^{ik}\,(v_{t+1}^E) - (\tau_j^i)^2/2\ q.$$

Where P^{ij} are the transition probabilities and V_j^{ik} is the utility to a parent of class j with preferences i if his child is of type k. Notice that the utility V_j^{ik} depends on v_{t+1}^E, which denotes the expectation about the proportion of selfish players in period $t+1$ in your own social class. In this work we will assume that parents have adaptive or backward looking expectations, believing that the proportion of selfish players will be the same in the next period as in the current period, that is, $v^E_{t+1} = v_t$.

Maximizing the above expression with respect to τ^i_j, $j \in \{1, 2\}$ and $i \in \{e, a\}$ we get the following optimal education effort functions[3]:

$$\tau^{e*}_j\,(v_t) = q \cdot \Delta V^e_j\,(v_t) \cdot (1 - v_t),$$
$$\tau^{a*}_j\,(v_t) = q \cdot \Delta V^a_j\,(v_t) \cdot v_t.$$

Here $\Delta V^e_j = V^{ee}_j - V^{ea}_j$ and $\Delta V^a_j = V^{aa}_j - V^{ae}_j$. That is, ΔV^i_j is the net gain from socializing your child to your own preferences. It can also be interpreted as the cultural intolerance of parents with respect to cultural deviation from their own preferences. According to the imperfect empathy notion, parents obtain a higher utility if their children share their preferences, so these levels of cultural intolerance are non-negative.

In the following section we compute these levels and the dynamics of preferences in both groups or social classes.

3. In order to have interior solutions the parameter must be chosen small enough so that in equilibrium $\tau^i_j < 1$.

6. Dynamics of Preferences Distribution in a Segmented Society

IN this section we will characterize the dynamics and the possible steady states of the economy for a segmented society, that is, a society with complete segregation or cultural separation betweeen the two social classes. Both social groups coordinate in an equilibrium of the sequential game and therefore, given their adaptive expectations, they believe that this equilibrium will be played by the next generation. We need to know the optimal level of education that parents choose in each period. In order to do so we have to compute the net gains for parents of transmitting their own preferences that are given by expression V_j^{ik}.

In order to simplify the analysis we will assume that the low surplus is zero $(l = 0)$. In this case, the pooling equilibria in which both workers choose G, only exists for every x and for $y = 1$. We will comment in another section the consequences of relaxing this simplifying assumption.

Now we can divide the space of pairs of population preference distributions (x, y) in four regions.

Region 1 is characterized by $y \geq y''$ and $x \leq \hat{x}$. In this region there is multiplicity of equilibria: the pooling equilibrium e^{p1} and the separating equilibrium e^{sep}.

Region 2 is characterized by $y \leq y''$ and $x \leq \hat{x}$ In this region there is a unique equilibrium: the pooling equilibrium e^{p1}.

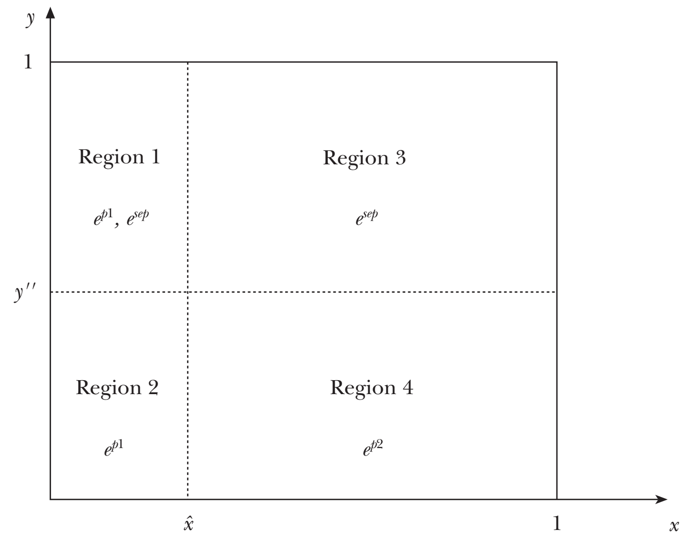
Region 3 is characterized by $y \geq y''$ and $x \geq \hat{x}$. In this region the only equilibrium is the separating equilibrium e^{sep}.

Finally, region 4 is characterized by $y \leq y''$ and $x \geq \hat{x}$. In this region there is also a unique equilibrium: the pooling equilibrium e^{p2}.

We display graphically these regions in graphic 6.1.

Notice that in region 1 there is multiplicity of equilibria. If the market is in this region, we will assume that all agents expect and coordinate in the Pareto dominant equilibrium, namely, the e^{p1} equilibrium. Notice that for

GRAPHIC 6.1: Regions of equilibria and population preferences distributions



$l = 0$ all types of both groups of agents obtain a higher material payoff in this equilibrium than in the separating equilibrium. Moreover, the e^{p1} equilibrium is more egalitarian and, therefore, the utility of all types is higher[4].

6.1. The dynamics of preferences when agents coordinate in the e^{p1} equilibrium

In this case, which comprises regions 1 and 2, the proportion of selfish workers in the population is relatively small $(x \leq \hat{x})$ and parents (workers and employers) play and expect to be played the equilibrium e^{p1}, in which both types of workers choose to make specific investment *(S)* and both types of firms choose to offer $b = 1/2$.

Notice that $V_j^{ik} = H/2$ for all types of parents. Therefore, the net gains for any type of parent of any social class obtained from transmitting their own preferences ΔV_j^{ik}, that is, their levels of cultural intolerance are zero. But this in turn implies that there are no incentives at all for socialization for any parent. Therefore, all the optimal education effort functions are zero and consequently, the distribution of preferences in both populations will remain unchanged, that is $x_{t+1} = x_t$ and $y_{t+1} = y_t$.

4. This result holds also for $l > 0$ whenever $\lambda^* \leq (H - l)/H$.

Summarizing, in this case there are no incentives to socialize and each of the two populations remains locked in the initial distribution of preferences. Therefore, any initial distribution of preferences in this region is a stable stationary state of the dynamics where the equilibrium e^{p1} is played.

6.2. The dynamics of preferences when agents coordinate in the e^{sep} equilibrium

For clarity in the exposition we will initially run the analysis for this case for all the regions where the e^{sep} equilibrium exists. That is, regions 1 and 3, where $1 > y \geq y''$ and thus, the proportion of selfish employers is relatively high. In this equilibrium the selfish worker chooses to make specific investment *(S)* and the inequity averse worker chooses to make general investment *(G)*. The selfish firm offers $b = 0$ and the inequity averse firm offers $b = 1/2$.

In this case, all types of parents have strictly positive levels of cultural intolerance and consequently, they will have incentives for active socialization. For example, a selfish worker parent expects that when his child turns out to be selfish he will obtain an expected payoff of $(1 - y)\ H/2$ and when his child turns out to be inequity averse he will obtain a payoff of zero. Therefore, the selfish parent has a positive level of cultural intolerance which depends on $(1 - y)$, the proportion of inequity averse employers, and on *H,* the gains from cooperation. The precise calculation of all these levels of cultural intolerance and the optimal education effort functions for both types of workers is relegated to the appendix.

Substituting these functions in the equation on differences of section 5 and using the assumption of backward looking expectations, we get the following dynamics for the workers' distribution of preferences:

$$x_{t+1} = x_t + x_t\ (1 - x_t)\ [\tau^e_{1t} - \tau^a_{1t}] =$$
$$= x_t + x_t\ (1 - x_t)\ [q\ (1 - y_t]\ \mathrm{H}/2\ (1 - x_t) - q\ (y_t \alpha \mathrm{H} - (1 - y_t)\ \mathrm{H}/2)\ x_t)].$$

We equate τ^e_{1t} to τ^a_{1t} to obtain the demarcation curve in which the distribution of preferences in the workers population remains constant over time which, as can be observed, depends on y. This equation is $x_t\ (y_t) = \frac{1-y_t}{2\alpha y_t}$. Thi s expression is decreasing with y_t. Another usual way of expressing this demarcation curve is to write $\dot{x}(y) = 0$.

