

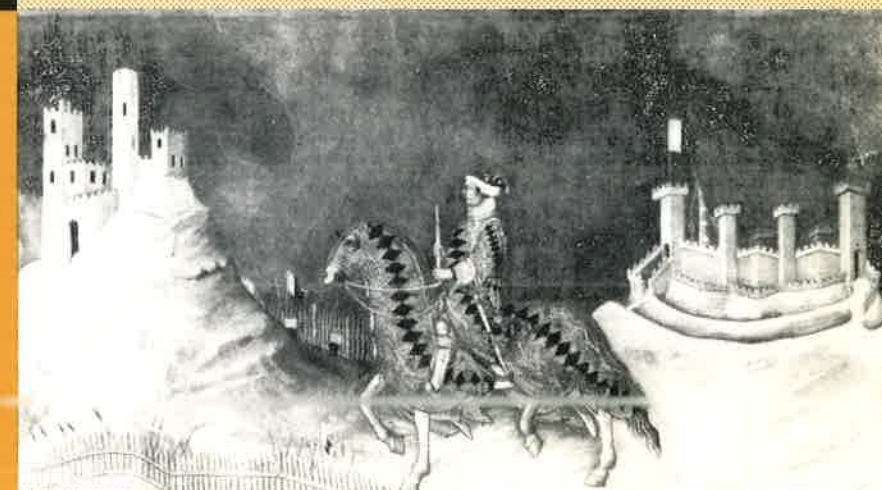
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QUADERNI DEL DIPARTIMENTO
DI ECONOMIA POLITICA

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**DISTRIBUTIVE JUSTICE
AS A COORDINATION PROBLEM**



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Francesco Farina

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COORDINATION PROBLEM**



Siena, ottobre 1992

1. Introduction (*)

In the traditional representation of the market, efficiency and distribution are distinct properties of the competitive equilibrium reflected by the First and the Second Theorem of Welfare Economics, respectively. Efficiency has a sort of theoretical "priority" with respect to distribution: it is only once a Pareto frontier has been determined that the distributive features of the equilibrium position can be evaluated (and changed by means of lump-sum transfers, in case society wants a given criterion of equity to be realized). Hence, in a world of perfect competition no ethical appraisal of the market process is meaningful: transactions reflect factor prices determined according to the productivity principle, so that the initial resource allocation replicates in the final welfare distribution.

Once the fiction of the autoauctioneer is abandoned, the representation of the competitive market becomes extremely complicated. In the absence of the vector of equilibrium prices determined by the autoauctioneer, the agents are required to issue price signals by themselves, and the amount of information and of computational capability which is needed enormously increase. Therefore, the market becomes a nexus of transactions and contracts, and prices will no longer just perform an allocative function but their strategic role emerges. By consequence, the distributive issue will impinge upon the determination of the equilibrium position of the economic system. An agent or a group of agents with market power, having foreseen possible opportunities for mutual advantage to be exploited, might for instance block a path of trade so that a higher price will result in the market (1). In the place of the Pareto-optimal connected to the clearing of the competitive market, many Pareto-optimal

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"core" solutions are possible, but it is by no means certain that a solution will emerge. Since each of these Pareto-optimal correspond to a different distribution of the mutual advantage among agents, the result of an efficient equilibrium depends on the solution of the distributive conflict. Given that in the anonymous competitive markets most interactions are not repeated, the analysis of relevant games will be limited to their one-shot version.

The pervasiveness of market failures has suggested that bargaining - and not perfect competition - is the coordination institution which governs most transactions. This paper aims at criticizing the view according to which bargaining solutions which solve a situation of market failure necessarily satisfy the productive principle of distribution, and at showing the role played by strategic behaviour (2). Whenever bargaining substitutes perfect competition as the coordination institution, the ethical neutrality of the market no longer holds: due to the individuals' pursuit of gain trade does not occur at equilibrium prices, and efficiency becomes conditional on the distributive outcome.

Yet, in most applications of bargaining to a situation of market failure, negotiations are modeled as the "visible hand" which supplements the "invisible hand" of the competitive market and permits to solve market failures by inducing cooperation. Similarly to the "parametric" consideration of equilibrium prices by agents in general equilibrium theory, bargaining solutions to non-cooperative games tend to assume that each agent relies on the "parametric" evaluation of the opponent's strategy. Therefore, the scope of bargaining solutions is limited to the objective to mimic the outcome of the competitive market, and the complexity of strategic interaction risks to be seriously undermined. If the bargaining solution consists of the equal division between agents participating in joint cooperation with equal investment, the same distributive shares which result in the competitive market equilibrium are replicated.

I will contend this bargaining approach to market, since it does not take properly into account the strategic aspects which are embedded in Bargaining Theory due to two forms of imperfect information : 1) uncertainty over the "type" of the other player will insert incomplete information in the game: the pay-off structure of the game is unknown to a player; 2) uncertainty which derives from the presence of multiple equilibria: since common beliefs about the each player's chosen strategy cannot be assumed, an "uniquely rational" solution might not exist.

If the incomplete information problem has been overcome (or is not present), it will be maintained that - in the situation of distributional conflict among Pareto-optimals which characterizes many Coordination Games - rationality does not require that the disposition to cooperate coincides with a disposition to comply only with fair bargains. The determination of the bargaining solution among multiple equilibria will result from a *convention* which might select an "asymmetric" division of the cooperative surplus; alternatively, any Pareto improvement might be blocked, due to a bargaining failure caused by strategic behaviour.

If the first kind of uncertainty exist, a player can take advantage of incomplete information and get by means of *opportunism* the distribution most favourable to him. Which efficient equilibrium point will be obtained on the Pareto-frontier - as a result of an "asymmetric" bargaining solution - will depend on which division of the cooperative surplus has turned out.

