A. Arrighetti and G. Seravalli

INSTITUTIONS
AND CO-ORDINATION COSTS

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ABSTRACT

Economic literature sees the existence of institutions as being justified by market failure. This paper attempts to develop a different hypothesis by linking institutions to the solution of co-ordination dilemmas. According to this line of thought, institutional action is not circumscribed to the supplying of 'regulative resources' able to lower uncertainty and limiting the risks of free riding. It includes rather the provision of a vast set of public goods characterised by high complementarity and marked constraints on the continuity of supply. In the production of such goods, the presence of multiplicity of equilibria and high costs of information born by individual agents in formulating a cooperative agreement often makes a decentralised decision-making process impracticable. On the other hand, as we try to show, a central authority (an institutional subject), assuming long term obligations and lowering co-ordination costs, can mitigate collective action problems in a wide range of circumstances.

INTRODUCTION

It is traditionally thought that non-rivalry in consumption and non-excludability influence the quantity and quality of supply of public goods. In the case of pure public goods these characteristics do not allow to correctly appraise individual preferences. And they make it impossible to define the prices and earnings on investment in supply. Thus, the failure of collective action in the production of public goods is associated with the realization that each rational agent, able to dispose of goods independently of his individual contribution, will inevitably tend to minimize his own investment (Olson 1965).

Moreover, the higher the number of agents, the lower the incentive to collective action. As the number of agents increases, the consequences of defection are, on the one hand, less measurable and on the other hand, have a less significant effect on the level of individual utility. As Hume (1888) noted:

" Two neighbours may agree to drain a meadow, which they possess in common; because `tis easy for them to know each others mind; and each must perceive, that the immediate consequence of his failing in his part, is, the abandoning the whole project. But `tis very difficult, and indeed impossible, that a thousand persons shou'd agree in any such action; it being difficult for them to concert so complicated a design, and still more difficult for them to execute it; while each seeks a pretext to free himself of the trouble and expence, and wou'd lay the whole burden on others" (p. 538)

It follows that only the coercive or disciplinary action of an autonomous body (the state), able to sanction defections, will reestablish incentives to cooperation and allow the realization of public goods. In this scheme, the configuration of public goods, the technology used to carry it through and the expected benefits are *known* conditions: individuals *must* know, at least approximately, the content and the result of collective action, otherwise an estimate of the benefits and the costs of their participation in the production of the good itself cannot be evaluated (Taylor 1987).

Such a premise is highly unrealistic. Although learning by experience makes it possible to evaluate the result of collective action in the provision of goods similar to those realized in the past, this is not be feasible in the case of innovative goods. Given that a large number of collective projects which are realized in the present have for various reasons (different technology, different availability of resources, changes in individual preferences/tastes etc) only partial analogies with those realized in the past, the assumption that the content and result of collective action is known cannot be considered generally correct.

The need to take this circumstance into account significantly modifies our approach to the problem of the production of public goods. If we

assume that the economic and technological content of the good to be made is not known to the agents, a new obstacle to common action emerges: before starting the collective production of a good, agents must decide *which* good must be made. The obstacle for the realization of a common good is not represented solely by uncertainty about the distribution of net benefits generated by the availability of the good itself. There are also the information and decisional costs that individual agents will have to sustain to identify which good must be produced.

A simple consideration of the nature of incentives for collective action is sufficient to understand the implications of this perspective of analysis. Collective action has its origin in the strategic complementarity which exists between the individuals who take part (*'individual agents are more productive the higher the production level of other agents*' (Cooper and Johri, 1996)). The existence of complementarity, on the one hand, determines incentive to collective action and justifies the greater efficiency of the choice of cooperative rather than individual action, on the other, it is the source of a multiplicity of equilibria. In fact, as we will see, the greater the size of the group of participants, the greater the value of its contribution and the more alternative technologies available, the wider the range of possible solutions.

The goods to be made become known only after the agents have organized the alternatives and have managed to identify the optimum solution (of the many possible ones). The equilibrium selected will determine the ammount of the individual investment (or its cost); the size of the group of participants and the technology. Only then will possible sanctions for non-observance of the agreement be decided and the production process start.

Even before control of the risks of *free riding*, collective production of a good appears to be conditioned by the costs of the search for the most efficient solution and the alignment of individual agents' plans to a single general plan (costs of co-ordination). The identification of the optimum solution from a multiplicity of efficient equilibria can be extremely laborious with the result, suggested by Hume *("it being difficult for them to concert so complicated a design ")*, that the very realization of the good is put at risk.

In logical time (and often in historical time) the failure of collective action depends firstly on co-ordination failure and secondly on conflicts about benefit redistribution. The problem of co-ordination comes before the control of opportunism and the seriousness of the first appears to be independent of the entity of the second. In fact, if we had significant co-ordination costs and absence of opportunism, the level of the former would nevertheless remain high and the likelihood of non-production would also be significant.

