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Abstract

We introduce the possibility of collusion and study the optimal organizational Job design in a three-tier hierarchy. We consider the incomplete grand contract situation and show that in one case, the pooling contract with cross subsidization may emerge as a second best solution to the political activities of some group, and in the other case, soft (unverifiable) supervisory information may make equilibrium side transfers optimal. This is a new way of distinguishing two types of organizations in terms of allowing collusion or deterring collusion. Considering the implications of this model, we see that this model deals with the problem of centralization versus decentralization of the firm and explains the source of firm competitiveness in terms of the organization structure.

Key words:Hierarchial Agency,Task Assignment problem, Information structure, Externality, Collusive (Group) Behaviour, Collusion-Proof incentive schemes, Equilibrium with Vertical collusion, Equilibrium with Lateral Collusion, Pooling Contract with cross subsidization, Centralized vs Decentralized Firm.

JEL. classification:C70, D23, D73 , D82

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1. Introduction

In large firms, due to the asymmetry of information or the incompleteness of the information structure and the limitation of the set of the ex ante contractible variables resulting from the above factors, the "hold-up problems"tends to occur due to the "Internal Opportunism". (This type of opportunism was at first suggested by O.Williamson (1975) in the context of the hierarchy of firms.)

In practice, this often takes the form of the competition for the good ranked task and/or the conflict between divisions (units) who actually carry out the tasks, in the stage before the implementation of the main project.

How the organization mitigates this "hold-up problem" or "the conflict among divisions" and how the main project should be carried out are vital for its success. Indeed, the so- called high- performance firms (e.g. Toyota, or more generally, the successful management of the project) deal with these problems very well. It is the purpose of this paper to analyze where the essense of this phenomenon exists. Concretely, it is as follows. Suppose that the purpose of each firm is to enhance the efficiency (total pie) as much as possible. We would like to characterize the organization structures (forms) as the optimal solutions to alleviate the "hold- up problem" or "conflict of interests" inherent to the organization with incomplete contracting, given the exogenous parameters and information structures.

In order to analyze this deep problem from the viewpoint of economics, we abstract and arrange the problem, as follows.

Consider the hierarchy consisting of a central unit, the management unit, and the operating units, such as the figure 0. The top unit (we use the term of the principal in the main text) can offer the contract (compensation scheme or incentive contract) over the main project, but the ex ante investment activities, which are not observable, and thus non verifiable, are generated before the enforcement of the project due to the incompleteness of the information structure.[1]

These activities are unproductive, and so it is the first best optimum to prevent them, while it can be understood that in practice, they arise as the "overinvestment problem" in the form of "conflict among divisions". Since the increase of the ex ante investment behaviour

[1] For an integrated analysis of these two types of inefficiency, see P.Milgrom and J.Roberts(1992). These are the same in that they are the inefficiencies resulting from the positive and negative externalities in organizations.

from zero brings about the dead weight loss in organizations, this can be understood as a case in which there exists the interdependence based upon the negative externality. Hence, we can abstract the problem as follows. When the organization can take into account the possible efficiency loss caused by conflict among the divisions in the stage before the enforcement of the project, how should the contract (incentive scheme) for the main project be modified, in order to enhance the overall efficiency? In order to analyze this problem in the model, we note the agency model incorporating the possibility that the subgroups in the organization collude and manipulate the private information. Though the traditional theory had excluded this possibility, this line of research was pioneered by J.Tirole (1986). The essense of the first model by Tirole is known as the *"Collusion Proofness Principle"*. This principle asserts that even if we consider the possibility of collusion between the supervisor and one agent in a three- tier hierarchy consisting of the principal, the supervisor and the agent, we can restrict our attention to the collusion proof mechanism (truth telling mechanism) without loss of efficiency. (We cannot find any other mechanisms which increase the total surplus besides these kinds of mechanisms.) However, the essense of this paper is placed upon the point that if the supervisor can be introduced, spreading the probability of the perfect information regime's occurring, which reduces the information cost resulting from the asymmetry of information and the limitation of the communication technology, the total surplus (efficiency) can be enhanced. In other words, when the principal grasps the state of nature from the verifiable report of the supervisor, the information rent (a kind of dead weight cost) as a prize to induce the private information from the good (efficient) type can be discretely reduced. On the other hand, the cost of incentive constraint for the supervisor to tell the truth is imposed only marginally (in the second order) in the form of the underprovision of the incentive of the inefficient type. Hence, the Pareto improvement can be achieved as a whole. In his model, the supervisor is incorporated as an intermediate of information, and in addition to it, the attention is restricted only to the truth telling mechnism.