Given a particular value of the preferences distribution in the employers' population y_t, if $x_t\ (y_t) \gtrless x_t$ then $\tau^e_{1t} \gtrless \tau^a_{1t}$ and $\frac{\partial x_t}{\partial_t} \gtrless 0$.

Now we proceed to analyze the socialization decision of the employers' parents. We again relegate the detailed calculations of the levels of cultural intolerance and the optimal education effort functions to the appendix.

The dynamics for the employers' distribution of preferences is given by:

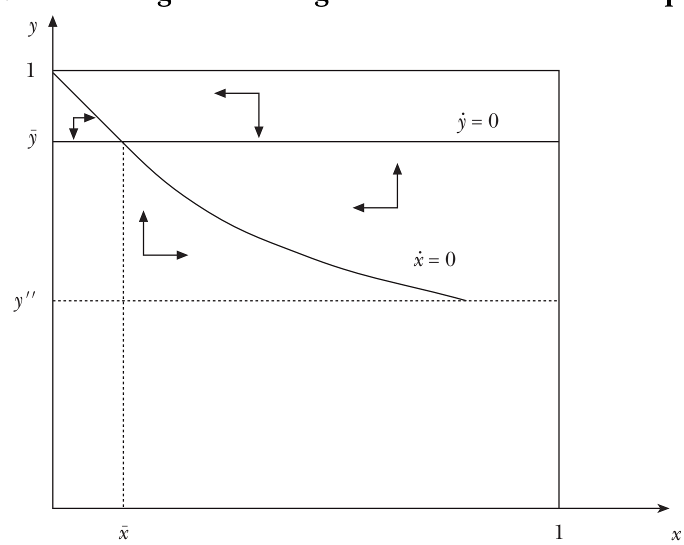
$$y_{t+1} = y_t + y_t\,(1 - y_t)\,\left[\tau^e_{2t} - \tau^a_{2t}\right] =$$
$$= y_t + y_t\,(1 - y_t)\,\left[q x_t \tfrac{H}{2}\,(1 - yt) - q x_t H\,(\beta - 1/2)\,y_t\right].$$

If we equate τ^e_{2t} to τ^a_{2t}, we obtain the demarcation curve in which the distribution of preferences in the employers population remains constant over time, which as can be observed does not depend on x_t. This equation is $\bar{y} = \frac{1}{2\beta}$. Another way of expressing this demarcation curve is to write $y = 0$.

If $\bar{y} \gtrless y_t$ then $\tau^e_{2t} \gtrless \tau^a_{2t}$ and $\frac{\partial_{yt}}{\partial_t} \gtrless 0$.

In graphic 6.2a, we represent the phase diagram of this nonlinear difference equation system in two variables. The directional arrows indicate the intertemporal movement of x_t and y_t.

GRAPHIC 6.2a: Phase diagram when agents coordinate in the e^{sep} equilibrium



The qualitative phase diagram analysis yields that there is a stable steady state or node of the dynamical system in the intersection of both demarcation curves: $\bar{x} = \frac{\beta - 1/2}{\alpha}$ and $\bar{y} = \frac{1}{2\beta}$.

To supplement this phase diagram analysis we make in the appendix a local stability analysis of this fixed point.

Recall that we have run this analysis for regions 1 and 3 but the separating equilibrium is only expected and played in region 3, because of the equilibrium selection made at the beginning of this section. Therefore, the steady state $(\bar{x}, \bar{y})$ only exists if $\bar{x} > \hat{x}$. Notice that when $\bar{x} \leq \hat{x}$ the dynamics will lead to region 1, where the e^{p1} equilibrium is played. This latter situation is more likely for high values of the workers' power λ^* and reasonable values, from the experimental point of view, of the parameter α (the degree of disadvantageous inequity aversion), namely, $\alpha > 1$.

6.3. The dynamics of preferences when agents coordinate in the e^{p2} equilibrium

In region 4, where $y \leq y''$ and $x \geq \hat{x}$, there is a relatively high proportion of selfish workers and a sufficiently low proportion of inequity averse employers and there exists a pooling equilibrium e^{p2}. In this equilibrium both types of worker choose to make specific investment *(S)* and the selfish employer offers $b = 0$ and the inequity averse employer offers $b = 1/2$.

Now, as in the previous case, all types of parents have strictly positive levels of cultural intolerance and consequently, they will have incentives for active socialization. For example, a selfish worker parent expects that when his child turns out to be selfish he will obtain an expected payoff of $(1 - y)\ H/2$ and when his child turns out to be inequity averse he will obtain this same expected payoff from the inequity averse employers but, as he will punish a selfish employer, he will incur in an expected cost of $yz\lambda^*H$. This latter amount is the level of cultural intolerance of the selfish parent. Proceeding in the same way as in the previous section we relegate the detailed calculations of all the levels of cultural intolerance and the optimal education effort functions to the appendix.

We obtain the following dynamics of the distribution of preferences in the workers' population:

$$x_{t+1} = x_t + x_t(1 - x_t)\ [\tau^e_{1t} - \tau^a_{1t}] =$$
$$= x_t + x_t(1 - x_t)\ [qy_t z\lambda^*H\,(1 - x_t) - qy_t\,\lambda^*H\,(\alpha - z\,(1 + \alpha))\,x_t].$$

If we equate τ^e_{1t} to τ^a_{1t} we obtain the demarcation curve in which the distribution of preferences in the workers' population remains constant over time. This equation is $x' = \frac{z}{\alpha\,(1 - z)}$, and it is independent of y_t. If $x' \gtrless x_t$ then $\tau^e_{1t} \gtrless \tau^a_{1t}$ and $\frac{\partial x_t}{\partial_t} \gtrless 0$.

We can apply the same procedure to analyze the socialization decision of the employers' parents (see the appendix). In this case we get the following dynamics of the distribution of preferences in the employers' population.

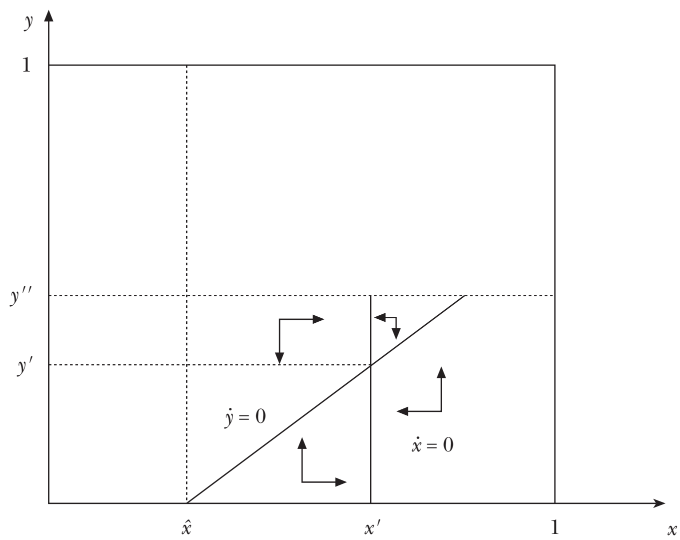
$$y_{t+1} = y_t + y_t(1-y_t)\,[\tau^e_{2t} - \tau^a_{2t}] =$$
$$= y_t + y_t(1-y_t)\,[q[H/2 - (1-x_t)\lambda^* H]\,(1-y_t) - (q[H/2 - [x_t(1-\beta)$$
$$H + (1-x_t)\,(H - \lambda^* H - \beta\,(H - \lambda^* H + z\lambda^* H)]]y_t)].$$

If we equate τ^e_{2t} to τ^a_{2t}, we obtain the demarcation curve in which the distribution of preferences in the employers' population remains constant over time. This equation is $y_t\,(x_t) = \frac{1/2 - (1-x_t)\lambda^*}{\beta\,(1-\lambda^*\,(1-x_t)\,(1-z))}$. As can be checked, this expression is increasing in x_t.

Given a particular value of the preferences distribution in the population of workers x_t, if $y_t\,(x_t) \gtrless y_t$ then $\tau^e_{2t} \gtrless \tau^a_{2t}$ and $\frac{\partial y_t}{\partial t} \gtrless 0$.