The hypothesis developed in this study is that co-ordination costs will significantly condition the result of cooperative decisions and influence

the configuration of the decision-making and regulatory processes arranged by economic agents to avoid the failure of collective action.

As a last point, following Hardin (1982), we focus attention on the problems of joint production of goods - rather than 'public' consumption problems- since it is in this dimension that there are the greatest risks of a failure of collective action[1].

This paper is organized as follows: Section 2 develops the problem of co-ordination and shows how the solution lies inevitably in the context of imperfect information. Agents can overcome these information gaps and make their courses of action converge, sustaining synchronization and optimum equilibrium selection costs. Section 3 shows how the sum of synchronization and selection costs influence the solution of the co-ordination problem and the form (decentralized and centralized) of the decision-making process. The features of centralized decision-making (institutional authority and private governments) are studied in Section 4. In Section 5 there is an attempt to generalize our proposal with a discussion of its implications.

2. *PROBLEMS OF CO-ORDINATION IN THE PRODUCTION OF GOODS*

The problem of co-ordination concerns the ability of agents to identify a *unique* equilibrium which makes mutual alignment of plans possible over time. If this objective can be reached through decentralized decisions resorting to price mechanism, the cost of the alignment of individual plans is low, even when the production and exchange activities to synchronize lie in the future. The co-ordination problem becomes particularly costly, however, when with the presence of increasing returns (and the aforementioned complementarities), there is no unique optimum equilibrium. In these circumstances a situation of *co-ordination failure[2]* is likely to result unable to harmonize their individual decisions, economic agents cannot put into practice the measures which would lead to a significant improvement in welfare[3]

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[1] Hardin (1982) emphasises that "Samuelson provides an account of public goods that is concerned entirely with *consumption*. However, the issue of whether groups succeed or fail in providing themselves with some collective good is instead concerned with *provision*. Their goods need to be collettive only in the sense that they are collectively provided."(p.19)(original italics).

[2] Co-ordination failures are a central issue of New Keynesian Economics. For a summary of the main aspects involved, in particular the subject of externality and strategic complementarity, see Leijonhufvud (1968), Cooper (1987), Cooper and John (1988), Colander (1992), Boitani, Delli Gatti and Mezzomo (1992), Van Ees and Garretsen (1992).

[3] This problem arises regardless of opportunism. The reason why agents are unable to co-ordinate their individual decisions is not seen here as connected to the fear of losses which could be inflicted by the others' opportunistic

More analytically, the co-ordination problem may be sub-divided into two dimensions: one dimension concerns agents' contractual or conventional constraints on making discordant decisions; the second dimension concerns the procedure to identify a unique equilibrium solution.

As we will see, specific information costs are connected to each stage in the decision-making process. These vary according to the numerical size and the characteristics of the group of individuals which are involved in the optimum equilibrium decision.

An example using a simple co-ordination game may clarify the above statements (see Fig. 1). Let us assume that agents operate in a context of perfect information concerning reciprocal behavior and resources endowments and that they need not sustain either costs for the co-ordination or for the regulation of collective action. A_1 and A_2 are two subjects which take decisions individually about alternative good production. The agents can decide to collectively produce good Y (P,P); to buy it simultaneously on the market (M,M) or to produce it individually while the other buys it on the market and vice-versa (P,M and M,P).

The game highlights the existence of the complementarity connected with decision co-ordination. The convergence of agents towards simultaneous decisions (P,P or M,M) determines a payoff which is superior to the production/purchase of the same good in the discordant solution[4]. Using standard co-ordination game form, an identical payoff is attributed to concordant decisions with the result that, not being an unique equilibrium, the choice remains indefinite.

Figure 1 - Co-ordination game (1)

$$A_2$$

		P	M
	P	3_1-3_2	2_1-2_2
A_1			
	M	2_1-2_2	3_1-3_2

behaviour. It is simply interpreted as *ignorance* of real opportunity for success and aversion to risk-taking

[4] We can imagine the existence of superadditivity in the joint production function in the solution P,P and a market price reduction in case of collective purchase (M,M).

The indefiniteness of the solution constitutes a limit on common action, but not the only one: the higher the effect of complementarity the more the benefits relative to collective action and the greater the incentive to extend the game to a greater number of players, to study alternative technologies and to consider different investment levels.

In fact we can see that given N agents and a function of individual utility $U(e_i, e_k, \Gamma)$, where e_i is the decisional variable (action) of the i-th agent, e_k is the decisional variable of the other agents($k{\neq}i$) and Γ = exogenous parameter, if (see Bulow, Geanakoplos and Kemplerer 1985; Artus 1993):

1. positive externalities exist between agents: $\dfrac{\partial U}{\partial e_k}\rangle 0$;

2. the relation between the agents is characterized by strategic complementarity (an increase in the value of the action of the other agents except the i-th agent determines an increase in marginal value of action of the latter): $\dfrac{\partial^2 U}{\partial e_i, \partial e_k}\rangle 0$;

3. The i-th agent reaction function is growing in e^* (which indicates decision of the k-th agent in equilibrium*): $e_i=e_i(e^*,\Gamma); \partial e_i/\partial e^*>0$

a multiplicity of equilibria will be generated both in relation to the production technologies and to the variation of the number of agents involved.