However, in this type of hierarchy, we cannot treat the problem of the conflict between divisions (units) and its mitigation from the viewpoint of economics. Also,not only does Tirole (1986) not treat the incompletness of contracts, but also its context is restricted to the environment of regulation. In the "multi-layer" productive organizations, which we analyze in this paper, it is rare that the central unit (the principal) delegates all of productive behaviours to the agent in the bottom level, and in practice, it is observed that the management unit (we call the supervisor) also participates in the production process by investing the inputs. For example, consider the following context. The central unit (top management group) owns the basic concept and idea (this can be also considered as an essential assent in the context of the Grossman-Hart-Moore approach) for the important project, and the management unit is at first a part of the central unit (the subset of members), but after he or they enter into the contractual relationship with the operating units (the lower-ranked divisions, engineers, or plants) with essential (human and physical) assets, the central unit (the principal) dispatch the management unit as a supervisor, who forms a production organization that actually enforces the project. In summary, unlike Tirole, we explicitly introduce a second agent into the model and consider the vertical production organization to be composed of a supervisor and two agents (e.g. two divisions, two plants. etc.), such as the figure 0. this management unit (supervisor) not only organizes the inputs by the operating units (agents), but also enhances the production condition (e.g. reducing their marginal cost of effort.). Typically,many of his productive efforts cannot be observed or ,more probably, verified. When the supervisor also plays the role of a productive agent, his relationship with the agent will be rather different from what it would be in the traditional principal-agent framework. "Collusion Problems" arise on subgroups considerd. In other words, it is possible that the bad (inefficient) agent colludes with the supervisor, manipulates the private information and pareto improves only among them, by cheating jointly. For the good (efficient) agent, this implies that he faces the fear of the opportunistic behaviour of the bad (rival) agents' colluding with the supervisor, and being exploited by them not only the compensation promised ex ante but also the large future prize not explicitly written in the contract. By this possibility, the conflict (or competition) among divisions arises, under no intervention, in the stage before the enforcement of the main project. This shares the same essence in the abstract level as the inefficiency resulting from the underinvestment problem in the relation- specific investment, and it implies that the inefficiency may arise resulting from the overinvestment in the ex ante stage. Hence, even if the principal can commit to the contract for the main project ex ante, the contract must suppress the threat of the ex post exploitation of the rent by the rival bad agent. That is, in order to prevent the ex ante competition (disincentive), the principal must offer the compensation scheme "credible" for the good type agent in that it deters the collusion incentive among the supervisor and the bad agent.

However, in other cases, such ex ante competition may not be so costly for the organization. If we note the function of the competition as a device for inducing the private information, the organization may increase the attainable efficiency by allowing the competition (conflict) among the units (divisions) and the formation of more efficient coalition, rather than by adopting the organizational structure such that it suppresses the conflict (competition) between the division (units). Further, if it is possible to achieve cooperation among divisions, he may create a structure to achieve it. In this case, the principal commits to the initial contract, but may induce the higher total surplus (efficiency) through designing the process of cooperation among divisions and letting them bargain with the threat of conflict among them, corresponding to the initial allocation proposed by the "non-credible" initial contract.[2]

We can infer these two as the stylized patterns of organization forms, given the exogenous conditions and information structures. We want to investigate this intuition in this paper. Before the detailed analysis, let us present the observed facts and case studies leading to this intuition. The first example is the studies on the structures of product development organizations by K.Clark and T.Fujimoto. According to their studies, whether they are in the United states, other Western economies or in Japan, the high- performance firms achieve the competitive advantage through mitigation of the "Hold up" problems in the form of the overinvestments, either by "egalitarianism" or "equalitarianism", which implies suppression of the source of the problem, or by "Cooperation among divisions (units) through close communication ("Face-to-Face" communication) which alleviates the conflict (competition), leading to the "Lean" production-development systems. The original work by Takamiya (1980), which was a forerunner of their studies, presents an example of the failure of the coordination in the organization in the plants (units) mainly in England. He

[2] Theoretically, this is the theme on which the implementation theory has a notice. This paper is placed upon the line of the extension of the agency theory, and explicitly considers both the characterization of incentive schemes and the application to the firm organization. Laffont-Tirole (1990) considered the regime of "commitment and renegotiation" in the context of the regulation over the two periods. There, in the first period, the government offers the long- term contract, but at the beginning of the second period, given the ex ante rent described in the initial contract, the government and both types of firms can revise the initial contract only when they are all pareto improvable. Our paper is related to this framework, but there are some fundamental differences, e.g. the form of the renegotiation game, whether it considers the lateral collusion or not, the context and its implications, etc.

investigated the practice of the firms which had lost the competitiveness, and showed in detail that in these firms, the competition for the good task (business), so called the "political competition" arises and it takes a large loss (e.g. time, effort, money). This is an example where the organization with externalities fails to allocate the resources efficiently.

As a theoretical work, recently, Aoki (1995) suggestively showed, using a team model, that the change of the degree of information sharing or the information structure enhances the possibility of coordination discretely. However ,this is still tentative and does not explain the facts described above. [3]

Another point is that the cost target for the individual division (unit) cannot be specified explicitly in the ex ante contract, which cannot be verified ex post. Only total expense (cost) spent by the operating units can be verified ex post. This is justified also from the auditing practice. It is often observed that "total cost" is observable but "the allocation to the individual cost" is prohivitively costly, and so is effectively unobservable, and so unverifiable. Hence, in the ex ante stage, the concerned parties can agree only to the "incomplete contract". This is the very reason why the manipulation of information through collusive behaviours, or if we use the more familiar term, the (collusive) moral hazard or the "Hold up" problem arises. [4]

This paper is organized as follows. In section 2, we present our three-tier model. This setting is similar with Tirole (1986) and Laffont-Tirole (1991) . But, it is shown that in the simplified model of their settings, if the principal commits to the first best contract, it becomes the collusion proof scheme, in other words, credible also for the good (efficient) agent, and so the competition among divisions (units) does not arise. So, we introduce the ex post renegotiation game in the second period, and suppose that the future rent distribution is largely changed, depending upon whether the good ranked task is assigned or not in the

[3] J.Hirschleifer also constructed the pioneering model which decided the incentives of each division and the transfer payments, though it did not deal with "the externality" correctly.
It is a model of multi-product firms consisting of one upstream and two downstream divisions (units), with the applicable examples such as the organization of GM, and oil refineries.