In graphic 6.2b, we represent the phase diagram of this nonlinear difference equation system in two variables. As we know the directional arrows indicate the intertemporal movement of x_t and y_t.

GRAPHIC 6.2b: Phase diagram when agents coordinate in the e^{p2} equilibrium



The qualitative phase diagram analysis yields that there is a stable steady state or node of the dynamical system in the intersection of both demarcation curves: $x' = \frac{z}{\alpha\,(1-z)}$ and $y' = \frac{1/2 - \left(\frac{\alpha(1-z)-z}{\alpha(1-z)}\right)\lambda^*}{\beta\left(1 - \frac{\lambda^*(\alpha(1-z)-z)}{\alpha}\right)}$.

Once again the steady state (x', y') only exists if $x' > \hat{x}$ and $y' < y''$. In the case that one or both of these conditions do not hold, the dynamics will lead to region 2 or, alternatively, to region 3, as we will analyze in the next section.

In the following section we will use all the previous dynamic analysis in order to characterize the long-run regimes in the labor market.

7. Preferences Distribution and Labor Cultures in the Long Run

OUR model yields different long-run outcomes, stable steady states of the cultural dynamics, depending on the particular values of the parameters of the employment relationship. And, in some cases, depending also on the initial conditions of the dynamics. The parameters that determine the final result are those concerning the balance of power. Namely, the workers' power (λ^*), that is, the maximum share of the surplus they are able to destroy and the unitary cost of punishing (z). But the degree of inequity aversion of fair-minded workers and employers is also important. With the assumption of low surplus equal to zero $(l = 0)$, the size of the high surplus H (that is, the net gains from cooperation) does not influence the long-run outcome. In this section we will characterize precisely the basin of attraction of the different steady states of the dynamics.

7.1. An Akerlof-type equilibrium

Let e^{p1} steady state denote any stable steady state of the preferences dynamics where the Perfect Bayesian Equilibrium (PBE) e^{p1} is played. Notice that in any e^{p1} steady state the proportion of selfish workers in the population, x, has to be smaller or equal to the critical value $\hat{x}$. There always exists an e^{p1} steady state in our model, except when $\hat{x}$ equals zero, which occurs when $\lambda^* = 1/2$. An e^{p1} steady state is a fully efficient outcome where reciprocity is at work. Employees make specific investment and employers reciprocate by rewarding their cooperation with high fair wages. This is the reason why we denote this situation as an Akerlof-type or *gift-exchange* labor culture.

Nevertheless, there are some differences with the Akerlof traditional model. The first one is a minor difference: in his model employers trust in workers, offering high wages, and then workers reciprocate exerting high effort (or making a costly investment). However, in our model the order of moves is reversed.

The second and main difference is that in our employment relation the *exchange of gifts* works because there is a credible threat of the inequity averse workers of harshly punishing low wages or hold up by the employers.

Next, in the following set of propositions we characterize the basin of attraction of this labor regime.

Proposition 1. *Any initial pair of distributions* (x_0, y_0) *in regions 1 and 2 is an* e^{p1} *steady state.*

Recall that regions 1 and 2 are defined by the condition $x \leq \hat{x} = (\lambda^* - 1/2)/\lambda^*$. This proposition means that for any initial condition of the society where there is a significant fraction of inequity averse workers and independently of the fraction of selfish employers, both types of employers set high wages. Selfish employers prefer to avoid punishment given the credible threat of the fair-minded workers. This result is a corollary of the analysis made in the previous section about regions 1 and 2. Notice that the size of these regions is bigger the higher λ^* is. In the limit, when $\lambda^* = 1$, $\hat{x} = 1/2$.

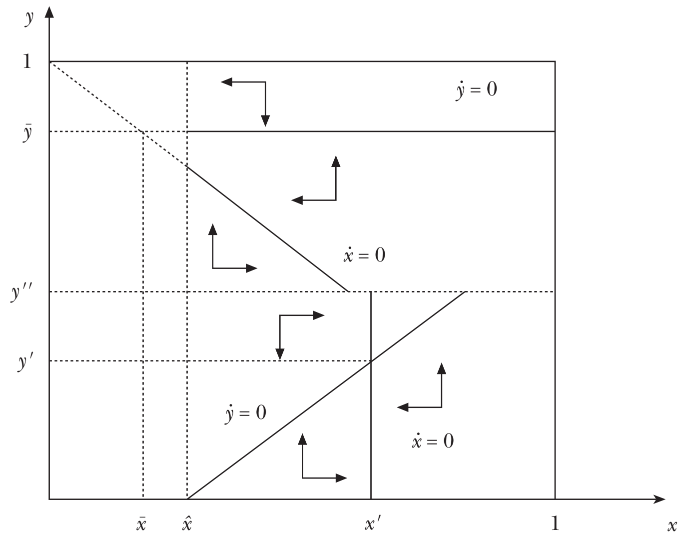
But the basin of attraction of the e^{p1} steady states includes other regions for some particular configurations of the parameters of the model.

Proposition 2. *Assume that* $\bar{x} \leq \hat{x}$*, then for any* (x_0, y_0) *in region 3 the dynamics converges to an* e^{p1} *steady state with* $x = \hat{x}$ *and* $y > y''$ (see graphic 7.1a).

The condition $\bar{x} \leq \hat{x}$ is equivalent to the following restriction on the parameters $(\beta - 0.5)/\alpha \leq (\lambda^* - 0.5)/\lambda^*$. This restriction is more likely to be satisfied for high values of the workers' power λ^* and reasonable values, from the experimental point of view, of the parameter a (the degree of disadvantageous inequity aversion), namely, $\alpha > 1$, as was commented in the previous section.

The proof of this proposition follows from the qualitative analysis of the phase diagram represented in graphic 7.1a. Notice that for (x_0, y_0) such that $x_0 > \hat{x}$ and $y_0 > y''$ the market initially coordinates in the inefficient separating equilibrium where only selfish workers make specific investment. But for most of this region 3 the incentives to socialize of inequity averse workers are greater than those of selfish workers, that is, $\tau_1{}^a > \tau_1{}^e$ and x decreases over time until it eventually reaches $\hat{x}$. From there on, everybody expects and plays the Akerlof-type equilibrium.

GRAPHIC 7.1a: Phase diagram in which the dynamics converges to an e^{p1} steady state when $\bar{x} \leq \hat{x}$

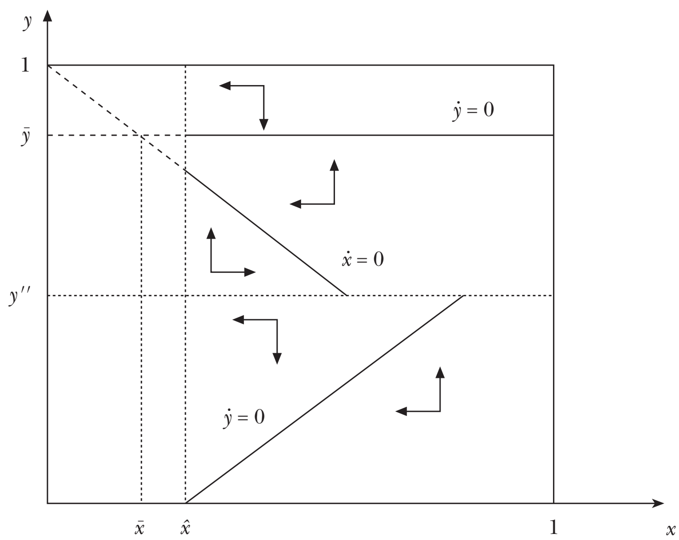


Proposition 3. *Assume that $\bar{x} \leq \hat{x}$ then,*

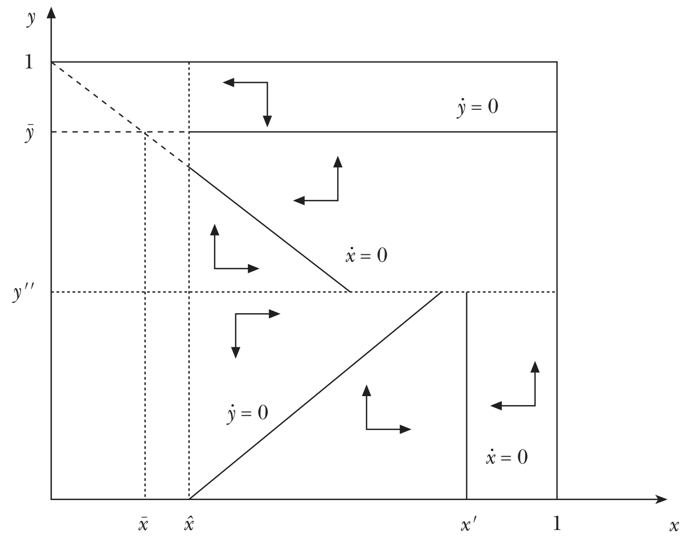
a) *If $x' \leq \hat{x}$, then for any (x_0, y_0) in region 4 the dynamics converges to an e^{p1} steady state with $x = \hat{x}$* (see graphic 7.1b).