Although the simplicity of game 1 makes the assumption of perfect information realistic, its extension to *n* players, to different technologies and to different investment levels makes the game structurally uncertain. The consequences will be that:

i. while the *payoffs* from individual action remain known, those from collective action are uncertain even if, in consideration of increasing returns, they may presumably be estimated higher than the former;

ii. the agents are able to recognize cooperation *payoffs* and to initiate common action only after having agreed (and having sustained relative costs) to select the equilibrium and to harmonize individual behaviors;

iii. the costs of synchronization of courses of action and selection of the equilibrium affect the value of co-ordination *payoffs* and thus significantly condition the adoption (or the abandonment) of collective action solutions.

Given the importance of selection and synchronization costs, the factors which determine their level are examined in more detail in the next sections.

2.1 SYNCHRONIZATION COSTS

The synchronization of individual courses of action is subject to constraints (costs) which vary according to the nature of the good to be provided and to the agents' characteristics. Independently of the equilibrium chosen and the selection mechanism adopted (see below), the synchronization of decisions is conditioned not only by the existence of information barriers (e.g. distortion; ambiguity, distance between agents), but also by asymmetries or unrelatedness in the technologies employed. Technical differences in the contribution and non-simultaneousness of decisions, stemming from the division of labour or from role specialization, may make the adoption of cooperative decisions significantly expensive.

These difficulties are amplified with an increase in group size (from 2 to *n* players). Further, if the game is not repeated in the future and the group is made up of anomic agents, as Hardin (1982) points out, learning through experience and conventions are unsuited tools to cutting (or at least limiting) the costs of formalizing a convergent and simultaneous decision. Consequently, with the exception of groups with high 'overlapping'(Hardin 1982) and when the same good is provided in the same fashion continuously over time[5], agents must invest increasing resources, according to the size of the group and the consequent dissimilarity of the actors, to perfect an integration and information agreement of their own plan of action. With the result that, even at this early stage, incentive for collective action, seen as the difference between co-ordination and non-co-ordination payoffs, may be significantly reduced.

2.2 SELECTION COSTS

The identification of optimum equilibrium is conditioned firstly by the *acquisition and transfer of relevant information among players*. Each individual agent must provide the others with any information which could affect the result of the co-ordination solution[6]. Individual plans may be elaborated only when agents have reached perfect information regarding all others contribution to the realization of final output, the

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[5] That is, in case where co-ordination can be achieved resorting to conventions. Lewis (1969)emphasises that co-ordination can be carried out through direct common knowledge of how it was carried out in a single case in the past which was exactly the same as the current co-ordination problem. We reach co-ordination through direct common knowledge of regularity which governed co-ordination of a group of past cases which have important analogy one to the other and with our current co-ordination problem

[6] See Arrow ((1974) for information costs in decentralised contexts

characteristics of the technology utilized and the resources required by the project. The more the agents have in common as regards knowledge, resources and technology, the lower the costs for the transfer of information. The more dissimilar they are, the higher the costs. In this sense Becker and Murphy (1992) argued that co-ordination costs increase with the growth in the division of labour and of the specialization of economic agents. Specialization increases productivity but it reduces the general knowledge of each individual, thus increasing the difficulty in interaction and communication between the holders of different areas of knowledge. Secondly identification of the optimum equilibrium is also conditioned *by the necessity of matching specific knowledge possessed by agents to the abilities necessary for the setting up/evaluation of different plans.* The greater the gap between known areas of knowledge and those required for the evaluation of the projects, the more laborious the evaluation and organisation of the plan. Thirdly, *agents are required to rank practicable alternatives (equilibria).* Subjects must invest resources in the research and analysis of different technologies for the realization of the project. Only a complete picture of the possible alternatives will allow a subsequent reorganization of the plans[7].

Selection costs are not generally limited to the setting up of projects, but they extend to the operational phase and to the renewal of their efficient provision. Finally, the step from two to *n* players[8] will determine an increase in average benefits and will reduce the realization costs of the initiative, but will intensify the co-ordination problem. Each increase in the number of participants requires an additional collection of information, a transfer of relevant data to each agent and a reorganization of practical alternatives. The increase in the number of participants tends to increase their dissimilarity in terms of information and skill in the evaluation of projects. Therefore the risk that the benefits of collective production of goods will be eroded by the rise of selection costs increases according to the number of agents involved.