[4] So, though this model has an organization structure similar to the one of L.Carmichael(1983), this model is an essentially new type of Agency model; the two have the essentially different information structures. Carmichael(1983) does not consider the collusion problem, which is the focus of this paper. By the information structure, this paper can also be positioned as an applied research of Hart-Moore(1988) in the context of the Agency theory.

main project in the first period. This implies that the "negative externality" has been introduced in the setting of Tirole (1986) and Laffont-Tirole (1991). This additional factor plays an important role in inducing the (unverifiable) investment competition in the ex ante stage in the first period. This kind of coordination problem in organizations with externalities has been the object of study, mainly in the O.R.field, but this paper has the new essential contribution in that it explicitly analyzes the possibility of manipulating private information through collusive behaviours, in other words, the conflict among divisions and its mitigation. In summery, we introduced the ex post fixed sum game in the Tirole model, and it enabled the conflict of interests among divisions(units) to be analyzed as the ex ante overeinvestment problem. Examples of this externality can be rather found in practice. In section 3.1, given the decision of the principal to offer the collusion proof compensation scheme, we characterize the incentive scheme and the attainable efficiency. In section 3.2, given the decision of the principal to allow the collusion in equilibrium, which implies that the principal allows competition in the ex ante stage, we investigate the change of total surplus(efficiency) and the characterization of the incentive scheme. Especially in the latter case if "the degree of information sharing" or "the information structure" can be changed, the ex ante " Lateral Collusion" (Dang o) becomes possible, and the attainable efficiency can be enhanced discretely. In section 4, we partially characterize the choice of organizational forms. The results are as follows. In the organization with negative externality over the problem of task assignment. We suppose the marginal dead weight cost of the ex ante rent seeking (investment decision) is λ c. When λ c tends to zero, the function as a device of the information revelation of the competition dominates. So, the first best efficiency can be approximately achieved. On the other hand, when λ c>0 and the difference of cost of two types is negligible , the marginal increase of the incentive scheme : $a_1 - a_2$ from zero brings about the discrete increase of the dead weight cost(the ex ante incentive), while the net benefit increases only marginally. So, the pooling solution as a corner solution is chosen. This can be considered as the solution of the problem by the "egalitarianism" derived from the equilibrium collusion problem.This type of solution can be obtained also from the collusion proof problem .In the text, we investigate the logic, intuition and technical analysis leading to the result.The former of these two can be considered as the solution of the problem by the close communication among members that shares the private information when it is possible to achieve cooperation among them. These two solutions are consistent with the observed two patterns of successful firms.

2. The Model

2.0 Preliminary Explanations and Notations.[*]

In our model, the principal directly contracts with only the supervisor and not with the two agents in the ex ante stage. As for the action information, the principal lacks the information about the supervisor's strategy choice (the possibility of the supervisor's moral hazard) and the agents' ex ante decision(rent-seeking efforts). As for the type information, he lacks information about the data on the relative productivity (this implies asymmetric information about agents' type). It is also crucially important for our results that there exists a kind of differential information among the parties in organizations.

In our model, the initial contract, which is publicly offered[5] from the principal to the supervisor and two agents, may be negotiated in the interim stage between the supervisor and the two agents according to the specified side contracting game. Indeed, in our "equilibrium collusion" regime, a side contract occurs in equilibrium. Thus, our paper tries to investigate how a cooperative choice of strategies(joint action) by supervisor and each agent processes information in interim equilibrium, thereby, to synthesize the static cooperative game theory and non - cooperative game theory(mechanism design game[6]) of information processing, through introducing the cooperative games into the larger noncooperative game.

Next, we refer to the notations of this paper. Contractible (observable and verifiable) variables are two output levels $y_1 = F(a_1), y_2 = F(a_2)$ and the cost target level C,where the input levels a_1 and a_2 are the target levels of the effort by the agents, such as the speed of production lines, or in a project team, the required level of research effort. These are substantially enforced by the third - party, because they are forced upon them since the output levels y_1 and y_2 are observable and verifiable. In this paper, we limit contracts to those which consist of two numbers : a wage payment: W and a required level of jobs (tasks), a or C. $\overline{C}$ is the total team cost (expense) which is allowed as an upper bound, and this joint outcome is publicly observed[7]. Unobservable variables are X, $\tilde{e}$ = e+Δe and Δi. X

[*] Readers can skip this part ,or come back here while and/or after they read the presentation of the model.

[5] But,it is only with the supervisor that the principal directly contracts in the ex ante stage.

[6] See,for example,Baron-Myerson(1982)and Maskin-Rily(1984).Tirole(1986) can be viewed as the first paper that considered the problem of the collusion in organization in the mechanism design game with side contracting.

[7] The individual cost of each agent or the cost allocation among the two agents is observable ex post among the

(1 or -1) is the productivity data which is exogenously given at the beginning. X = 1 means that agent 1 is efficient and 2 is inefficient, and X= -1 means the opposite case. e is a supervisor's effort norm for the success of his project when he tells the truth. The level is optimally decided by the principal, and let $\varphi(e)$ with $\varphi > 0, \varphi'' > 0, \varphi''' \geq 0$ denote the supervisor's disutility of effort, Δe is an extra effort by supervisor when he misreports the information. Thus, $\tilde{e} = e + \Delta e$ is his actual effort, only the part of e of which is compensated by the principal. Itoh (1991) and Lazear (1989) consider only the incentives of agents, given the that the supervisor is given control rights of the project as a whole. Our paper considers also the supervisor's effort incentive. The first reason is that in modern development organizations, the project manager's incentives to invest effort are crucial to the success of the project. Secondly, the technical reason is that it enables the supervisor to misreport the type information among the agents.In the main text, we can understand that $d \cdot X + \tilde{e}$ denote the actual productivity of each coalition. Finally, Δ i (ex ante "unverifiable" investment) is the bribe or influence (rent - seeking) activities by the agent.Actual cost allocation among two agents is also unobservable even ex post. Only total cost can be observed (and verified).

This setting implies that even if the third party (the court) observes the level of total cost C ex post, the collusive moral hazard may happen as a possibility,and the truth can not be verified even in the ex post stage.