b) *If $x' \geq \hat{x}$, but $y'' < y'$, then for any (x_0, y_0) in region 4 the dynamics converges to an e^{p1} steady state with $x = \hat{x}$ and $y > y''$* (see graphic 7.1c).

GRAPHIC 7.1b: Phase diagram in which the dynamics converges to an e^{p1} steady state when $x' \leq \hat{x}$



GRAPHIC 7.1c: Phase diagram in which the dynamics converges to an e^{p1} steady state when $x' \geq \hat{x}$ and $y'' \leq y'$



Corollary 1. *Under the conditions of proposition 3, an Akerlof-type equilibrium is the unique stable steady state outcome of the dynamics. That is, for any initial condition in any region there is convergence to an e^{p1} steady state and $\bar{x} \leq \hat{x}$.*

Therefore, proposition 3 captures a situation in which the basin of attraction of the Akerlof-type equilibrium coincides with the whole space of preferences distributions.

The proof of this proposition follows from the qualitative analysis of the phase diagram represented in graphics 7.1b and 7.1c. In graphic 7.1b, notice that for (x_0, y_0) in region 4, that is, for a preferences distribution in the population of workers with a relatively high proportion of selfish ndividuals and a relatively low proportion of selfish employers, agents expect and play the equilibrium e^{p2}. But, as $x' \leq \hat{x}$, then for all workers preferences distribution the incentives to socialize of inequity averse workers are greater than those of selfish workers, that is, $\tau_1{}^a > \tau_1{}^e$ and x decreases over time until eventually it reaches $\hat{x}$.

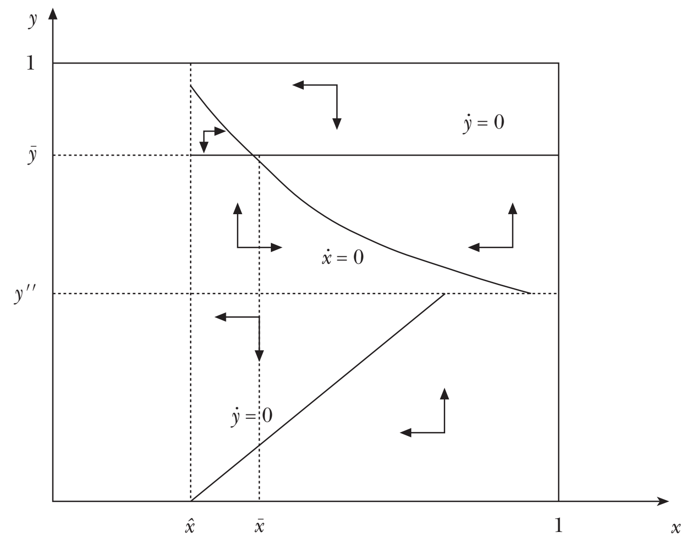
Finally, in graphic 7.1c, when $x' > \hat{x}$, but $y' > y''$, what essentially happens is that if the dynamics starts with a high proportion of selfish workers and a low proportion of selfish employers (region 4) then the socialization effort of the latter are greater than the effort of inequity averse employers. Therefore, y increases until region 3 is reached, where the separating equilibrium is played and the socialization effort of inequity averse workers is greater than that of selfish workers. Eventually the dynamics converges to a situation where $y > y''$ but $x = \hat{x}$ This is a e^{p1} steady state.

Notice that in the two previous propositions the condition $\bar{x} \leq \hat{x}$ holds. This implies, as it has been already mentioned, a high value of the workers' power λ^*. However, also for some situations in which the balance of power is not so high (λ^* small), the basin of attraction of the e^{p1} steady state can be greater than regions 1 and 2.

Proposition 4. *Assume that $\bar{x} > \hat{x}$, but $x' < \hat{x}$, then for any (x_0, y_0) in region 4 the dynamics converges to an e^{p1} steady state with $x = \hat{x}$* (see graphic 7.1d).

Once again, as $x' < \hat{x}$, then for all workers preferences distribution x greater than $\hat{x}$ the incentives to socialize of inequity averse workers are greater than those of selfish workers, that is, $\tau_1{}^a > \tau_1{}^e$ and x decreases over time until it eventually it reaches $\hat{x}$.

GRAPHIC 7.1d: Phase diagram in which the dynamics converges to an e^{p1} steady state when $\bar{x} \geq \hat{x}$ and $x' \leq \hat{x}$



Corollary 2. *The basin of attraction of the e^{p1} steady state is larger the higher is λ^* (the workers' strength or power), the lower is z (the unitary cost of punishing) and the higher is α (the degree of disadvantageous inequity aversion).*

Notice that a high λ^* implies a high $\hat{x}$, a high α implies a low $\bar{x}$ and x' and a low z also implies a low x'.

In fact with a high λ^* and a low z, a not too small α is needed, to obtain a situation of uniqueness: from any initial condition the cultural dynamics converges to a e^{p1} steady state with $x = \hat{x}$.

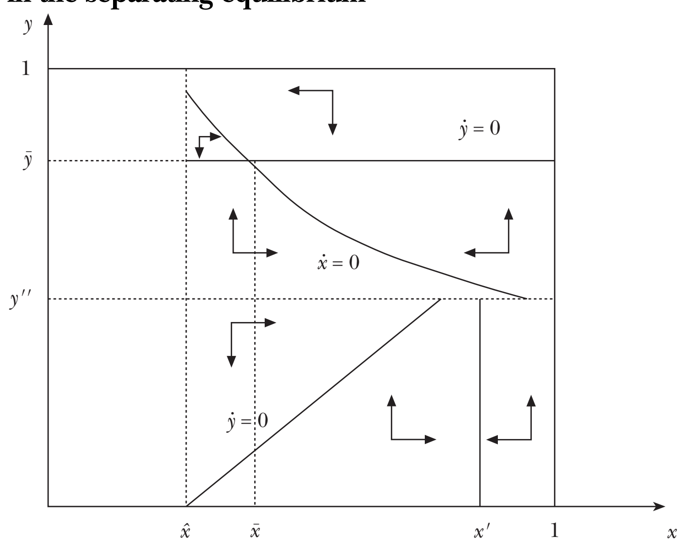
7.2. The inefficient separating equilibrium

Under some configurations of the parameters and initial conditions of the dynamics the inefficient e^{sep} is a stable steady state, where only selfish workers make specific investment and only inequity averse employers pay high wages. In this labor market, inequity averse workers make general investment and they neither make use of the punishment technology nor do they threaten with it.

Proposition 5. *Assume that* $\bar{x} > \hat{x}$, *then for any initial condition* (x_0, y_0) *in region 3 the dynamics converges to the preference distribution* $\bar{x} = (\beta - 0.5)/\alpha$ *and* $\bar{y} = 1/2\beta$, *where the separating equilibrium is played.*

The basin of attraction of this steady state also includes region 4 if $x' > \hat{x}$ and $y' > y''$. Then, for all $x > \hat{x}$, the market converges to $(\bar{x}, \bar{y})$. The reason is that in this case, in region 4, $\tau_2^e > \tau_2^a$. So, given this higher socialization effort of selfish employers, their proportion reaches region 3 where the separating equilibrium is played (see graphic 7.2).