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[7] Difficulties in communication and information in co-ordination games were noted by Schelling (1980): "whenever the communication structure does not permit players to divide the task ahead of time according to an explicit plan, it may not be easy to co-ordinate behavior in the course of the game. Players have to understand each other, to discover patterns of individual behavior that make each player's actions predictable to the other; they have to test each other for a shared sense of pattern or regularity and to exploit clichés, conventions, impromptu codes for signalling their intentions and responding to each other's signals (p.84).

[8] There is still absence of opportunism.

3. SOLUTIONS OF THE CO-ORDINATION GAME

The solution of the game requires that, after having Pareto-ranked the various equilibria-projects *(Y,Z, ...,N),* the agents manage to identify the optimum equilibrium solution and to define mutual guarantees of the effective accomplishment of the agreed investment decisions. In other words it is hypothesized that agents agree beforehand to individually sustain the information costs necessary to identify a mutually satisfying equilibrium, to align their own plan of action to those of the others, and to define contractual safeguards which bind the parties to effectively carry out decisions.

The solution to the co-ordination problem through a decentralized decision-making process will depend on two factors: a) the likelihood that the agreement, once reached, can be finally enforceable and b) the chance that level of information, knowledge and contractual costs, necessary to define the agreement, are not so high as to nullify the cooperation payoff. The latter condition is of fundamental importance in the analysis presented here. It suggests possible co-ordination failure, not only because of the existence of the uncertainty surrounding the cooperative attitude of the players, but also because of objective difficulties or the existence of high information costs in the formulation of co-ordination projects. The more information is already known , the lower the co-ordination costs. The more dissimilar or incomplete the information, the higher the costs of making uniform common knowledge.

The absence of opportunism does not eliminate the co-ordination problem. If we assume that agents involved in the co-ordination game are fair, the agreement does not require enforcement. And although it is true that contractual costs would be cut, information costs would remain unchanged. So the decentralized solution to the co-ordination problem is not to be found in the simple neutralization of the effects of a non-accomplishment of signed obligations, nor in more general terms, in the risk of free riding[9]. Considering the characteristics of the game, non-opportunistic agents might encounter, nevertheless, numerous obstacles in the identification of cooperation equilibrium.

On the basis of the previous considerations there are three possible solutions according to the variation in co-ordination costs:

Solution 1

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[9] Rizzo and Sindelar (1996) reach similar conclusions, showing that perfectly rational agents and contracts able to eliminate moral hazard do not exclude the possibility of co-ordination failure.

The comparison between the different alternatives and the definition of an agreement on individual action harmonization is made with limited co-ordination costs, and an optimum technology project corresponding to a quantified domain of users is identified. The choice of efficient equilibrium requires the direct participation of individual agents and a decentralized decision-making process. The differentiated nature of co-ordination costs in relation to the characteristics of the production of individual goods (cfr. par. 2) make a perfect coincidence between cooperation payoffs unlikely. Therefore, the game takes the form of the cooperative Prisoner's Dilemma with a unique equilibrium in favour of the collective realization of the good (P,P) - or joint purchase (M,M) - as the net difference between increases in the payoff from the effect of complementarity and co-ordination costs (see Fig.2).

This solution tends to be associated with small communities. Societies of limited size, very homogenous as far as basic knowledge and criteria of decisional organization is concerned, having only low co-ordination costs to sustain, may be encouraged to collectively realize goods with limited alternative technologies.

Figure 2 - Co-ordination game (2)

$$A_2$$

		P	M
	P	$3,5_1$-$3,5_2$	2_1-2_2
A_1			
	M	2_1-2_2	$3,2_1$-$3,2_2$

Solution 2

A greater variety of alternative techniques, but especially, a greater differentiation of knowledge and information among agents can make decentralized planning and a common provision of goods unpracticable. Whenever co-ordination costs eliminate the expected advantages in collective production of goods, there are two alternative solutions: either individual production or centralization of the decision process. Centralization involves allowing the definition of incentives to synchronization of courses of action and the selection of equilibrium to a limited and specialized sub-set of agents. The centralization of the decision-making process, determining a significant containment of co-ordination costs, allows the realization of initiatives/projects which would not otherwise be possible. The reduction in co-ordination costs originates in the exploitation of economies of scale in the collection of

relevant information (co-ordination costs become semi-fixed in so far as they are not bound by the number of beneficiaries). Secondly, the smaller number and greater similarity of contributing subjects reduce information transfer costs and narrow individual information gaps. In addition, the components of the decision-making authorities who can be selected on the basis of their skills, can operate without having to make significant supplementary investments in knowledge to evaluate projects. Therefore, all synchronization costs being equal, the containment of project selection costs through the adoption of a centralized decision-making plan may allow positive net benefits from collective action even when a decentralized process would determine a less favorable outcome[10] (example Fig. 3) .