2.1 The Parties

The setting of the model is based on Tirole(1986) (1992)and Laffont -Tirole(1991). We consider a three- tier hierarchy consisting of three risk neutral players: a principal, a supervisor and two agents. The principal owns the original idea and basic concept of an important project. It is one of the essential assets for the implementation of the project. He or she delegtates all of the productive behaviors , that is, the implementation of the project to the parties with the vertical structure, e.g. a product development organization or a divisionalized firm.(for a concrete image of the organization structure,see the figure 0 in the back of the paper.) For the context, the supervisor in the middle layer is a product manager or an internal supplier, in other words, a delegated expertise[8] . He participates in the development or

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supervisor and two agents ,but is unobservable to the principal or the third party(court).This is a new assumption in the agency models. Carmicheal(1983) assumes the observability of the individual cost, though it resembles this model a little in that it introduces the tournament structure with the productive principal .

[8] He is a kind of field overseer or substantially in charge of the vertical structure mentioned above.

production process with the role of a productive member. He can have two- dimensional activities, one of which is the information collection and reporting and the other is the execution of the global task. The role of the supervisory(global) task is to reduce the marginal cost of the efforts by two agents (e. g. improving work conditions) at two tasks intended for them. The bottom layer is the level that actually produces any output. He is called an agent, who is ,for example, viewed as an production division or an plant or an unit in organizations. The agent supplies the level of effort: a at task 1 or 2 at a cost of $c(a,e;d\cdot X)$.

Depending upon a relative productivity parameter X, this determines the cost of the effort supply such that $c(a,e;d\cdot X)=(B-e-d\cdot X)\cdot a$ where e is the supervisory effort at his global task. And $y_i = F(a_i)$ denotes the product or output resulting from the level of effort a_i.

We assume $F(a_i)$ is an increasing, concave function, that is, $F'>0, F''<0$ for all $a_i \geq 0$.

The outputs $F(a_1)$ and $F(a_2)$ at first belongs to the principal, who compensates the agent with the transfer payment W_1 and W_2.The agent maximizes his utility $W-c(a,e;d\cdot X)$(in the case of no externality or a one- project case and no freedom to offer bribes). We suppose that there are two types of agents and we assume it is optimal for the principal to employ also the inefficient agent ; in other words,it is necessary to employ the two agents for the implementation of the basic project.

The supervisor in general observes a signal imperfectly correlated with the state of nature X. He receives a wage payment Ws from the principal, and his objective is to maximize his utility(the monetary income minus the cost of effort).It is represented by $W_s-\varphi(e)$ (when he does not obtain any side payment ,and so does not exert any extra effort.)The principal pays the transfer payments to the other members of the hierarchy from the joint revenues resulting from the two final outputs of the vertical structure and receives the residual profit. His objective is to maximize the following profit (revenues minus wages).

$$\pi = \sum_{i=1,2} F(a_i) - (w_1 + w_2 + w_s)$$

Next ,we consider the situation of the model in more detail .

In the following team production consisting of the supervisor and two agents, the total team production cost (expence) is assumed to be

$$C=(B-e)(a_1+a_2)+d\cdot(a_2-a_1)\cdot X \quad (1)$$

where X=1 or -1 with equal probabilities and $d>0$. The parameter X indicates which of the two agents is more efficient, that is, the marginal production cost of one agent with the supervisor's effort is 2d lower than the marginal cost of the other agent. The cost differential parameter 2 d is common knowledge.

We assume that principal contracts with the supervisor directly in the ex ante stage (though he cannot do so as for the two agents),but after his participation in the production process ,cannot monitor the supervisory effort directly. Now to simplify the analysis, B is known also to the principal. Here, B is the innate cost of team production or the' average'marginal cost of two agents . e is the supervisor's effort, and this is the essential production factor in our model. We often intrepret : Δe as the extra effort of the supervisor.The interpretation of e and Δe is in a sense important. For example, in Japanese subsidiaries, it is often said that the work custom is much more flexible than in American and European ones. It is always stated that the work differentials between the sections or divisions or between the ranks does not exist. Anyone will do if the team norm will be attained. Again, we rewrite the team production cost.

$$C=(B-e-d\cdot X)a_1+(B-e+d\cdot X)a_2 \qquad (1)'$$

If X=1, Agent 1 is more efficient,and so, the relatively efficient team is formed with the supervisor in the sense that the marginal cost of the agent 1with the supervisory effort:e is B-e-d, while the other agent's cost is B-e+d[9] . If X = -1, Agent 2 is more efficient. From now on, we restrict the analysis to the case of X=1 without loss of generality . If the principal knows that X=1 and can verify it to the court(outside party), the optimal initial contract by the principal specifies the first best allocations and can enforce it. In our model, the principal is a competitive firm in the entry stage before the formation of the binding short-term relationship with two agents,and so it must maximize two agents' total rent subject to a zero profit constraint[10] .

2.2 Collusion and soft (unverifiable) information

Form now on, we assume that the supervisor perfectly knows X, ie,which of the two agents has the comparative advantage in the production (development) cost , in other words,

[9] If we consider that the common supervisor makes a team with each agent,we can view the costs $(B-e+d)$ or $(B-e-d)$ as the cost parameter of each team.

[10] The supervisor belongs to the principal in the entry stage ,and after the principal can get the relationship with the two agents ,he becomes an 'incarnation' delegated the responsibility of the success of the project,participating in the project in a middle management position.Of course, other examples are also possible.

which is better fitted to the good task. Further, X is "soft (unverifiable) information". For any realization of the state of the nature X, the supervisor can claim to have received any of the possible two signals X={1,-1}. That is, the supervisor cannot "prove" to the principal that X is equal to 1 or -1, but only announce it as $\hat{X}$ This implies that the principal knows that the supervisor knows X, but cannot subpoena the supervisor to supply the physical (hard) evidence that substantiates its announcement $\hat{X}$. By this assumption, X is the shared information among supervisor and two agents, but it is not verifiable for the principal.In summery, the principal can talk with the supervisor only, but after his report (message) ,he or she cannot observe the state even with the help of the supervisor .(This is the important point.)