GRAPHIC 7.2: Phase diagram when agents coordinate in the separating equilibrium



Notice that the basin of attraction of this inefficient steady state is greater the smaller is λ^* and the higher is z. In fact, if λ^* tends to its lowest possible value (1/2) and with a high z, then $\hat{x}$ tends to zero and $y' > y''$. In this labor market there is uniqueness: from any initial condition the unique stable steady state is the inefficient e^{sep}.

7.3. The labor market regime e^{p2}

There is a third possible labor culture that can emerge as the long-run outcome of the cultural dynamics: the e^{p2} equilibrium where all type of workers make specific investment but selfish employers pay low wages. In this equilibrium inequity averse workers punish these low wages by destroying the maximum allowed amount of surplus. So, although there is efficient investment, this equilibrium is also inefficient because of the destruction of the surplus.

This equilibrium can be a stable steady state only for some particular configurations of the set of parameters and for an initial condition of the market with many selfish workers and many fair-minded employers.

Proposition 6. *Assume that $x' > \hat{x}$ and $y' < y''$ then for any (x_0, y_0) in region 4 the dynamics converges to the preferences distribution (x', y') where the e^{p2} equilibrium is played* (see graphic 7.1a).

It is easy to check that this case only appears for some *intermediate* values of λ^* and z. The combination of this intermediate balance of power and the initial condition with relatively many selfish workers and not so many selfish employers results in the market getting stuck in the e^{p2} equilibrium.

7.4. The balance of power and efficiency

Let us put together the previously obtained results and remark the driving role played by the retaliatory power of the workers in order to enhance efficiency in the labor market.

If the institutional setting permits a high capacity of punishment on the side of the workers, which is captured by a high λ^* (close to one), and unless their degree of inequity aversion a is very small (and this would not be very realistic according, for instance, to the experimental evidence), then the efficient e^{p1} steady state, the Akerlof-type equilibrium is the unique stable stationary state.

Only for particular intermediate values of λ^* and z, the unitary cost of punishment, and for initial conditions with a relatively high proportion of selfish workers and a relatively small proportion of selfish employers, the less efficient steady state e^{p2} is reached, but there is still specific investment.

However, if the workers' power λ^* is not high enough (that is, it is close to 1/2) and is not too big, then the Akerlof-type equilibrium is a stationary point only for very extreme initial conditions with very low values of $x < \hat{x}$, since $\hat{x}$ is very small.

Only if z is very small, then $x' < \hat{x}$ and region 4 belongs to the basin of attraction of the Akerlof-type equilibrium. But for higher values of z, the resulting long-run outcome for almost all initial conditions is the inefficient separating equilibrium.

Notice that if λ^* tends to the minimum, ½ , and z is high enough, the e^{sep} is the global attractor for any initial conditions. So, in a market where workers have a very small degree of power and punishment is relatively costly, it is not possible to obtain efficiency whatever the initial proportion of fair-minded or reciprocal agents in both social classes is.

Therefore, trust and gift exchange operates in the market only if there is a balance of power. Or, in other words, under the shadow of a credible threat of a significant punishment. We should not conclude from this result that the presence of a significant fraction of agents with preferences for reciprocity is irrelevant. In fact, what makes the threat credible is indeed the presence of a sufficiently high proportion of fair-minded workers in the population. The driving force for achieving efficiency is the interaction and the joint effect of reciprocal preferences and the institutional feasibility of inflicting a substantial punishment on the employer.

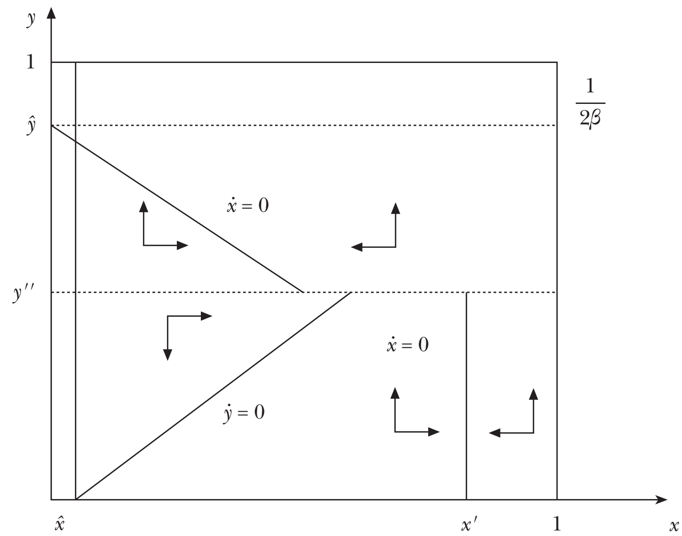
7.5. Pooling in general investments

With the simplifying assumption we have made of normalizing the low surplus to zero, a pooling in general investment (that is, both types of workers choosing action G) is an equilibrium of the employment relation only for $y = 1$ (an homogeneous population of selfish employers). Let us comment on what happens if $l > 0$.

Now this very inefficient equilibrium e^{pg} is a stable steady state for any preference distribution such that $x > \hat{x}$ and $y > (H - 2l)/H$. In other words, for initial conditions of the dynamics with a high proportion of selfish workers and employers, the labor market can get trapped in a very inefficient outcome. This area is greater the smaller the distance is between the low surplus $2l$ and the high surplus H. That is, the smaller the net productive gains derived from making specific investment are.

Interestingly, if this situation is combined with a very low β, the degree of advantageous inequity aversion, then the basin of attraction of this equilibrium increases dramatically (see graphic 7.3). The reason is that now when the market starts with on initial y_0 below $\tilde{y}$, the agents play the separating equilibrium, for instance, but the incentives for socialization of the selfish employers are higher than those of their inequity averse fellows (because $y < 1/2\beta$). Therefore, provided $x > \hat{x}$, y keeps growing until it reaches the region where the e^{pg} is played. If this situation coincides with a very low workers'power (λ^* tends to ½), which implies that $\hat{x}$ tends to zero, then the very inefficient outcome e^{pg} is the unique global attractor of the cultural dynamics. Cultural transmission will give place to a stationary labor culture where neither trust nor punishment works from any initial condition.

GRAPHIC 7.3: Phase diagram when agents coordinate in the pooling equilibrium in general investments



8. Concluding Remarks

WE have shown through the paper the key role of the workers' power to achieve trust and efficiency in the labor market but, what happens without a balance of power? Suppose that we remove from our employment game the punishment option. That is, only the presence of a fraction of inequity averse agents operates. Notice first that the e^{p1} equilibrium is no longer a Perfect Bayesian Equilibrium (PBE) of this employment game, because obviously selfish employers will always set low wages. But the remaining set of previously obtained equilibria are still equilibria in the new game.

However, now the e^{p2} equilibrium is not a stationary point of the dynamics under any initial condition. That is, both types of workers making specific investment is not a long-run outcome of cultural evolution. The only possible steady states are the inefficient equilibria e^{sep} or e^{pg}, depending on the initial conditions[5].

Therefore, as we have already seen, positive reciprocity is not enough to achieve an efficient labor culture. Also needed is a significant allocation of power to the workers in order to make the threat of punishment a powerful tool to enhance efficiency and cooperation. In fact, if the worker's power, λ^*, were small but positive (to be precise $\lambda^* < 1/2$), essentially the same result would be observed as if there were no punishment option.

Obviously, our game represents an asymmetric relationship, in the sense that only employers can hold up on workers, while the latter lack this capacity with respect to the employers. A more symmetric situation will be the object of future research. Nevertheless, we claim that a situation in which workers put at risk much more than employers in their bilateral relationship, again abstracting from reputational considerations, is very widespread in real-life employment relationships.

Another future extension of our analysis is to study a non-completely segregated society, where children can also meet cultural models from the other social group.