Figure 3 -Co-ordination game (3)

A_2

		P	M
	P	$3,2_1$-$3,2_2$	$2_1,2_2$
A_1			
	M	2_1-2_2	3_1-3_2

Solution 3
However, resorting to a central authority is not always efficient. Selection of components, identification of decision-making criteria and formulation of information collection procedures give rise to sunk starting up costs which make this solution practicable only for relatively large-scale projects. Therefore, in theory there are particular categories of goods aimed at very small groups for whom high co-ordination costs and the impossibility of resorting to a centralized decision-making process make collective action unfeasible (see Fig.4)

4. INSTITUTIONAL AUTHORITY AND PRIVATE GOVERNMENTS

In the previous pages we have tried to show that if the good to be realized is not commonly known complementarity, on one hand, determines incentives for collective action, and, on the other, it generates costs for research into efficient solutions and for aligning the behaviors

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[10] Even if in a different analytical context, Schelling (1980) make an interesting point here: "The co-ordination game lies behind the stability of institutions and traditions and *perhaps the phenomenon of leadership itself*"(p.91) (Our italics).

of agents. These costs may be so high that they actually eliminate the benefits which derive from the complementarity itself. This conclusion was reached without taking into consideration opportunism and the

Figure 4 - Co-ordination game (4)

$$A_2$$

		P	M
		P	$1,5_1 - 1,5_2$	$2_1 - 2_2$
A_1			
		M	$2_1 - 2_2$	$1,8_1 - 1,8_2$

possible conflicts involved in the re-distribution of the benefits of collective action. In fact, co-ordination costs are not eliminated if it is assumed that agents adopt behaviors inspired by principles of fairness or even of altruism.

Two procedures for the solution to the co-ordination problem have been identified: the first procedure is practicable with limited co-ordination costs and is based on direct participation in the decisions of subjects involved in collective action (decentralized decision-making). Resorting to the second procedure is efficient if co-ordination costs are particularly high and based on the concentration of the decision-making process in a single decision-making authority (centralized decision-making).

Although it aims to reduce co-ordination costs, central authority decision-making can be significantly differentiated. In defining the operative plan, the central authority may be conditioned by certain characteristics of goods and by obstacles put forward by agents who take part in collective action. The next analytical stage is the qualification of central authority activity and the refinement of the characteristics which distinguish different models of central decision-making.

Among the various forms of centralized decision-making, there are two basic categories based on the existence or otherwise of the criteria of *non-excludability* and *continuity* in the definition of the co-ordination plan.

The criteria of non-excludability restrains any modification of the size of the collective action group by the central authority, whereas the criteria of continuity prevents any interruption in the supply of collectively provided goods by the decision-maker at his own discretion.

If collective production of goods develops in a finite time period or if the benefits expected by the producers/consumers deriving from the availability of goods vary in time because , for example, the introduction of new products, the central authority will have to adopt decisional criteria which cannot be conditioned by the constraints of non excludability and continuity. Acceptance of the criteria of continuity even in these cases would imply the carrying on of the collective production

of goods even in the presence of negative complementarity, while the adoption of non excludability would require that the size of the group of agents remains unchanged even when its reduction to safeguard the benefits of the majority of the participants in collective action is necessary. The minimizing of co-ordination costs and the maximizing of collective action benefits in this case, imply that the central decision-maker disposes of the rights of exclusion and of the possibility of modifying and even stopping the collective production process of goods. This behaviour is symmetrical to that of agents who are required to conform to the plan formulated by the central authority. If the individual benefits of complimentarity are objectively (or are subjectively considered to be) unstable or temporary, the obligation to participate in collective action will not be so binding as to debar their leaving (abandonment of collective action). On the other hand, the advantages of a guarantee of the availability of goods will tend to be offset by the costs of behavioural restrictions.

Briefly, then, the absence of obstacles to participation in a plan different to the initial one corresponds to the absence of obligations of the central authority for continuity of the productive process and for confirmation of group size. In this context the authority is able to reduce co-ordination costs both because it centralizes the decisional process and because it has access to all the individual incentives to choose efficiently (Grossman and Hart 1986). The right of exclusion (or leaving) and of interruption (or abandonment) of collective action constitute the main conditions for the formulation of (or the agreement to) the general plan. Thus, the co-ordination plan becomes a private good in the same way as output of the process of collective production is private (excludable and not continuous). The decisional model described corresponds to the hierarchical organization of the *firm*.

The modalities of defining the co-ordination plan seem to vary significantly when the central authority must observe the constraints of non excludability and continuity. If the goods to be produced are not replaceable and the benefits of complementarity are not only considered stable over time but could be cancelled out or significantly reduced even by a temporary interruption of supply, the constraint of continuity of collective action becomes particularly strong. In other words, the individual and collective utility of some goods, comes not only from their present availability but also from the guarantee of future availability. Production of these goods, therefore, requires a co-ordination plan with an infinite time horizon and commitment to the stability obligation of supply. Numerous physical and immaterial goods commonly known as public goods come into this category: in many social environments rules and regulations, norms, large-scale physical infrastructures, collective services present the above characteristics and are supplied in following the criterium of continuity.