Even if the principal does not know X, if there is no possibility for side-contract between the supervisor and any type of agent, the supervisor has no incentive to misreport X. Indeed, lying about X would only lead the principal to switch the'true' roles between Agent 1 and 2, and this would increase the team production cost(expence) by $2d\cdot(a_1-a_2)$ and therefore the supervisor would have to spend extra effort of $2d\cdot(a_1-a_2)/(a_1+a_2)$. On the other hand, his wage or compensation from the principal is only the amount compensated for the cost of ϕ (e). So,he cannot get any gain from the false reporting.The following equation summarizes the above argument.

Signal	Agent 1	2	Team cost norm
X=1	-d	d	$C=(B-e)(a_1+a_2)+d\cdot(a_2-a_1)$

If $\hat{X}$ =-1, the realized team production cost(expence) is increased as follows

$$C'=(B-e)(a_1+a_2)-d\cdot(a_2-a_1)$$

The supervisor must increase his effort by $\Delta e=2d(a_1-a_2)/(a_1+a_2)$,so as to achieve his assigned norm.This effort is not compensated by the principal.

In contrast, suppose, for example, that type 2 (inefficient)agent can make a take-it-or-leave-it offer [11] to the supervisor when X=1 to induce the supervisor to announce that $\hat{X}$ =-1, ie, to swich the 'true'role of him and his competitor and mimick the type information collusively. This, in turn ,leads the principal to allocate a good job a_1 for type 2 agent, and a bad job a_2 for type 1 agent, which may benefit type 2 and hurt type 1 agent. From this, we can recognize that there exists the potential of negative externality effects in this setting.

[11] Consider this offer is done secretly, until you reach the section on the' lateral' collusion(integration) among agents.In other words, it is unobservable to Agent 1.

2.3 Strategy Spaces

The principal designs a contract (compensation scheme) and offers it to the supervisor and the agents. He pays the agent $W\left(F(a); \hat{X}\right)$. [12] For each X (in our model, this distinction is irrelevant since two types are perfectly correlated), the contract determines the optimal levels of effort (a_1 and a_2), yielding two outputs ($F(a_1)$ and $F(a_2)$). If $F(a_i) \neq F(a_1)$, when the agent is assigned to the task 1 based on the "type" reported by the supervisor, the agent gets punished. So we can substantially restrict our attention to input levels: a_1 and a_2 [13]. He pays the supervisor Ws (C). If C > $\overline{C}$, that is, a cost overrun occurs, then the supervisor get punished. The supervisor recommends to the principal the agents for the good task ,and after that, exerts his productive efforts at the global task.The spervisor recieves Ws only when the publicly observable (verifiable) cost norm can be achieved. The agent chooses effort a (assigned) at task (job) 1 or 2. He can collude with the supervisor to manipulate $\hat{X}$ in exchange for a side payment. More explicitly, side payment Δ could be written as a function of the supervisor's report of $\hat{X}$ given the state X. Some readers may wonder how such contracts may be enforced. For the time being, I assume [14] that parties can coordinate on their actions, following the collusion literatures.

2.4 Timing of the Game

(1) The principal offers an initial contract specifying the transfer for the agent $W\left(F(a_i); \hat{X}\right)$ as a function of output F(a) and the supervisor report[16], the transfer for the supervisor Ws (C; $\hat{X}$) as a function of total cost(expense).This contract is publicly announced and perfectly observable to other parties.The principal faces the competitive pressure by the

[12] The readers will know that the payments equal to $F(a_i) - \frac{1}{2}W_s, i = 1,2$ for each agent i =1,2 in equilibium,after they read the later partof this paper.

[13] In this sense,the principal commits to the compensation scheme and offers a kind of forcing contract,but due to the incompleteness the set of contractible variables,the model can treat the (collusive) moral hazard and/or possibility for renegotiation between the remaining parties.

[14] Though I present some foundations of the enforceability of the side contracts,even without it,this paper *does* include some new viewpoints on the theory of organization.

[16] The principal decides which of the two contracts he offers to which agent,depending upon this supervisory unverifiable report.

rival principal ,and so he must offer the contract which maximizes the joint welfare of the two agents in order to obtain the relationship.

(2) The principal contracts with the supervisor directly , and teaches the basic idea and concept of his project to the agents through the supervisor(e.g product manager)

(3) Nature chooses the state of relative productivity (X) and the signal for the supervisor.In this model, the state and the signal are perfectly correlated, that is, the supervisor observes non-noisy signal:X. The informativeness of the signal is perfect.

(3)' The agent learns X. We assume that the supervisor is a colluding type[15] who recieves bribe with probability 1,if it increases his private utility. This is common knowledge.

(4) The supervisor and two agents can sign a side contract specifying a side transfer (bribe) dependent on the supervisor's report. They engage in bargaining over side contracts according to some game form. We specify the collusion game by assuming that 2 agents make simultaneously take-it-or-leave-it offers to the common supervisor for side contracting (recontracting). (We are here envisioning a second price auction between heterogeneous agents. However, we also present the other extensive game form, which has the same equilibrium outcome.)

(5) Supervisor reports $\hat{X}$. Side transfers are realized.

(6) The contract which specifies the assigned task is offered to each agent based on a "type" report of the supervisor.

(7) The contract is signed between the principal and each agent. The agents and the supervisor choose their effort inputs at their assigned tasks. Output $F(a_1), F(a_2)$ and C are realized and observed by all parties (so these are verifiable variables).

(8) Transfers that are pre-determined in the initial contract are realized.