5. As was commented in section 7.5, if $\tilde{y} < 1/2\beta$, the unique steady state is the pooling in general investments equilibrium.

Appendix

Proof of lemma 1. Optimal punishing policy of inequity averse workers

If the inequity averse worker receives a compensation $b \geq 1/2$, he will not punish the firm. Effectively, the utility of punishing for this worker would be:

$$U^{p}_{1a}\,(bH - z\lambda H\,(1-b),\, H\,(1-b) - \lambda H\,(1-b)) = bH - z\lambda H\,(1-b) - \beta\ [bH - \\ - z\lambda H\,(1-b) - (H\,(1-b) - \lambda H\,(1-b))] = H\,(b - z\lambda\ (1-b) - 2\beta b + \beta - \lambda\beta \\ (1-b)\ (1-z)).$$

It can be observed that this expression is maximized when $\lambda = 0$.

Next, we assume that $0 \leq b < 1/2$.

Note that in this case this worker will punish the firm provided that the unitary cost of punishing z is smaller than $\frac{\alpha}{1+\alpha}$, since $U^{p}_{1a} > U^{np}_{1a}$, where $U^{p}_{1a}\,(bH - z\lambda\ (1-b)\ H,\, H\,(1-b) - \lambda H\,(1-b)) = H\,(b - z\lambda\ \ (1-b)) - \alpha\ [H\,(1-b) - \lambda H\,(1-b) - H\,(b - z\lambda\ \ (1-b))] = H\,(b\,(1+2\alpha) - \alpha\ + \lambda\ (z\,(1+\alpha) - \alpha)\,(b-1)$ (the utility of punishing by the inequity averse worker) and $U^{np}_{1a}\,(bH,\, H\,(1-b) = bH - \alpha\ (H\,(1-b) - bH) = H\,(b\,(1+2\alpha) - \alpha)$ (the utility of not punishing by the same worker).

We call $\bar{\lambda}$ the proportion of punishment that equals the payoff of both players after the punishment, that is, $H\,(1-b) - \bar{\lambda} H\,(1-b) = Hb - z\bar{\lambda} H\,(1-b)$. The value of $\bar{\lambda}$ is $\frac{1-2b}{(1-z)\ (1-b)}$.

If $\lambda > \bar{\lambda}$, the payoff of the employer will be smaller than the payoff of the worker. To maximize his utility the inequity averse worker has to set λ as small as possible becuase this punishment generates advantageous inequality and this option is dominated by punishing until both players get the same payoff, that is, setting $\lambda = \bar{\lambda}$.

Note that, for instance, for $b = 0$, the optimal amount of punishment is $\bar{\lambda} = \frac{1}{1-z}$, but this is greater than 1. We assume that the maximum proportion of punishment is λ^*, with $\lambda^* \leq 1$. So, for these low offers the optimal punishment is the maximum one, λ^*. We equate $\frac{1-2b}{(1-z)\ (1-b)}$ to λ^*, in order to obtain the threshold reward that will trigger the maximum level of punishment λ^*. This level is $b^* = \frac{1-\lambda^* + \lambda^* z}{2-\lambda^* + \lambda^* z}$.

Summarizing, the optimal punishment policy of the averse worker is:

For $0 \leq b \leq b^* = \frac{1 - \lambda^* + \lambda^* z}{2 - \lambda^* + \lambda^* z}$, the optimal proportion of punishment will be $\lambda = \lambda^*$.

For $b^* < b < 1/2$, the optimal proportion of punishment will be $\lambda = \frac{1 - 2b}{(1 - z)(1 - b)} < \lambda^*$.

For $b \geq 1/2$, the inequity averse worker will not punish.

Optimal rewarding policy of a strongly inequity averse employer

If an inequity averse firm offers a compensation of $b = 1/2$, its utility would be: $U_{2a}(H/2, H/2) = H/2$.

If this firm decides to offer a compensation of b to its worker, where $0 \leq b < 1/2$, its utility at most would be:

$$U_{2a}(bH, H(1 - b)) = H(1 - b) - \beta(H(1 - b) - bH) = H((1 - \beta) - b(1 - 2\beta)).$$

Therefore, as $\beta > 0.5$, to maximize this expression the firm has to set b as big as possible, but it would be strictly smaller than $H/2$.

If the firm decides to reward the worker with b, where $b > 1/2$, its utility would be $U_{2a}(bH, H(1 - b)) = H(1 - b) - \alpha(bH - H(1 - b)) = H(1 + \alpha - b(1 + 2\alpha))$, that is strictly smaller than $H/2$.

Therefore, the optimal policy of strongly inequity firms is to offer a reward of $b = 1/2$.

Proof of lemma 2. Optimal rewarding policy of a selfish employer when faced with a probability one with an inequity averse worker

If a selfish firm offers half of the surplus H, that is, offers a proportion $b = 1/2$, then its utility would be $H/2$ since this inequity averse worker will not punish it.

If the firm decides to offer a smaller reward b, where $0 \leq b < 1/2$, its payoff would be strictly smaller. Let us check it. If the firm offers a b such that, $0 \leq b \leq b^* = \frac{1 - \lambda^* + \lambda^* z}{2 - \lambda^* + \lambda^* z}$, it knows that an inequity averse worker will punish it with the maximum intensity, λ^*; and its utility will be $H(1 - b)(1 - \lambda^*)$, that is smaller than $H/2$ since $\lambda^* > 1/2$.

On the other hand, if it decides to offer a wage b, such that, $b^* < b < 1/2$, the inequity averse worker will punish it choosing a $\lambda = \frac{1 - 2b}{(1 - z)(1 - b)}$, and thus, its payoff would be $U_{2e} = H\,(1 - b - \frac{1-2b}{(1-z)\,(1-b)})$, that is also smaller than $H/2$. Notice that this result holds for $z = 0$ and this utility is decreasing with z.

Therefore, the selfish firm will offer $b = 1/2$ when it faces an inequity averse worker with probability one.

Proof of lemma 3.
Optimal rewarding policy of a selfish employer with incomplete information

The expected payoff of offering $0 \leq b < b^*$ is $\mu\,[H\,(1-b)] + (1-\mu)\,[H\,(1-b) - \lambda^* H\,(1-b)] = H\,(1-b)\,[1-(1-\mu)\lambda^*]$, given that the selfish worker does not punish and the averse worker applies the maximum punishment λ^*. It is easy to check that setting $b = 0$ dominates any other $b > 0$ whenever $b < b^*$. So, the expected payoffof offering $b = 0$ is $H\,[1-(1-\mu)\lambda^*]$.

On the other hand, offering $b = 1/2$, generates to the firm a payoff of $H/2$, since none of the types of workers punishes it.

Then, for the firm, offering $b = 0$ is better than offering $b = 1/2$ when $\mu > \frac{\lambda^* - 1/2}{\lambda^*}$. And offering $b = 1/2$ is better than offering $b = 0$ when $\mu \leq \frac{\lambda^* - 1/2}{\lambda^*}$.

Next, we have to prove that to offer $b = 0$ is better than to offer $b^* \leq b < 1/2$, when $\mu > \frac{\lambda^* - 1/2}{\lambda^*}$.

The expected payoff of the selfish employer of offering b, such that, $b^* \leq b < 1/2$ is $\mu\,[H\,(1-b)] + (1-\mu)\,[H\,(1-b) - \lambda H\,(1-b)] =$
$= \mu\,[H\,(1-b)] + (1-\mu)\,[H\,(1-b) - \frac{1-2b}{(1-z)\,(1-b)}\,H\,(1-b)]$.

Assume that $\mu > \frac{\lambda^* - 1/2}{\lambda^*}$. Then, we have to prove that $H\,[1-(1-\mu)\lambda^*] > \mu\,[H\,(1-b)] + (1-\mu)\,[H\,(1-b) - \frac{1-2b}{(1-z)\,(1-b)}\,H\,(1-b)]$.

It is easy to verify that this expression holds for $\mu = 1$. It also holds for $\mu = \frac{\lambda^* - 1/2}{\lambda^*}$.