2. The PD as a competitive market Pareto sub-optimal

Let us start by analysing one-shot non-cooperative games between two players, in which imperfect information consist of the uncertainty over the opponent's strategy. The *common knowledge of rationality* is defined by the usual assumptions: a) the mathematical description of the game - a list of strategies for each player, and a pair of utility indexes for every combination

of strategies that might be played - is common knowledge (a player knows, and knows that the other player knows, and so on); b) both players are supposed to be rational, in the sense of expected utility theory; c) every theorem related to the game is common knowledge.

The mathematical description of the Prisoners' Dilemma (PD) is often used to express a deviation from the Pareto-optimal corresponding to the competitive market equilibrium. In a PD pay-off structure, a market failure might be viewed as the outcome (D,D) of an attempt by two agents to jointly provide a public good. As Figure 1 shows, this outcome means that a player is not willing to provide any of the public good by himself and evaluates the amount of the public good provided by his opponent alone more than the total amount of the public good provided by joint cooperation less his own costs of cooperation. The PD Pareto sub-optimal is solely caused by the parting of individual rationality from collective rationality, that is from the strategy which would lead to the cooperative agreement for the joint production of the surplus. The reason why in this game each player refrains from cooperation is well-known: due to the absence of an enforceable commitment, in case of agreement the opponent might always defect, gain the "free-riding" pay-off (which exceeds that resulting from cooperation), and leave him with a pay-off which is inferior to that linked to the *status quo*.

The peculiarities of the PD pay-off structure above summarised greatly restrict the scope of the bargaining coordination. The Pareto sub-optimal Nash equilibrium of a PD game stems from a pay-off structure in which the cells representing the asymmetric distribution of the cooperative surplus show (C,D) to be dominated by (D,D): that is, defection is the rational strategy *whatever the other does*. Due to this market failure, those transactions which would have pushed the economy up to the Pareto-frontier - according to the signals that the vector of "notional" prices would have provided if allowed to work - were not fulfilled. Since defection is the individually dominant strategy, it is not required to be aware that any decision has

consequences on the opponent's behaviour, and each agent considers himself the sole variable in a fixed environment.

The bargaining approach to market, which will be here considered by discussing Gauthier's bargaining solution (3), tackles the issue of the cooperative agreement - aiming at bridging the gap between the sub-optimal equilibrium of the *status quo* and the Pareto-optimal equilibrium - along the same lines.

3. Gauthier's bargaining solution of "equal division"

In *Morals by Agreement* it is claimed that bargaining is the coordination institution which supplements the competitive market in case of failure. Morality springs from rationality once the "equal division" of the cooperative surplus is accepted by players otherwise blocked in a PD sub-optimal equilibrium (the necessary pre-condition being that, before the bargaining takes place, the "initial bargaining position" is such that all *unfair* transfers due to free-riding and parasite behaviour have been eliminated) (4). I will contend Gauthier's "equal division" bargaining solution, where the perfect competition result of proportionality between returns and contributions, and the conception of the market as a "morally free zone", are maintained.

Gauthier's approach can be presented as the transformation of the PD (see Figure 1) in a Coordination Game with a *unique* Pareto-optimal solution (see Figure 2). This specific pay-off structure should result from the conditional disposition to cooperate that rational players, interacting with similarly disposed players, will assume by abandoning the standard selfish behaviour which the author names *straightforward maximization* (SM) - the agent does not attach importance to other individuals' well-being and tries to exploit their willingness to cooperate - and accepting to base their actions on the disposition to make mutual concessions, which is defined *constrained maximization* (CM) (5).

The attainment of the Pareto-optimal, such as outcome (2,2) in Figure 2, in which both players equally gain with respect to the *status quo* pay-offs, is considered as the result of the application - by *constrained maximizer* agents - of the moral rule of the "minimax relative concession", the reciprocal decision to renounce to the same quantity starting from the "ideal" claim of the total amount of the cooperative surplus (6). This moral rule stemming from rationality guarantees that the equilibrium on the Pareto frontier replicates the notion of distributive justice pointed out by the productivity principle of distribution: given that the production of the cooperative surplus needs equal investment shares by the two players, the equal division of it means that the bargaining solution reproduces the outcome of the competitive market.

I will question the derivation of a moral rule of cooperation from rationality, because the claim that rational players will necessarily recognize a role for a moral behaviour consisting of compliance only with *fair* bargains is unsound; the disposition to *reciprocal cooperation* will instead be introduced, since it captures how in a coordination game with conflict of interest an "asymmetric" bargaining solution might reflect the disposition to comply with an *unfair* bargain when a *convention* which favours the opponent applies, or should be traced to a opportunistic behaviour.

Let us then analyse the procedure followed by Gauthier to solve the two problems mentioned above, related to the uncertainty over the agents' behaviour and to the uncertainty over beliefs and strategies, respectively.

As for the first kind of uncertainty, Game Theory usually resorts to the "Harsanyi's doctrine" in order to overcome the imperfect information over the behavioural features of the players. The hypotheses can be summarised as follows: 1) each player has a subjective distribution over all the other player's possible *types* (the pay-offs in each state of nature); 2) the Nature is the stochastic mechanism which selects the *type* of each player; 3) the Nature is common knowledge, in the sense that each

agent knows the objective probability distribution of possible choices (7). Once this "common prior" assumption is interpreted as players having the same probability distributions, agents are supposed to be in the position to share a common reasoning which brings about a unique set of rational beliefs (this argumentation, anyway, is very controversial) (8).