(9) The second project is started. We can consider this stage as an ex post renegotiation game. And we assume that the divisional profit in the second project is $S_i(y_i, y_j) = \overline{E} + \frac{1}{2} E \cdot (a_i - a_j)$, where $y_i = F(a_i), i \neq j, i = 1,2$ .In this case, at the task i, the agent supplies the input in the 1-period project (today's investment). That is, the additional gain or loss: $\frac{1}{2} E \cdot (a_i - a_j)$ occurs, depending upon which task the agent has taken charge of in the 1-

[15] Of course,other settings such that where the positive probability of non-colluding type is incorporated in the model are also possible.However, it may be able to be analyzed more suitably in other frameworks,such as repeated games.

period. Hence, we see that the payoff structure in this stage has the structure of Fixed (zero) Sum Games. The crucial point is that by adding stage (9) there exists an additional gain or loss due to the existence of a second period prize : $E(a_1 - a_2)$, thereby a kind of negative exernality occurs.

The principal must take into account this dynamic effect and the conflict of interests which works among agents in today's task design.

We can summarize the timing of the Game as follows

(1),(2)	(3)	(4)	(5)	(6),(7)	(8)	(9)
All parties learn that X ε{1,-1}. The principal designs and offers an Initial contract	Supervisor and 2 Agents learn X	side contracting Game {the Renegotiation game}	Reports $\hat{x}$ side transfers.	Selection production outputs $F(a_1)$,$F(a_2)$ cost C are publicly observed.	Transfers Initial Contract is implemented	Expost renegotiation game occurs. the extra prizefor the 1-period good task occurs.

Timing

We allow side transfers to be costly. i. e, $\lambda c>0$. An income equivalent of $1 transfered by agent i to the supervisor costs $(1+ λ c) to the agent i. The parameter $\lambda c>0$ is a measure of the dead weight cost of collusive transfers for the two parties. Assuming that $\lambda c>0$ is meant to rule out the possibility that side transfers occur only because an agent is a better collector of funds than the principal.And it implicity means that the principal has a better access to the capital market.It is also equivalent to introducing a kind of the bargaining cost into the model.

2.5 The First Best contract

[Collusion-Free problem]

We characterize briefly the first best optimal contract when collusion is not a feasible option. It maximizes a total surplus, which is the sum of both the 1- period and the 2- period surplus, that is, "the Joint Surplus",with no incentive constraint.

$$\max_{\{a_1,a_2,e\}} F(a_1)+F(a_2)-\left[(B-e)(a_1+a_2)+d\cdot(a_2-a_1)+\varphi(e)\right]+2\overline{E}$$

The first order conditions for the optimum are

$$F'(a_1)=B-e-d \qquad (2)$$

$$F'(a_2)=B-e+d \qquad (3)$$

$$\varphi'(e)=a_1+a_2 \qquad (4)$$

The term $2\overline{E}$ in the objective function is the 2-period surplus.F.O.Cs(2) and(3) means that the marginal product of agents' efforts a_1 and a_2 equal to each team's marginal cost. Supervisor and each agent forms a coalition, which we can treat as a production team. They produce a marketable goods, such as autos or computers which are sold at the price of $F(a_1)$ and $F(a_2)$. The two equalities (2)and(3) implicitly define the power of the incentive scheme in the first best, $a_1^{FB}-a_2^{FB}$

(4) means that the marginal disutility of the supervisor's effort is equal to the marginal cost savings .Once the supervisory effort is provided,it has a common effect on both team costs.

When we allow 'collusion', we shall say that there is cross subsidization of agent 2 by agent 1 if

$$F'(a_1)>B-e-d \text{ and } F'(a_2)<B-e+d \qquad (5)$$

Note that (2) and (3) imply that $F'(a_1)<F'(a_2)$ and $a_1>a_2$

2.6 Ex post Negative Externality and Ex ante Competing Behaviour.

Here, we enumerate the important facts. These are original in this model and distinguished from other models that deals with collusion problems in hierarchy. The detailed analysis and proofs are relegated in Appendix 1.

Lemma 1

If there is no externality (extra prize) at stage (9), the ex ante competing behaviour (conflict of interest) does not occur. The global incentive constraint for the bad agent is satisfied (non binding)at the first best allocation.

This lemma implies that both players have the same preference pattern over the task assignment outcome in the ex ante stage, and so, there is no problem in this situation.

Lemma 2

Let $E(a_1 - a_2)$ represent the extra prize in the ex post stage[17], and let E represent the marginal prize when the agent gets the good task. Then, the global incentive constraint for the bad agent is not satisfied at the first best outcome if and only if

$$E(a_1 - a_2) \geq [F(a_1) - F(a_2)] - [(B - e - \Delta e + d)a_1 - (B - e + d)a_2] - (1 + \lambda c)[\varphi(e + \Delta e) - \varphi(e)]$$

or if

$$E \geq (2d) \cdot \left[(1 + \lambda c) - \frac{a_1}{a_1 + a_2} \right] + d$$

where the first best allocation is defined by the system of F.O.Cs(2)-(4)

In this case, the problematic situation (the ex ante conflict of interests) occurs.

Lemma 3

If the ex post renegotiation game does not have fixed (zero) sum structures, the first best outcome can be achieved.

The implication of this lemma is very important. If the sharing rule in the ex post renegotiation has non-fixed (zero) sum structures, such as $\bar{E} + P_i(a_i)$, i =1,2, where $P_i(a_i)$ is the private benefit from taking charge of the task a_i, the principal can offer the first best contract, internalizing the additional surplus: $\sum_{i=1,2} P_i(a_i) + (2\bar{E})$, thereby converting the situation (whole original game) into *games with no conflict*. In the games with the zero (fixed) sum payoff structures, the sum of the payoffs of the agents is constant ($2\bar{E}$), derived from the ex post stage (9). So, the principal cannot control the sum and its distribution of payoffs among the agents, thereby solving the ex ante conflict of interests (competing behaviour) over the problem of task assignment. Lemmas 1, 2 and 3 show that the crucial factors supporting the further story in this paper are that there exists *a strong negative externality in the ex post renegotiation stage (9)* and that it is *a Fixed (zero) sum game among agents*. In this case, there exist some inefficiencies impossible to remove.