Moreover, there is another reason for observing these constraints. If the central authority does not commit itself to reconfirming its action over time, the equilibrium solution would only be temporary and the centralization of decisions would determine only a partial reduction in co-ordination costs. In fact co-ordination costs, which are already high for such goods at the planning stage, increase further in the operational stage whether synchronization procedures need to be frequently carried out. Finally the stability of complementarity over time and the non-substituibility of goods indicate that collective action is undertaken by agents who forecast continuously positive individual benefits. Consequently, the preliminary condition which makes it possible to centralize decisions is observance of the constrain of non-excludibility: no rational agent would transfer power of decision to another if there was the risk of his exclusion from the benefits of action, where these are considered certain and high.

The simultaneous inclusion of ties of continuity and non-excludability, makes public both the co-ordination plan and the result of central authority action (unlike private governments). When it proves efficient for decision-makers to formulate their own choices on the basis of universalistic principles ('for all') and with a infinite time horizon ('for ever'), the central authority assumes the characteristics of an *institution*.

5.GENERALISATION AND IMPLICATIONS

Figure 5 helps us to summarise the analysis carried out above and generalise the initial hypothesis.
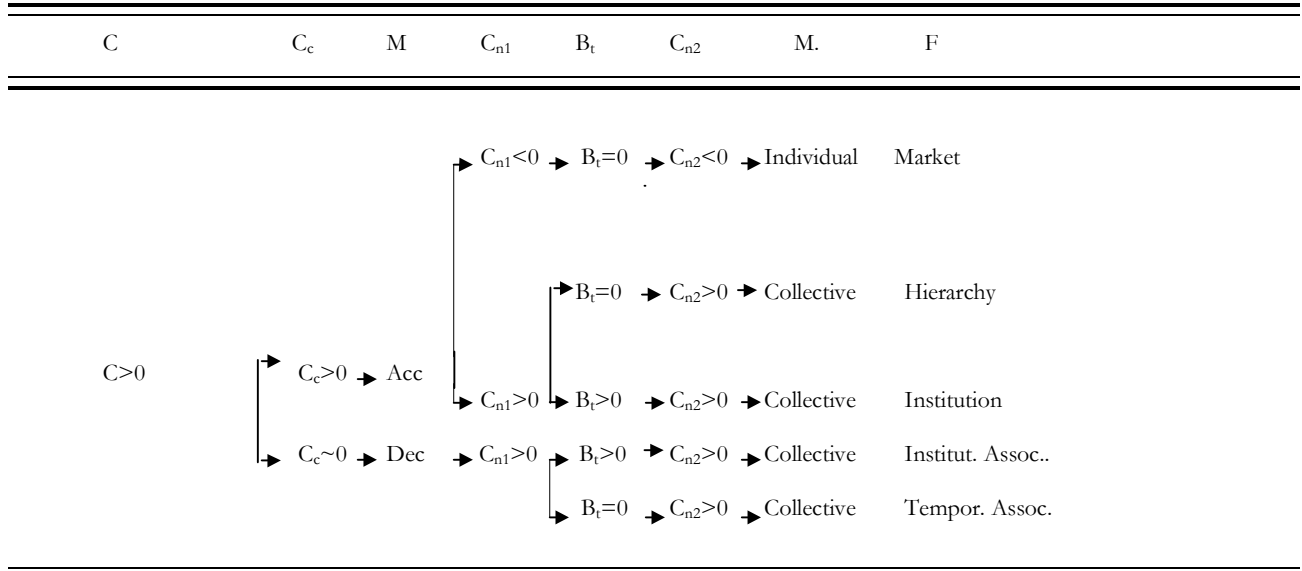
The starting up of collective action for the realisation of a collective good is usually accounted for by complementarity $(C>0)$. The absence of complementarity $(C=<0)$ in fact makes collective action irrational since co-ordination costs, as we have seen, are always positive. The usefulness of production and collective availability of a good is however influenced by behavioral constraints assumed by contributing individuals, and by the level of co-ordination costs necessary for the identification of optimum equilibrium and defining the co-operative agreement (C_c).

Where co-ordination costs are low $(C_c \sim 0)$, the plan is designed collectively by participating agents developing a decentralised decision-making process which we call here association.

Where co-ordination costs are high $(C_c>0)$, we have seen that the net benefits of co-operation can be lower than those associated with individual production. Centralisation of the decision-making process can allow the reduction of co-ordination costs and make the net balance between benefits and costs of collective action $(C_{n1}>0)$ positive. Nevertheless if the result of the comparison is not favourable to collective action $(C_{n1}<0)$, the production of the good can only be in the

context of individual action and the exploitation of eventual economies of specialisation can be left to market mechanisms (ex-post co-ordination).