However, Gauthier's solution is different, as it originates from the assumption of *translucency* (9) of the agents. Each player should have a reasonable probability to identify the type of his opponent (10), : a CM who encounters a SM defects (so that in Figure 2 the CM label has been substituted by the "D" one) and there is no difference with respect to the *status quo* pay-offs. The rationale is that expectations over the *type* of the opponent depend on subjective probabilities. Yet, the choice between the SM or the CM disposition - upon which these expectations impinge - is made by considering constant the proportion between SMs and CMs in the population (11).

In a situation characterised by strategic interaction, this is a particularly weak assumption. Since the outcome depends not only on one's own choice, but also on the choice of all others, the usual infinite regression process of beliefs over beliefs occurs, but Gauthier's method lacks the "truncation" device which in the "Harsanyi's doctrine" is represented by the Nature. Players are asked to decide under conditions of strategic interdependence, whereas in the *Morals by Agreement* model agents relate each other "parametrically" (12). Therefore, Gauthier's solution to the first kind of uncertainty is not firmly founded.

4. Disposition to cooperate and *fair* bargains

The way in which Gauthier solves the second problem, the uncertainty over the opponent's beliefs and strategies, is strictly related to the objective to transform the PD in a Coordination Game without conflict of interest. In fact, once the dominance of (D,D) over (C,D) in the PD pay-off structure is

Figure 1

	C	D
C	2, 2	0, 3
D	3, 0	1, 1

Figure 2

	CM	SM
CM	2, 2	1, 1
SM	1, 1	1, 1

Figure 3a

	C	D
C	3, 3	0, 2
D	2, 0	1, 1

Figure 3b

	C	D
C	3, 3	0, 1
D	1, 0	1, 1

Figure 3c

	C	D
C	3, 3	-2, -2
D	-2, -2	1, 1

annulled, the "new" game is a Coordination Game which keeps the feature of the original game to be a symmetrical game with a *unique* Pareto-optimal. The bargaining solution by which this Pareto-optimal is reached slightly differs from the Nash's one, due to the substitution of the "independence of irrelevant alternatives" axiom with the "monotonicity" axiom (13), so that for two persons this is equal to the egalitarian solution put forward by Kalai-Smorodinsky (14). *Morals by Agreement* bargaining solution, consisting of equal concessions, can be thought of as the efficient equilibrium point of the competitive market on the Pareto frontier: bargaining solves the market failure by leading to equal improvements with respect to the *status quo* pay-offs.

The condition of uniqueness is very important for this bargaining solution to be found. If there is a unique Nash equilibrium which is Pareto-optimal, common knowledge of rationality ensures that this will be the bargaining solution. On the one hand, if there is a uniquely rational solution, each rational player can duplicate his opponent's expectations and strategy, and is common belief between players that each of them is able to predict the move of the other, so that strategies which are in Nash equilibrium with one another will be chosen (15). On the other hand, in a symmetric game, the uniquely rational solution is a symmetric Nash equilibrium: the Pareto-optimal must be the result of equal improvements with respect to the *status quo* pay-offs.

Morals by Agreement exploit just this mutual correspondence between uniqueness and symmetry - which only applies when an uniquely rational solution exist - in order to argue that players are able to complete the "equal division" bargain because of the principle of "equal rationality": "no one can expect any other rational person to be willing to make a concession if he would not be willing to make a similar concession" (16). The conclusion is that the disposition to *constrained maximization* coincides with the disposition to *narrow compliance*, that is, "to cooperate in

ways that, followed by all, yield nearly optimal and fair outcomes" (17).

However, this argument is doubtful. It will now be shown that the correspondence relation between *constrained maximization* and *narrow compliance* is totally unwarranted. By no means rationality requires that the disposition to cooperate and the disposition to comply only with *fair bargains* are to be regarded as identical attitudes.

To cooperate only if a *fair bargain* is negotiated means that the solution must be symmetrical. Yet, it is not necessarily true that a symmetric game must have a symmetric solution. Only in a symmetric game with a uniquely rational solution the bargaining solution will certainly be symmetric. For a symmetric solution to be considered uniquely rational, the unicity of the Nash equilibrium of the coordination game has to be demonstrated. Gauthier puts forward the argument according to which CMs are able to recognize their opponent. If the lower-left and upper-right cells in Figure 2 can present pay-offs which are identical to the *status quo* ones, it is because of the CM players' capability to defect in case a SM is encountered. Therefore, it is just by means of the expedient of the agents' *translucency* that the unicity of the rational solution of the Coordination Game in Figure 2 is obtained. But this argument is unsound, since it does not take into account that strategic interaction causes the infinite regress problem to arise. Then, the SM players will probably not be detected by the CM players, and the pay-off structure will be different from that of Gauthier's Coordination Game with a *unique* Pareto-optimal.

To question Gauthier's bargaining solution to the Coordination Game with a *unique* Pareto-optimal Nash equilibrium - as the one sketched in Figure 2 - means that also the way in which the market failure is solved has to be questioned. That the bargaining solution has to be uniquely rational is due to the Gauthier's view according to which bargaining has to mimic the equilibrium that, in the absence of market failures, would have been determined by perfect competition. It is apparent that this

is very similar to assuming that the walrasian autoauctioneer is still operating: to the same extent of market coordination, in which no value judgement can be attached to interactions based on individual preferences and performed by means of exogenously given equilibrium prices, bargaining coordination is characterised by absence of conflict. In fact, the "equal division" bargaining solution matches the competitive market result: the final distribution among agents replicates - on the basis of factor prices derived from the equality between marginal return and marginal productivity for each factor - the initial distribution of the endowments, and the market can be considered a "morally free zone" (18).