As the function $H\,(b - (1-\mu)\,\lambda^* + (1-\mu)\,\frac{1-2b}{(1-z)\,(1-b)}) > 0$ is monotonically increasing in μ, then this expression always holds. It can be verified that $b + (1-\mu)\,\frac{1-2b}{(1-z)\,(1-b)} > (1-\mu)\lambda^*$, since in the worst case, that is, when $\mu = \frac{\lambda^* - 1/2}{\lambda^*}$, it holds. Therefore, it is shown that to offer $b = 0$ is better than to offer $b^* \leq b < 1/2$, when $\mu > \frac{\lambda^* - 1/2}{\lambda^*}$.

Next, we have to prove that to offer $b = 1/2$ is better than to offer $b^* \leq b < 1/2$, when $\mu \leq \frac{\lambda^* - 1/2}{\lambda^*}$. Then we have to prove that: $H/2 \geq \mu\,[H\,(1-b)] + (1-\mu)\,[H\,(1-b) - \frac{1-2b}{(1-z)\,(1-b)}\,H\,(1-b)]$.

If we are in the worst case, that is $\mu = \frac{\lambda^* - 1/2}{\lambda^*}$ and $b = 1/2$, this expression holds. Therefore, it is shown that to offer $b = 1/2$ is better than to offer $b^* \leq b < 1/2$, when $\mu \leq \frac{\lambda^* - 1/2}{\lambda^*}$.

Proof of lemma 4.
Separating equilibrium

Suppose that the selfish worker ($1e$) chooses S and the inequity averse worker ($1a$) chooses G, then the updated beliefs of the firms are $\mu(e/S) = 1$. Therefore the selfish firm ($2e$) will offer $b = 0$ and the inequity averse firm ($2a$) will offer $b = 1/2$.

The expected payoff of $1e$ will be $(1 - y)$ H/2 and the payoff of $1a$ would be l.

Incentive compatibility for the selfish player implies that $(1- y)\ H/2 \geq l$, that is, $y \leq \frac{H-2l}{H} = \tilde{y}$.

On the other hand, incentive compatibility for the inequity averse worker implies that $(1 - y)\ \frac{H}{2} + y\ (- z\lambda^*H - \alpha\ [H - \lambda^*H + z\lambda^*H])$ has to be smaller than l, and this is achieved if $y \geq \frac{H-2l}{H(1+2(z\lambda^*(1+\alpha)+\alpha(1-\lambda^*)))} = \tilde{y}$.

Note that there exist separating equilibria because $y'' \leq \tilde{y}$.

Proof of lemma 5.
Pooling equilibrium e^{p1}

Given that $x < \hat{x} = \frac{\lambda^* - 1/2}{\lambda^*}$ and that both types of workers choose S, the updated probability remains the same as the prior, there is no updating of beliefs and the best option for both type of firms is to offer $b = 1/2$. Every player gets a payoff of $H/2$ without any punishment. No type of worker has incentives to deviate, since $H/2 > l$.

Proof of lemma 6.
Pooling equilibrium e^{p2}

Given that $x > \hat{x} = \frac{\lambda^* - 1/2}{\lambda^*}$ and that both types of workers choose S, as there is no updating of beliefs, now the selfish firm will offer $b = 0$. The inequity averse firm will keep offering $b = 1/2$. On the other hand, given that $y \leq y''$, both the inequity averse worker and the selfish worker will choose to make specific investment. The selfish player will not deviate because $(1 - y)\ H/2 > l$, since $y \leq y'' < \tilde{y}$.

On the other hand, the inequity averse worker does not deviate either, because $(1 - y)\ H/2 + y\ (- z\lambda^*H - \alpha\ [H - \lambda^*H + z\lambda^*H]) \geq l$ since $y \leq y''$.

Proof of lemma 7.
Pooling equilibrium e^{pg}

The selfish worker will deviate if $y < \tilde{y}$, so since $y \geq \tilde{y}$ player *1e* does not deviate from choosing general investment. Player *1a* does not deviate if $y \geq y'$, since $y \geq \tilde{y} \geq y''$, this worker does not deviate either from making general investment.

Analysis of preferences dynamics

The dynamics of preferences when the agents expect the e^{sep} equilibrium

In this equilibrium the selfish worker chooses to make specific investment *(S)* and the inequity averse worker chooses to make general investment *(G)*. The selfish firm offers $b = 0$ and the inequity averse firm offers $b = 1/2$. The equilibrium payoff of the selfish worker is $(1 - y)\ H/2$, for the inequity averse worker is $l = 0$, for the selfish firm is xH and for the inequity averse firm is $x\,\frac{H}{2}$.

We start computing the levels of cultural intolerance of the selfish workers parents:

$$V_{1e}^{ee} = (1 - y)\ H/2,$$
$$V_{1e}^{ea} = l = 0.$$

Therefore $\Delta V_{1e}^{e} = (1 - y) H/2 > 0$.

With respect to inequity averse workers:

$$V_{1a}^{aa} = l = 0,$$
$$V_{1a}^{ae} = (1 - y)\ H/2 + y\,(-\alpha H).$$

Therefore $\Delta V_{1a}^{a} = 0 - [(1 - y)\ H/2 + y\,(-\alpha H)] = y\alpha H - (1 - y)\ H/2 > 0$.

Note that to compute V_j^{ik} we assume that a parent of type i evaluates his child's well-being using his own utility function. For example, V^{ae} is the utility to an inequity averse player if his child is selfish. This child will not punish the firm when he is offered $b = 0$.

We can now obtain the optimal education effort function for both types of workers:

$$\tau_1^{e*}\ (x_t) = q \cdot \Delta V_{1e}^{e}\,(x_t)\ (1 - x_t) = q\ (1 - y_t)\ H/2\ (1 - x_t),$$

$$\tau_1^{a*}\ (x_t) = q \cdot \Delta V_{1a}^{a}\ (x_t)\ x_t = q\ (y_t \alpha H - (1 - y_t) H/2)\, x_t.$$

Now we proceed to analyze the socialization decision of the selfish employers parents. In this case:

$$V_{2e}^{ee} = xH,$$
$$V_{2e}^{ea} = xH/2.$$

Therefore $\Delta V_{2e}^{e} = xH/2 > 0$.

The same for inequity averse employers:

$$V_{2a}^{aa} = xH/2,$$
$$V_{2a}^{ae} = x\,(1-\beta)\,H.$$

Therefore, $\Delta V_{2a}^{a} = xH/2 - x\,(1-\beta)\,H = xH\,(\beta - 1/2) > 0$.

The same analysis as before gives place to: $\tau_2^{e*}\,(y_t) = q \cdot \Delta V_{2e}^{e}\,(y_t) \cdot (1-y_t) = q x_t \frac{H}{2}\,(1-y_t)$.

And, $\tau_2^{e*}\,(y_t) = q \cdot \Delta V_{2a}^{a}\,(y_t) \cdot y_t = q x_t H\,(\beta - 1/2)\,y_t$.

The dynamics of preferences when the agents coordinate in the e^{p2} equilibrium

In the pooling equilibrium e^{p2}, both types of worker choose to make specific investment *(S)* and the selfish employer offers $b = 0$ and the inequity averse employer offers $b = 1/2$. The equilibrium payoff of the selfish worker is $(1-y)\;H/2$, for the inequity averse worker is $(1-y)\;H/2 + y\,(-z\lambda^*H - \alpha\,(H - \lambda^*H + z\lambda^*H)$, for the selfish firm is $xH + (1-x)\;(H - \lambda^*H)$ and for the inequity averse firm is $H/2$.

We start computing the levels of cultural intolerance of the selfish workers parents:

$$V_{1e}^{ee} = (1-y)\;H/2,$$
$$V_{1e}^{ea} = (1-y)\;H/2 - yz\lambda^*H.$$

Therefore, $\Delta V_{1e}^{ee} = yz\lambda^*H > 0$.

The same reasoning applies for inequity averse workers:

$$V_{1a}^{aa} = (1-y)\;H/2 + y\,(-\,z\lambda^*H - \alpha\;(H - \lambda^*H + z\lambda^*H)),$$
$$V_{1a}^{ae} = (1-y)\;H/2 + y\,(-\,\alpha H).$$

Therefore, $\Delta V_{1a}^{a} = y\lambda^*H\,(\alpha - z\,(1+\alpha)) > 0$.