---

[17] This implies the constant surplus is generated ,but the distribution may be discretely changed.

remark

The tournament scheme such as

$$S_i(y_i,y_j)=\begin{cases}\bar{E}+E & \text{when } y_i>y_j\\ \bar{E} & \text{when } y_i<y_j\\ \bar{E}+\frac{1}{2}E & \text{when } y_i=y_j\end{cases}$$

is also the fixed sum:2 $\bar{E}$ +E game. A big difference between this and the one in the main text is whether the principal can adjust the size of the extra prize $E\cdot(a_1-a_2)$ by his strategy (contract) or not. Between these two cases, the local (marginal) property of incentives in the initial contract changes largely.

3. Can collusion enhance efficiency as a second best mechanism ?

When there are some inefficiencies impossible to remove, the principal has a choice between two types of contracts. The first is the collusion-proof contract. The second is the equilibrium-collusion contract where the side contract between supervisor and one of the bottom- layer agents occurs in equilibrium. That is, the main contract (a_1,a_2,e) is classified into two categories by the nature of the equilibrium that it induces in the side contracting game. We call the former a collusion-deterrence regime, and the latter a collusion-allowing regime, which is furthur divided into two subregimes depending upon the information structure (observability) on actions (side payments).

3.1 Collusion-Proof Contract: Deterring Collusion

In the first step, we assume that it is optimal for the principal to structure incentive schemes so as to prevent collusion (the side contracting decision). We later show that collusion proofness is optimal *only for a subset of parameters.*

To prevent collusion between the supervisor and type 2(inefficient) agent when X = 1, the gross collusive gain for type 2 agent of a misreport of X, $U(a_1,e+\Delta e;2)-U(a_2,e;2)$, must be smaller than the following extra disutility of supervisor's effort,

$$\varphi\left(e+\frac{2d(a_1-a_2)}{a_1+a_2}\right)-\varphi(e)\equiv\varphi'(e)\cdot\frac{2d(a_1-a_2)}{a_1+a_2} \tag{6}$$

valued at the additional transfer cost between type 2 agent and Supervisor. The gross gain for type 2 agent is rewritten as follows

$$U(a_1,e+\Delta e;2)-U(a_2,e;2)=F(a_1)-(B-e-\Delta e+d)a_1-[F(a_2)-(B-e+d)a_2]+E(a_1,a_2)$$
$$=[\ F(a_1)-F(a_2)\ ]-(B-e+d)(a_1-a_2)+\Delta e\cdot a_1+E(a_1,a_2) \qquad (7)$$

where $E(a_1,a_2)=E\cdot(a_1-a_2)$ according to the setting of (9) in the timing of the game

We relegated the logic of collusive behaviours and the careful derivation of (7) and the below constraint (8)to Appendix 1.

see Appendix 1

So, Coalition Incentive constraint is,

$$(1+\lambda c)\cdot[\varphi\left(e+\frac{2d(a_1-a_2)}{a_1+a_2}\right)-\varphi(e)]\geq U(a_1,e+\Delta e;2)-U(a_2,e;2) \qquad (8)$$

The interpretation of inequality (8) is as follows. When X=1, the bad type agent 2 can collude with the supervisor and collusively misreport $\hat{X}=-1$. The gain for the inefficient type 2 is the right hand side. The supervisor contracts the team cost norm C with the principal, so he must provide an extra effort. His extra cost must be compensated by the bad type agent 2, at least by the amount of the left hand side of (8). Hence, if the initial contract satisfies (8), it is not renegotiated,or 'credible' for the efficient type 1 and so, the allocation proposed through the initial contract becomes the final allocation.

Consider the collusion-free first best solution. If we introduce the possibility of collusion, the solution is not supported for a subset of parameters. In such a case, when the two agents are faced with the first best optimal allocation $\{a_1^{FB}, a_2^{FB}, e^{FB}\}$, the bad type agent wants to select the good contract. He and the supervisor can improve their welfare at the expence of the good type agent. The supervisor can get both the centralized transfer $\varphi(e^{FB})$ plus the decentralized transfers, which is the left hand side of the inequality (8), in this case the total surplus decreases. Hence, in the non- verifiable information case, in a subset of parameters,the principal gives up the first best solution because of the threat of collusion, and he contrives another device, one of which is the collusion-proof revelation mechanism.Needless to say, the supervisor, who has no private information about B, enjoys

no information rent resulting from it.
The principal's optimization problem is to choose a pair of $\{a_1, a_2, e\}$ in order to maximize the total surplus subject to the collusion- proof incentive constraint.

[Collusion-Proof problem]

$$\underset{\{a_1, a_2, e\}}{Max} \quad F(a_1)+F(a_2)-[(B-e)(a_1+a_2)+d(a_2-a_1)+\varphi(e)]+2\overline{E}$$

$$\text{s.t} \quad (1+\lambda c)\left[\varphi\left(e+\frac{2d(a_1-a_2)}{a_1+a_2}\right)-\varphi(e)\right] \geq U(a_1, e+\Delta e;2)-U(a_2, e;2)$$

Note that when X=1, in equilibrium $X=\hat{X}=1$, that is, the shared information among the remaining players except for the principal is induced truthfully. We can now describe the equilibrium collusion proof contract structure.