However, due to weaknesses in the solution of the incomplete information problem by the *translucency* hypothesis, and to the restriction of the Coordination Game to a unique Pareto-optimal solution, Gauthier's conception of distributive justice has to be put in doubt. By consequence, the correspondence relation between distributive justice in the competitive market and the *fairness* of a bargaining solution consisting of equal concessions does not hold. The assumption of the existence of a uniquely rational solution has then to be abandoned and the general case of multiple equilibria of Coordination Games applies.

5. The reciprocal cooperator

Let me introduce the view according to which the players' disposition to cooperate does not derive from morality but from a reciprocity rule brought about by "instrumental rationality". As it is well-known, in the repeated PD game, the rational solution might turn out from a *Tit for Tat* strategy (a player must cooperate at the first node, and then replicate the previous node's move of the opponent) (19); similarly, the remarks above made on the Gauthier's one-shot game show that it is just the existence of a uniquely rational solution to induce players to adopt the MRC rule. As it has pointed out by Sen, "the

recognition of interdependence may suggest following certain rules of behaviour, which are not necessarily of intrinsic value, but which are of great *instrumental* importance (...) *social* rules are accepted for the *general* pursuit of *individual* goals" (20).

It will then be argued that strategic interaction is better coped with by assuming that players' behaviour corresponds to *reciprocal cooperation*: that is, to cooperate when and only when cooperation is necessary and sufficient for the other's cooperation (21). Since in this behavioural disposition the problem of reciprocal trust is central, the Assurance Game - each player is willing to cooperate, but only if the other does - appears as the game more suited to represent this type of behaviour. Differently from Gauthier's "it is rational to be moral", it will be maintained that "it is rational to be reciprocal". *Reciprocity* and not *morality* is what rationality indicates: thus, the problem of trust faced by *reciprocal cooperators* has to be analysed.

In the Assurance Game's pay-off structure, similarly to the PD and in contrast with most relevant games, (C,D) is worst than (D,D). However, differently from the PD, to defect when the other cooperates does not result in a higher pay-off than in the Pareto-optimal (C,C) outcome. The Assurance Game has no dominant strategy, but two Nash equilibria (C,C) and (D,D). Assuming that the other player cooperates, whatever the first player's "defection" pay-off is - higher, equal or inferior to the *status quo* one -, since the (C,C) equilibrium, differently from the PD, is not dominated by (D,C), the Pareto-optimal (C,C) is expected to result. However, the problem remains that the pay-off of the "sucked" - just as in the PD - goes below the *status quo* one. If he decides not to cooperate, the Pareto-optimal outcome is impossible to reach. Thus, the most likely impediment to cooperation is a coordination failure due to lack of trust. I will now illustrate three versions of the Assurance Game (AG), where the cost-and-benefit structure and the distributive conditions slightly evolve from the one to the other, so that increasing trust sets up between *reciprocal cooperators*.

The first version of this game, AG I (see Figure 3a), depicts a situation characterised by an exploited player, who is producing alone only part of the public good. His pay-offs reflects the fact that costs (which amount to 2) accrue only to him, but benefits are limited to 2 and are to be equally shared with the other player who does not cooperate (see the lower-left and upper-right cells). Due to lack of trust, the permanence at the *status quo* is likely: each player predicts that the opponent might prefer the inferior pay-off of defection, so that the joint provision of the public good cannot become the dominant strategy.

In the second version, AG II (see Figure 3b), the situation is more positive. Because of the hypothesis that neither agent can alone produce any of the public good, the balance between benefits (2 to each player) and costs (1 for each player) renders the pay-off related to defection, when the opponent cooperates, no higher than the *status quo* one. However, the incentive to defect due to the fear of being left alone is still there. The problem, again, is the lack of trust. The difficulty to get the assurance that the other will do his part of the productive effort might convince each player to defect in order not to lose the investment and go below the *status quo* pay-off in case the opponent does not accomplish his share of work.

In the third version, AG III (see Figure 3c), the probability of cooperation further augments, because benefits are assumed to materialize only if a minimum amount of the public good is provided, so that the "defection" pay-off (when the other cooperates) goes below the *status quo* one. Both costs and benefits of joint production are equally split, but a minimum level of effort has to be endured by each player in order to gain some benefits. Hence, the pay-offs resulting from the difference between benefits and costs are linked to the necessary condition that both players contribute: total costs for the minimum quantity amount to 6 and are equally divided between the two players, while the benefits for each player amount to 5. Since both players will lose the same amount as in case the joint

effort fails to reach the minimum level and no benefits will be available, there is no stimulus to defect. Therefore, a commitment to joint production by one player is likely endorsed also by the other, and it is rational for each player to cooperate. In fact, to quit the cooperative effort still penalizes the opponent, whose pay-off will be inferior to the *status quo* one, and might then be only attributed to *nastyness*.

It can be said that the less defecting is convenient (provided that the other bears the whole burden of production), the more is likely that players' chosen disposition corresponds to the behaviour of the *reciprocal cooperator*. Since the risk related to the cooperative behaviour diminishes in passing from AG I to AG III, there is more scope for a cooperative agreement to be reached with respect to the PD: in all versions, the gain stemming from the "free riding" behaviour is inferior to that related to cooperation; moreover, in AG II, if the player defects, the difference between benefits and costs accruing to him - in the lower-left and upper-right cells - no longer exceed zero (the pay-offs are equal to the *status quo* ones); eventually, in AG III, this difference becomes negative.