Then, we can compute: $\tau_1^{e*}\,(x_t) = q \cdot \Delta V_{1e}^{e}\,(x_t) \cdot (1-x_t) = q y_t z\lambda^*H\,(1-x_t)$.

And, $\tau_1^{a*}\,(x_t) = q \cdot \Delta V_{1a}^{a}\,(x_t) \cdot x_t = q y_t \lambda^*H\,(\alpha - z\,(1+\alpha))\;x_t$.

Now we proceed to analyze the socialization decision of the selfish employers parents. In this case:

$$V_{2e}^{ee} = xH + (1 - x)\ (H - \lambda^* H),$$
$$V_{2e}^{ea} = H/2.$$

Therefore, $\Delta V_{2e}^{e} = H/2 - (1 - x)\ \lambda^* H \geq 0$.

The same computation can be done for inequity averse employers:

$$V_{2a}^{aa} = H/2,$$
$$V_{2a}^{ae} = x\ (1 - \beta) H + (1 - x)\ (H - \lambda^* H - \beta\ \ (H - \lambda^* H + z\lambda^* H)).$$

Therefore, $\Delta V_{2a}^{a} = H/2 - [x\ (1 - \beta) H + (1 - x)\ (H - \lambda^* H - \beta\ \big(H - \lambda^* H + z\lambda^* H)] \geq 0$.

Thus we can obtain: $\tau_2^{e*}\ (y_t) = q \cdot \Delta V_{2e}^{e}\ (y_t) \cdot\ (1 - y_t) = q\ [H/2 - (1 - x_t)\ \lambda^* H]\ (1 - y_t)$.

And $\tau_2^{a*}(y_t) = q \cdot \Delta V_{2a}^{a}\ (y_t) \cdot y_t = q\ [H/2 - [x_t\ (1 - \beta)\ H + (1 - x_t)\ (H - \lambda^* H - \beta\ (H - \lambda^* H + z\lambda^* H))]]\ y_t$.

Proof of the stability of the dynamic system in region 3

We have a nonlinear difference equation system. In order to check the stability of the system we can use a linear approximation to this system. As long as we analyze a small neighbourhood of the fixed points, the linear approximation can give us the same equilibrium as the original system, therefore the linear approximation (the local stability analysis) could serve as a supplement to the phase-diagram analysis.

The local stability or instability of the equilibrium can be deduced from the behavior of the matrix of partial derivatives—the Jacobian matrix of the nonlinear system—evaluated at the equilibrium.

We will denote the Jacobian evaluated at the equilibrium $(\bar{x}, \bar{y})$ by J_E and its elements by a, b, c, d:

$$J_E = \begin{bmatrix} \frac{\vartheta \dot{x}_t}{\vartheta x} & \frac{\vartheta \dot{x}_t}{\vartheta y} \\ \frac{\vartheta \dot{y}_t}{\vartheta x} & \frac{\vartheta \dot{y}_t}{\vartheta y} \end{bmatrix}_{(\bar{x}\ \bar{y})} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}.$$

To check the stability of the dynamical systems we have to verify that the trace of J_E is negative, that is, $a + d < 0$ and that the determinant of J_E is positive, that is, $a \cdot d - b \cdot c > 0$, evaluated in the fixed points.

In region 3 the dynamics is governed by the equations:

$$\dot{x}_t = [x_t\,(1-x_t)\;(1-y_t)\;(\tfrac{1}{2}-\alpha y_t x_t)],$$
$$\dot{y}_t = x_t\,[y_t\,(1-y_t)\;(\tfrac{1}{2}-\beta y_t)].$$

Therefore the Jacobian matrix J_E would be:

$$\begin{bmatrix} x_t\,y_t - \tfrac{1}{2}y_t \; - x_t + 3\alpha x_t^2 y_t - 2\alpha x_t y_t \; + \tfrac{1}{2} & \tfrac{1}{2}\,x_t^2 \; - \tfrac{1}{2}\,x_t - \alpha x_t^2 + \alpha x_t^3 \\ \tfrac{1}{2}y_t \; - \tfrac{1}{2}y_t^2 - \beta y_t^2 + \beta y_t^3 & \tfrac{1}{2}\,x_t - x_t y_t + 3\beta x_t y_t^2 \; - 2\beta x_t y_t \end{bmatrix}.$$

If we substitute the value of the fixed points $\bar{x} = \frac{\beta - 1/2}{\alpha}$ and $\bar{y} = 1/2\beta$ in this matrix, we obtain:

$$\begin{bmatrix} -\frac{1}{8\,\alpha\beta}\,(2\,\beta\; - 1)\;(2\alpha - 2\beta + 1) & -\frac{1}{4\,\alpha^2}\,\beta\;(2\,\beta\; - 1)\;(2\alpha - 2\beta + 1) \\ 0 & -\frac{1}{8\,\alpha\beta}\,(2\,\beta\; - 1)^2 \end{bmatrix}.$$

Therefore the trace of the Jacobian evaluated in the equilibrium *(a + d)*, after simplifying and rearranging terms is, $-\ \frac{1}{4\beta}\ (2\beta - 1)$, this expression is negative if $\beta > 0.5$, therefore the trace is negative.

On the other hand, computing the determinant of the Jacobian matrix, $a \cdot d - b \cdot c$ yields the result: $\frac{1}{64\alpha^2\beta^2}\ (2\beta - 1)^3\ (2\alpha - 2\beta + 1)$, expression that is positive, since $\alpha > \beta$. Therefore, the dynamical system is locally stable.

Proof of the stability of the dynamic system in region 4

In region 4 the dynamics is governed by the equations:

$$\dot{x}_t = x_t\,(1-x_t)\;(y_t z\lambda^*\,(1-x_t) - y_t\lambda^*\,(\alpha - z\,(1+\alpha))\,x_t),$$
$$\dot{y}_t = y_t\,(1-y_t)\;((1/2 - (1-x_t)\lambda^*)\;(1-y_t) - ((1/2 - (x_t\,(1-\beta) +$$
$$+\,(1-x_t)\;(1-\lambda^* - \beta\;\;(1-\lambda^* + z\lambda^*)))\,y_t\,).$$

Therefore the Jacobian matrix J_E would be:

$$\begin{bmatrix} y_t\,\lambda^*\,(z - 2zx_t - 2\alpha x_t + 3\alpha x_t^2 + 2z\alpha x_t - 3z\alpha x_t^2\,) & -x_t\lambda^*\,(x_t - 1)\;(z - \alpha x_t + z\alpha x_t) \\ -\,y_t\,\lambda^*\,(y_t\; -1)\;(z\beta y_t - \beta y_t + 1) & \begin{array}{r} y_t - \lambda^* - \tfrac{3}{2}y_t^2 - 2\beta y_t + x_t\lambda^* + 2y_t\,\lambda^* + 3\beta y_t^2 + \\ +\,2\beta y_t\,\lambda^* - 2x_t\,y_t\,\lambda^* - 3\beta y_t^2\lambda^* - 2z\beta y_t\,\lambda^* - \\ -\,2\beta x_t\,y_t\,\lambda^* + 3z\beta y_t^2\lambda^* + 3\beta x_t\,y_t^2\lambda^* + \\ +\,2z\beta x_t\,y_t\lambda^* - 3z\beta x_t\,y_t^2\lambda^* \end{array} \end{bmatrix}.$$

If we substitute the value of the fixed points $x' = \frac{z}{\alpha\,(1-z)}$ and $y' = \frac{1/2 - \left(\frac{\alpha(1-z)-z}{\alpha(1-z)}\right)\lambda^*}{\beta\left(1 - \frac{\lambda^*(\alpha(1-z)-z)}{\alpha}\right)}$ in this matrix, we obtain similar conclusions to the previous section that is, the trace of the Jacobian evaluated in the equilibrium is negative and the determinant of the Jacobian matrix is positive, thus the dynamical system is locally stable.

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