Figure 5

C	C_c	M	C_{n1}	B_t	C_{n2}	M.	F

$C_{n1}<0$ → $B_t=0$ → $C_{n2}<0$ → Individual   Market

$B_t=0$ → $C_{n2}>0$ → Collective   Hierarchy

$C>0$ $C_c>0$ → Acc

$C_{n1}>0$ → $B_t>0$ → $C_{n2}>0$ → Collective   Institution

$C_c\sim0$ → Dec → $C_{n1}>0$ → $B_t>0$ → $C_{n2}>0$ → Collective   Institut. Assoc..

$B_t=0$ → $C_{n2}>0$ → Collective   Tempor. Assoc.

Complementarity, co-ordination costs and provision of private and collective goods

Legenda
C= complementarity
Cc= co-ordination costs
C_{n1}= complementarity net of behaviour constraints and of C_c
M= mode of decision-making
B_t= benefits connected to the guarantee of availability of the good over time
C_{n2}= C_{n1}-Bt
M= mode of production of the good
F= form of co-ordination

In both cases of central authority and association, the decision-making process is also influenced by binding ties of non-excludability and continuity claimed for the good to be produced. Where benefits are perceived as stable over time and there are no substitutes for the good ($B_t>0$), the collective plan is able to minimise the costs of co-ordination if during the decision-making process criteria of non-excludability and continuity have been adopted ($C_{n2}>0$). In this case the central authority takes on the characteristics of an institution and the association incorporates such binding obligations, institutionalising the decision-making process through the definition of explicit constitutive rules and

the formalisation of statutes which circumscribe to a sector and extend through time the activity of the association (institutionalised association). If, on the other hand, the benefits are assessed as transitory or variable over time ($B_t=0$), net complementarities prove positive ($C_{n2}>0$) and centralised authority takes on the characteristics of hierarchy in a neo-institutionalist definition and association (temporary association) operates in a time horizon defined exclusively by technical requirements of project realisation.

A consequence of the hypothesis of co-ordination costs and an examination of their influence on collective action is that the constitution of private government and institutions cannot be derived exclusively from the necessity to control or attenuate opportunism of agents participating in collective action. Even perfectly loyal agents can be obliged to operate centralised decision-making mechanisms able to lower co-ordination costs. In fact costs of limiting opportunism can be added to co-ordination costs and this strengthens and supplements the model, but does not modify its conclusions.

Institutional output is not in the end constituted only by regulative goods. Current economic literature, identifying institutions exclusively with structures set up to 'direct and regularise behaviour' (Scott 1995, p.35) and to reduce the consequences of failures of collective action stemming from free riding, circumscribes the field of intervention to an unjustifiably restricted area[11]. In the present approach, institutional action extends to a vast set of goods (material and non-material) which require the observance of continuity and non-excludability constraints and which are subject to collective action failure because co-ordination costs are high.

This approach has received little attention in economic literature but is present in other disciplines. Karl Wittfogel (1957) for example, analysing the solutions in the planning of large scale hydraulic works in Imperial China gives an example of a public good which requires an extended collective mobilisation of resources. With reference to the link between ex ante cooperation and co-ordination, he points out that:

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[11] In most interpretations institutional functions are seen as aimed at reducing uncertainty and establishing or re-establishing the efficiency of competition mechanisms. They are thus constitutive prerequisites for market exchanges without which efficiency and perfect allocation of resources would be prevented by insuperable information asymmetry, by opportunism and by inequality in the contractual power of the parties. According to this interpretation, which is prevalent in economic literature, institutions essentially carry out a role of regulation. They define schemes and binding ties on the conduct of agents, carry out monitoring of their actions and punish defections (Scott 1995).

"Orderly cooperation involves planned integration. (...) Most writers who mention the cooperative aspect of hydraulic agriculture think in the main of digging, dredging and damming; and the organizational tasks involved in these labors is certainly considerable. But the planners of a major hydraulic enterprise are confronted with problems of a much more complex kind. How many people are needed? (…) On the basis of previously made registers, the planners must determine the quota and criteria for selection. Notification follows selection, and mobilization notification.. The assembled groups frequently proceed in quasimilitary columns. Having reached their destination, the buck privates of the hydraulic army must be distributed in proper numbers and according to whatever division of operations (spading, carrying of mud, etc.) is customary. If row materials such as straw, wood, fagots, lumber or stone have to be procured, auxiliary operations are organized. (...). Even in its simplest forms, agrohydraulic operations necessitate substantial integrative action. In their more elaborate variations, they involve extensive and complex organizational planning." (p.26).