The game is now similar to a Coordination Game: differently from the PD, (C,D) is not dominated by (D,D). Since both players lose with respect to the *status quo* pay-offs when the (C,D) outcome turns out, one of the two outcomes connected to both players choosing the same strategy - obviously the Pareto-optimal corresponding to collective rationality (C,C) - should stand out. The AG III is, in fact, a Coordination Game in which players are in the condition to trust each other, so that an exchange of promises to cooperate is credible and the cooperative effort should materialize.

The strategic interaction between a *straightforward maximizer* and a *reciprocal cooperator* will now be considered. To this extent, the transformation of this game of trust in a Coordination Game with multiple equilibria is needed. In fact, the third version of the Assurance Game is a Coordination Game with a *unique* Pareto-optimal: once the uncertainty over the opponent's disposition had

been solved by applying the "common prior" hypothesis, there would be no point in analysing the moves of these two players since the unique Pareto-optimal would be obviously selected. In the following sections, I will then examine how a bargaining solution to coordination problems with conflict of interest might be obtained.

6. "Asymmetric Division" in Coordination Games with conflict of interest

Let us assume that the "common prior" hypothesis works in solving the uncertainty over the opponent's type, and examine the problem of trust in Coordination Games with multiple equilibria. The objective is to demonstrate that - differently from the *constrained maximizer* of Gauthier's Coordination Game with a *unique* Pareto-optimal - the *reciprocal cooperator* comply with *fair* and *unfair* bargains stemming from Coordination Games with conflict of interest, and rationality does not forbid this behavioural attitude. Coordination Games where players are asked to select one bargaining solution among Pareto-optimals characterised by asymmetric distributions will be analysed.

The second kind of uncertainty - the uncertainty over the other player's expectations and strategy - is likely to be solved if the nature of the Coordination Game conveys the principle of alternation. The Crossroad Game pay-off structure (see Figure 4) shows a situation in which a driver is better off if the other "slows down" (*slow*) while he "maintains speed" (*speed*), but more than one equilibrium is present. If the "asymmetry" embedded in this game is properly understood by players (22) - to alternate in taking the advantage of being the one who maintains speed - a *convention* with a peculiar prominence (23) will probably emerge by repetition.

In the Crossroad Game, however, the *convention* can evolutionarily emerge also because the conflict of interest typical of one-shot anonymous market interactions is absent.

Figure 4

	slow	speed	
slow	0	3	dove
speed	3	-6	hawk

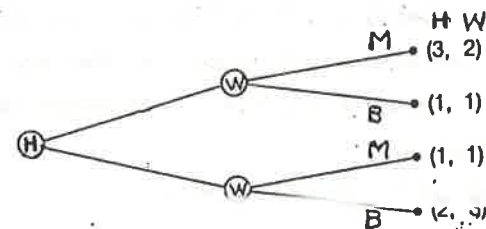
Figure 5

	dove	hawk
dove	1	2
hawk	0	-1

Figure 6a

		H	
		dove	hawk
hawk	W	3	1
dove		1	2

Figure 6b



Coordination equilibrium is stronger than Nash equilibrium, since it refers to an outcome in which each player - had he or the opponent behaved differently - would not have improved his pay-off. Quite the contrary, in one-shot Coordination Games with conflict of interest, although a bargaining solution implies the certainty of mutual advantage - the (C,D) outcome dominates (D,D), so that both players improve with respect to the *status quo* pay-offs - each player would have preferred that his opponent had played in such a way that the bargaining solution most favourable to him would have been selected.

Thus, when the choice is conditional on a conflict of interest in one-shot games similar to the interactions in the anonymous market, the problem to select one among possible equilibria becomes severe. The following two games show that, the sharper is the conflict of interest which is embedded in the coordination nature of the game, the more difficult is for players to exploit the opportunity for mutual but "asymmetric" advantage.

The Battle of the Sexes (see Figure 6) is a coordination game with conflicting preferences. We can anyway think of it as a situation which asks for a bargaining solution (the pay-offs in Figure 6a show that wife and husband will feel discontent if they choose different entertainments, while the outcome *dove-hawk* corresponds to both going to the boxing match and *hawk-dove* to both going to the ballet).

It has been shown above that in the case of possible coordination failure depicted by the third version of the Assurance Game, the opportunity to benefit from equal improvements should render the cooperative effort successful, even if no exchange of promises has taken place. But in the Battle of the Sexes the possible coordination failure is more difficult to avoid. For a Pareto-optimal to be reached, a clear commitment to coordinate is strongly needed (this will be sufficient, because it would not be rational any attempt to foul the wife (husband) and play hawk when they agreed that she (he) plays hawk).

Yet, in the absence of commitment to coordinate, it is not possible to predict which one among three possible solutions - two "pure" strategy Nash equilibria ((3,2) and (2,3), in Figure 6a), and a "mixed-strategy" Nash equilibrium - rationality would indicate. In the two "pure" strategy Nash equilibria, in which one of the two players in turn gets most of the cooperative surplus, there is no reason to conclude that one and not the other is the rational equilibrium that will be selected. As for the mixed strategy equilibrium - for instance, each player behaves as a *hawk* with probability = $2/3$ (each player's expected pay-off will then be equal to $5/3$) - a player cannot hold any belief that would render uniquely rational this equilibrium (24).

The difficulty for players to choose a rational bargaining solution is avoided only in the "extensive form" version of this game (see Figure 6b). Since the second mover is aware of the first mover's prior choice, (B,B) is not a "subgame perfect Nash equilibrium": in fact, once subgame II is reached in the top half of the tree, the threat by the wife (W) to play B (ballet), while the husband (H) is actually going to the boxing match (M), is not credible and is not a best reply. But this is a situation of perfect information (a player moves on the basis of the information about the opponent's behaviour), and thus is of limited applicability to the interactions of the anonymous market, in which by definition there is shortage of information due to the absence of personal relations.

In the Chicken Game (see Figure 5), two important features are present: a) the conflict of interest dominates the coordination nature of the players' interaction; b) a bargaining solution can be traced back just to the "asymmetry" related to the sharpness of the conflict of interest. As for the first aspect, the necessary condition for the cooperative effort to be accomplished is that, in a two-persons game, at least one player performs the productive effort of the public good, and in the *n*-persons Chicken Game, the number of players who pre-commit to defection does not exceed the maximum number of individuals who can free-ride on the cooperation of others without causing the

non-provision of the public good (25). It is the possible refusal by a player (by a group of players) to cooperate in the joint production of a public good - or even the pre-commitment to defect - to oblige the other(s) to produce the whole effort. However, the pay-off structure reveals that the cooperative surplus should be obtained because it is still worthwhile for the "sucked" player to perform the work.

As for the second aspect, from the bargaining solutions to the Chicken Game emerge the counterintuitive result of the great importance of "asymmetry" - already observed with regard to the Crossroad Game - as a vehicle for agreement. The "asymmetric" solutions to the Crossroad Game give the maximum total benefit just because both players gain from complying with a *convention* from which the acceptance of an "asymmetric" distribution of the advantage follows. Similarly, in the Chicken Game, the pay-off structure shows that two aggressive moves (*speed-speed*) will damage both players, while the two asymmetric distribution (following from *slow-speed* and *speed-slow*) are Nash equilibria.

Yet, the above mentioned difference with respect to Coordination Games *without* conflict of interest stands out. In the Crossroad Game, both players gain in one or the other asymmetrical Nash equilibrium vis-a-vis a situation in which they play symmetrically; in the Chicken Game, instead, if both players move asymmetrically, the one who has played *dove* will lose with respect the pay-off that would have accrued to him had both played *dove* (26). Therefore, for the "asymmetry" to perform its function of vehicle for agreement, this player has to be convinced to abide by an unequal division of the cooperative surplus.

A possible answer is that distributive conflicts can be ruled by a *convention* which has to be traced - not to repetition - but to expectations related to the type of each player. If it is common beliefs between players that for some reason a certain type always wins when encounters another given type, the division of the cooperative surplus will be accordingly unequal. In the strategic interaction between the *straightforward maximizer*

and the *reciprocal cooperator*, due to characters - such as the first one to stand firm in market interactions while the second to be disposed to comply even if an *unfair* bargain has been proposed to him - an "asymmetric" bargaining solution will probably follow.

The conclusion that asymmetric solutions can exist in a symmetric game due to this sort of *convention* cannot be accommodated in the *Morals by Agreement's* model. Gauthier argues that *broad compliance* - the disposition of the agent who "compares the benefit she would expect from co-operation on whatever terms are offered with what she would expect from non co-operation, and complies if the former is greater" (27) - contradicts "equal rationality": "if some persons are more than narrowly compliant, then others would find it advantageous, and so rational, to be less compliant" (28). But "equal rationality" is not a prerogative only of a uniquely rational solution. The "asymmetric" division of the cooperative surplus between the *straightforward maximizer* and the *reciprocal cooperator* derives from the rational expectation by both players that this is the way in which the bargaining has to be struck.

Therefore, it cannot be assumed that *broad compliance* contradicts rationality: a *reciprocal cooperator* might find himself in the position to accept to be exploited by a *straightforward maximizer*. As bargaining solutions to the Chicken Game show, given the circumstance that (C,D) dominates (D,D), an individual fares better by accepting to coordinate on a Nash equilibrium even though in the other Nash equilibrium the same total gain would have been distributed to his advantage instead of to the other's advantage. The less benefitting player would have gained more - at the expense of the other - if the "cooperative" Nash equilibrium corresponding to equal division of the surplus had been chosen; but it is convenient to abide by the "asymmetric" coordination although he is the one who loses because *dove-dove* cannot be obtained. Differently from Gauthier's CMs, who solely propose (and enter in) *fair* bargains, RCs might rationally agree to make asymmetric concessions (with respect to the "ideal claim"

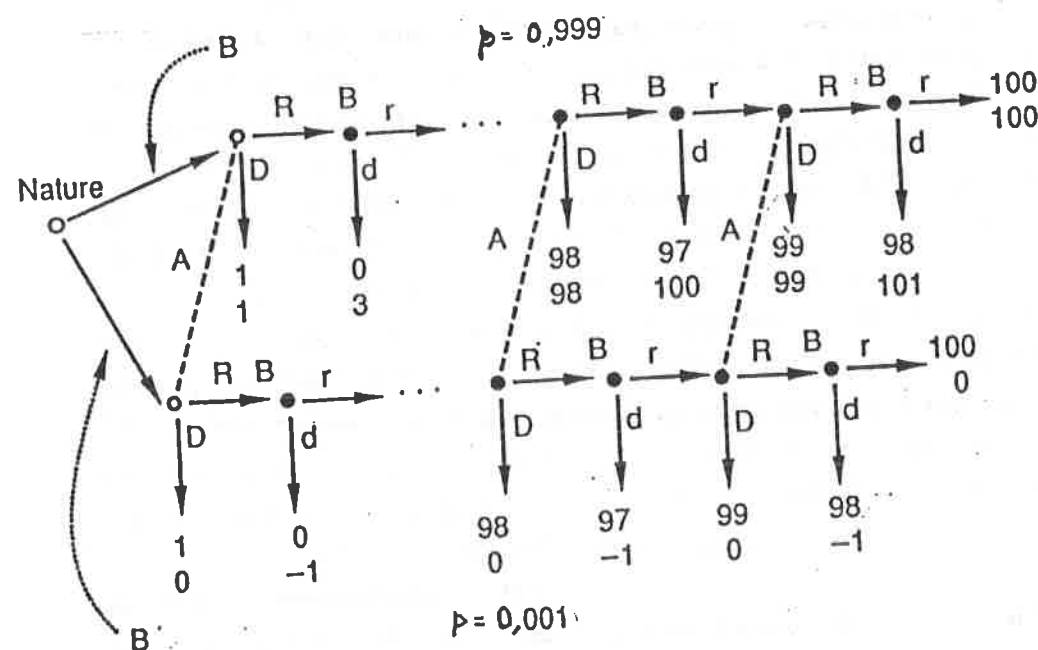
to get the whole cooperative surplus) from which unequal gains ensue. Therefore, it can be perfectly rational to be "broad compliant" and enter in *unfair* bargains. The bargaining solution can then be rational and *unfair*.