The link between the design of great collective works, complementarity, co-ordination costs and the emergence of embryonic forms of central institutional authority has also been studied in social anthropology. M. Harris (1978) in fact claims that preindustrial hydraulic agriculture recurrently led to the formation of a state apparatus

" …because the expansion and intensification of hydraulic agriculture (...) was uniquely dependent on massive construction projects (…) . The larger the river, the greater the food production potential of the region through which it flowed. But the larger the river, the greater the problem in making use of its potential. On the one hand, the state undertook the construction of extensive networks of diversionary and feeder canals, ditches, sluice gates to ensure that there would be enough water at the right time; on the other hand, the state undertook the construction of dams, leeves, and drainage ditches to avoid the damaging effects of too much water all at once. The scale of the activities in question literally demanded changing the face of the earth: moving mountains, reshaping riverbanks, digging out whole new riverbeds. Recruiting, coordinating, directing, feeding, and housing of the brigades of workers needed for the monumental undertakings could only have been carried out by cadres obedient to a few powerful leaders pursuing a single master plan. Hence the larger the hydraulic networks and facilities, the greater the overall productivity of the system, the greater the tendency of the agro-managerial hierarchy to become subordinate to one immensely powerful person at its top." (p. 158)

6. CONCLUSIONS

Economic literature sees the existence of institutions as being justified by market failure. This paper has attempted to develop a different hypothesis by linking institutions to the overcoming of co-ordination dilemmas. According to this line of thought, institutional action is not

circumscribed to supplying 'regulative resources' able to lower uncertainty and limiting the risks of free riding. It includes rather the provision of a vast set of public goods characterised by high complementarity and marked constraints on the continuity of supply. In the production of such goods, the presence of multiplicity of equilibria and high costs of information and knowledge born by individual agents in formulating a cooperative agreement makes often a decentralised decision-making process impracticable. On the other hand, as we have tried to show, a central authority (an institutional subject), assuming long term obligations and lowering co-ordination costs, can mitigate collective action problems in a wide range of circumstances.

REFERENCES

Arrow, K.J. (1974). *The Limits of Organization*, New York, W.W. Norton & Company.

Artus, P. (1993). Défauts de coordination des activités, in *Reveu économique*. 44, pp.551-568

Becker, G.S. and Murphy, K.M. (1992). The Division of Labor, Co-ordination Costs, and Knowledge, in *Quarterly Journal of Economics*, CVII, pp.1137-1160

Boitani, A., Delli Gatti, D. and Mezzomo L. (1992). Concorrenza imperfetta, esternalità e spiegazioni delle rigidità nella Nuova Economia Keynesiana, in *Economia Politica*, IX, pp.299-361

Bulow, J.I.,Geanakoplos, J. and Klemperer, P. (1985). Multimatket Oligopoly: Strategic Substitutes and Complements, in *Journal of Political Economy,* June, pp.448-511

Colander, D. (1992). New Keynesian Economics in Perspective, in *Eastern Economic Journal*, Fall, pp.438-448

Cooper, R. (1987). Dynamic Behavior of Imperfectly Competive Economies with Multiple Equilibria, in NBER, *Working Paper*, n.2388

Cooper, R. and John, A. (1988). Co-ordinating Co-ordination Failures in Keynesian Models*, in Quarterly Journal of Economics*, Agosto, pp.441-465

Cooper, R. and Jorhi, A (1996). Dynamic Complementarities: a Quantitative Analysis, in NBER, *Working Paper*, n.5691

Grossman, S. and Hart, O. (1986). The Costs and Benefits of Owenership: a Theory of Vertical and Lateral Integration, in *Journal of Political Economy*, 94, agosto, pp.691-719

Hardin, R. (1982). *Collective Action*, Baltimore, The Johns Hopkins University Press.

Harris M. (1978). *Cannibals and Kings. The Origins of Culture*. London, Collins

Hume, D.(1888). *Treatise of Human Nature*, Oxford, Clarendon Press

Leijonhufvud, A. (1968). *On Keynesian Economics and the Economics of Keynes*, Oxford, Oxford University Press

Lewis, D.K. (1969). *Convention. A Philosophical Study*, Cambridge, Harvard University Press

Olson, M. (1965). *The Logic of Collective Action*, Harvard, Harvard University Press.

Rizzo,J.A. and Sindelar, JL. (1996). Optimal Regulation of Multiply-Regulated Industries: the Case of Physician Services, in *Southern Economic Journal*, 62, pp.966-978

Schelling , T.C. (1980). *The Strategy of Conflict*, Cambridge, Harvard University Press

Scott, R.S. (1995*). Institutions and Organizations*, London, Sage Publications

Taylor, M.(1987).*The Possibility of Cooperation*, Cambridge, Cambridge University Press

Van Ees, H. and Garretsen, H. (1992). On the Contribution of New Keynesian Economics, in *Eastern Economic Journal* , 18, pp.465-477

Wittfogel, K. (1957). *Oriental Despotism. A Comparative Study of Total Power*, New Haven, Yale University Press