If this - or some other sort of - *convention* does not work, however, a bargaining solution might not be reached. The importance of "bargaining failures" due to an unsolvable conflict of interest is greatly overlooked, even when the pervasiveness of market failures is recognized. Contrary to the traditional interpretation of the Coase Theorem (29), due to strategic interaction the "visible hand" of bargaining might fail in the attempt to supplement the "invisible hand" of the market.

In the Coase Theorem, the market failure to be eliminated - with the consequent move from a Pareto sub-optimal equilibrium to a Pareto-optimal - consist in the efficient exchange of externality rights. If it is assumed that transaction costs are absent, pollution is prohibited except by holders of resealable pollution coupons issued by the government, the externality might consist in the positive divergence between the social cost (benefit) of a polluter acquiring a coupon (of a pollutee retaining a coupon) and his private cost (and his private benefits). The rationale is that a competitive market for coupons is unlikely to function in an efficient way: since there is excess demand by pollutees (excess supply of coupons by the polluters), the divergence is doomed to persist (30).

The standard interpretation of the Coase Theorem in terms of the absence of transaction costs maintains that there should be no obstacles to a bargaining agreement leading to the efficient equilibrium position. This interpretation cannot be shared, since it is based on the flawed assumption that - due to the formation of perfect competition prices in the negotiations over the coupons - the cooperative surplus stemming from internalization will surely be obtained. Just as in the bargaining approach to market, in this interpretation questions related to strategic interaction have been overlooked.

Figure 7



The argument that - whatever is the initial property rights allocation - an efficient outcome will certainly emerge is then unsound: the problem remains that in most bargaining situations alternative asymmetric solutions are feasible, so that negotiations might be stuck at the disagreement point. Therefore, for the equilibrium on the Pareto frontier to be reached, the distributive problem - how to split gains from cooperation - has previously to be solved. In addition, the notion of efficiency becomes conditional on which specific division has been negotiated. Bargaining power might determine a cooperative outcome, but which efficient equilibrium point on the Pareto frontier will be obtained depends on which is the asymmetric division of the cooperative surplus will be imposed by a player backed by bargaining power.

7. Incomplete information and strategic interaction

As it has already been observed, if uncertainty due to incomplete information persists, strategic interaction might influence the bargaining solution because the type of the other player is unknown. This is the hypothesis on which the "extended" version of the Centipede Game (31) has been built (see Figure 7). It is a game in extensive form particularly suited to accommodate the behavioural dispositions discussed above: in fact, that - in this game in which it is the Nature to choose the "type" - the decision can be thought as concerning whether player B is a *straightforward maximizer* (with probability = 0,999) or a *reciprocal cooperator* (with probability = 0,001). Hence, player A - whom I will assume to be a *reciprocal cooperator* - is uncertain about the behaviour of his opponent and this is a matter of common beliefs.

The interesting game is obviously the one in the upper part of the picture. By recourse to "backward induction", the solution of this game is found, according to which player A, the first mover, has to play D in the first node. It can be assumed, however,

that A "mistakenly" plays C (32). The situation drastically changes, since player B is drawn in the same condition of uncertainty over the opponent's "type" (33). In this case, cooperation will certainly emerge: given the pay-off structure, B always prefers to play r, while A - by moving forward - gets *ex post* the information that B is cooperating.

It can be proved that the maximizing behaviour can no longer be considered "common knowledge" in the following moves of the game, except by arguing that A is "irrational" (34). In fact, if B may rationally play r and gain from the augmentation of the "surplus" to be divided, it is just because - by not defecting - A has induced B to consider that he is not a straightforward maximizer. This game thus depicts a situation of intense interdependence between the strategic behaviour of the players. Since B is an hidden SM and A is RC (although B does not know it), B will try to influence the strategy of player A by exploiting the advantage of uncertainty over his type. Since common knowledge of maximizing behaviour no longer holds, by moving forward B will succeed in building up a "reputation" as a cooperator while allowing the pay-off bunch to accumulate; for the same reason, A will keep cooperating as well. At the last but one node, however, B reveals his true disposition, by choosing "defection" in order to get the most favourable distribution.

8. Some conclusive remarks

It is more and more recognized that whether an coordination institution works properly or not, and the way in which the distributive issue is solved are central questions on which the evaluation of the efficiency of resource allocation depends (35). In this paper the focus was on bargaining solutions. To what extent the distributive conflict embedded in most coordination problems can be solved, and how it impinges on the determination of the equilibrium position on the Pareto frontier, has been examined. Some tentative remarks are the following.

The disposition to cooperate is not a guarantee that a *fair* bargain will be completed. Rationality is compatible with the disposition to comply also with *unfair* bargains. Due to strategic interaction, the bargaining solution will probably not mimic the competitive market outcome. In the presence of incomplete information, cooperation might result from a player's strategic behaviour consisting in the attempt to influence the opponent's strategy and eventually take most of the gain.

When bargaining is needed to secure the Pareto-optimal, due to market failure, the competitive market notion of efficiency is put in doubt. In Coordination Games with conflict of interest, an "asymmetric" bargaining solution should obtain when a convention related to the players' type exist. Therefore, in most bargaining solutions, distributive justice - understood as the productivity principle of distribution - does not apply. In addition, because of the unequal division of the cooperative surplus, which efficient equilibrium will turn out depends on the specific distributive result. Thus, the separability between efficiency and distribution, asserted by the two Theorems of Welfare Economics, breaks down.

- (1) See Sugden (1992), p.192
- (2) See Schelling (1960), p.160
- (3) See Gauthier (1986)
- (4) Ibidem, Ch.VII
- (5) "Let us say that a *straightforward* maximizer is a person who seeks to maximize his utility given the strategies of those with whom he interacts. A *constrained* maximizer, on the other hand, is a person who seeks in some situations to maximize her utility, given not the strategies but the utilities of those with whom she interacts". (See Gauthier (1986), p.167).
- (6) Each person must suppose that every rational person is willing to make a concession as large as the "minimum maximum concession" and to accept a concession at least as large. The "minimax relative concession" is the ratio between the concession relative to the ideal claim (u^*) which both players are willing to make and the complete concession (the maintenance of the status quo pay-off: u^*). The MRC results from the following equation: $(u^* - u) / (u^* - u^*)$, where u represents the agreement pay-off (See Gauthier (1986), pp.133-7).
- (7) For a more extensive account, see Aumann (1987)
- (8) It has been observed that players with the same information necessarily entertain the same probabilities and the bargaining solution might not be obtained (See Sugden (1991), p.768).
- (9) See Gauthier (1986), p.174
- (10) A CM cooperates with an individual whom he takes to be a CM in turn and defects from a supposed or actual SM. The assumption is that persons are "translucent", in the sense that their disposition to cooperate or not cannot be ascertained for sure. Gauthier calls p the probability with which two CMs mutually recognize each other, while q stands for the probability that CMs are recognized by SMs but do not recognize them (See Gauthier (1986), pp.174-82).
- (11) Gauthier determines the ratio between p and q in order to calculate the "critical" value that - for every given proportion of CMs in the population - is required for it to be rational to dispose oneself to "constrained maximization" (See Gauthier (1986), p.178).
- (12) "We may therefore employ the device of parametric choice among dispositions to choose to show that in strategic contests, the disposition to make straightforwardly maximizing choices is the disposition to make utility-maximizing (See Gauthier (1986), uncontroversially utility-maximizing (See Gauthier (1986), p.183). "We have defended the rationality of constrained maximization as a disposition to choose by showing that it would be rationally chosen. Now this argument is not circular; constrained maximization is a disposition for strategic choice that would be parametrically chosen" (Ibidem, p.183).
- (13) See Gauthier (1985), pp.31-8
- (14) See Kalai-Smorodinsky (1975)
- (15) See Sugden (1990), p.774

- (16) See Gauthier (1986), pp.143-4
- (17) Ibidem, p.178
- (18) Ibidem, p.105
- (19) See Axelrod (1984)
- (20) See Sen (1987), pp.85-6
- (21) This definition has been proposed by Danielson (1991), p.299
- (22) See Sugden (1992), pp.181-3. See also Lewis (1969)
- (23) See Schelling (1960), pp.54-8
- (24) See Sugden (1990), p.776
- (25) See Taylor-Ward (1982), p.357 and Taylor (1987), pp.40-9
- (26) See Sugden (1992), p.185
- (27) See Gauthier (1986), pp.225-6
- (28) Ibidem, pp.226-7. The judgement of "irrational" behaviour is maintained as follows: "Broad compliance is not a rational disposition for utility-maximizers. Not only does a broad compliant person invite others to take advantage of her in setting terms of co-operation, but if some persons are broadly compliant, then others, interacting with them, will find it advantageous not to be broadly, or even so much as narrowly, compliant" (Ibidem, p.226)
- (29) See Coase (1960)
- (30) See Cooter (1982), pp.14-24
- (31) The "Centipede Game" is a complete information game. In Figure 3, in which the incomplete information version put forward by Rosenthal (1980) is sketched, the original game is represented by the upper part of the picture. It can be solved by applying the "backward induction" method. At the last node, it is apparent that B chooses d ; at the last but one node, A certainly prefers D ; at the previous node, B has to choose d ; and so on. Hence, we can predict that A will start the game by playing D .
- (32) This game has a unique "credible" Nash equilibrium, in which for the first 160-odd moves, A plays R and B - whatever is the behaviour that Nature has chosen - replies r (More details can be found in Kreps (1990a), pp.537-43 and in Kreps (1990b), pp.79-82).
- (33) In a truncated version of this game, (all but the last three nodes are deleted), Binmore has proposed an explanation of the move "forward" by player A according to which subjective probabilities are assigned by this player to the event that player B is defective or not (See Binmore (1987), pp.199-200).
- (34) Reny (1992), pp.110-11.
- (35) "With a change in the rule or institution, however, the pattern of outcomes reached through within-rule trades or exchanges would be expected to be different from that attained under the rules that existed prior to the change. This suggests only that any allocation of resources that is to be classified as 'efficient' depends necessarily on the institutional structure within which resource utilization-allocation decision are made. This implication creates no difficulty for the subjectivist-contractarian who does not acknowledge the uniqueness of the resource allocation that is properly classified to be efficient" (See Buchanan (1986), p.96).

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