[Proposition 1]

For the solution to be collusion-proof, there exists $d_1>0$ and $d_2>d_1$ ($d_2<+\infty$) such that

(a) If $d<d_1$,flat and extreamly low-powered incentive schemes are optimal. Both agents choose an identical effort input. They are intermediate between the two levels of efforts that will prevail under complete information about X. In this case, strong cross subsidization occurs between two agents. This scheme implies ' pay equality' or pooling contract.

(b) If $d_1 \leq d<d_2$, the incentive contracts with wage spread or discriminatory incentive schemes (separating contracts) are optimally adopted. Since the threat of collusion is effectively costly, the principal removes the potential incentive to collude between supervisor and agent 2.As a result, the low-powered (but nonzero- powered) incentive schemes are implemented.

(c) If $d \geq d_2$, the threat of collusion is socially costless, i.e., the solution is given by the F.O.Cs(2)-(4). This is exactly the first best solution. $\{a_1^{FB}, a_2^{FB}, e^{FB}\}$

<u>**proof**</u>

Appendix 2

An interesting conclusion is that, for small d,(which means that two production teams are not so different) the stake in collusion : $U(a_1, e+\Delta e;2) - U(a_2, e;2)$ is not only reduced at the optimum but *totally disappears.*

The principal imposes the flat incentive scheme (pay equality). This is an extreme form of cross-subsidization among two agents, and every type is required to implement the same level of tasks (jobs) for the same wage.

The intuition for this result is as follows. The efficiency loss due to the inefficient job design is at most of the order of d(cost differential parameter) because the principal can adopt the flat wage scheme. This results exactly in the efficiency loss of order d.

Hence, a contract in which $a_1 - a_2$ is not of order at most d is suboptimal, because it involves a distortion relative to the full information first best case, and it does not converge to zero at rate d or faster.

Now, consider the collusion-incentive constraint (8). As a first order approximation, the left hand side is proportional to $(a_1 - a_2)\cdot d$, and the right hand side is of order($a_1 - a_2$), hence the constraint cannot be satisfied unless $a_1 = a_2 = a$, ie, flat incentive scheme or pay equality. In other words, in the collusion- proof problem, the principal can approximate the loss of order d to zero if pay equality (cross-subsidization) can be applied. In this case, it can be said that the cross-subsidization (implied by 'pay equality') can emerge as an optimal overall solution to the political (rent-seeking) activities of some agent in the team productive system. The conflict for the good task between two agents is optimally resolved by establishing a single incentive scheme: $a_1 = a_2 = a$ In this collusion-proof regime when d is (very) small, the cost induced by inefficient job design is very small, deviating little from the first best. While the benefit of the disappearance of the rent seeking activities (bribes) is large or discrete (in the first order). This is the theoretical intuition as to why the pooling contract is adopted.

For a large d, the supervisor's cost of lying is very large, and the inefficient type cannot compensate for his extra (non contractible) effort. So, the constraint (8) is satisfied by the first-best-solution in the case of $d \geq d_2 < +\infty$. In this case, the collusion- free first best solution is exactly collusion-proof.

For an intermediate d, the analysis is somewhat involved. This is due to the fact that lowering the effort spread $a_1 - a_2$ reduces the agent's stake, ie, coalition benefit(the tournament prize), but also the increase of the supervisory effort as the accompanying solution makes it more costly for supervisor to misreport,while *the value of informatio*n is relatively large . In this case, as a traditional contract design literature,the principal faces the trade- off between his temptation to set the high-powered incentive scheme and the cost of coalition incentive compatibility(the cost of the transmission of information). 2d is the difference of two type, and principal must consider the control cost of inefficient type agent's incentive. In our model,the principal adjust the good type's effort a_1 ,the bad type's effort a_2 and the supervisor's effort e so that the inefficient type coalition 2 will not mimic the efficient type 1. In this case, the source of inefficiency in the first-project: $E\cdot(a_1-a_2)$is reduced in equilibrium. The slope of the incentive scheme a_1-a_2 is small. The benefit of increased incentives is small compared to the cost of inefficient rent seeking. Not using of information is also inefficient, so the low- powered incentive scheme is adopted as an optimal solution. Though the theoretical intuition is the same between (a) and (b) in proposition 1, the main difference between them is the value of information to be used.

3.2 Equilibrium Collusion 1 : Allowing Vertical Collusion

We now investigate the possibility that it may be second best optimum to allow side-transfers (bribes) in equilibrium between two parties of an organization who "share" soft (unverifiable) information.

In this section, we assume that the top management allows two divisions to compete for a given prize$E\cdot(a_1-a_2)$. Then at the next section, we assume that two divisions bargain efficiently so that the competition (conflict) only defines the status quo of the bargaining game.

To see why allowing the side transfers (bribes) may be optimal, suppose that X=1, i.e., type 1 agent and supervisor can form a more efficient coalition than type 2 and supervisor, and suppose that there exists an job spread $(a_1>a_2)$. In this situation, type 2 agent is willing to pay the following value to the supervisor.

$$
\begin{aligned}
&U(a_1,e+\Delta e;2)-U(a_2,e;2)\\
&=F(a_1)-(B-e-\Delta e+d)\cdot a_1+E\cdot(a_1-a_2)-[F(a_2)-(B-e+d)\cdot a_2]\\
&=[F(a_1)-F(a_2)]-(B-e+d)\cdot(a_1-a_2)+\Delta e\cdot a_1+E\cdot(a_1-a_2)
\end{aligned}
$$

Let

$$\Delta \equiv \left[\frac{U(a_{1,}e+\Delta e;2)-U(a_{2,}e;2)}{1+\lambda c}\right]-\left[\varphi\left(e+\frac{2d(a_1-a_2)}{a_1+a_2}\right)-\varphi(e)\right] \tag{9}$$

denote the side payment (bribe) that the supervisor must receive from the type 1 (good) agent, to tell the truth about X if coalition incentive constraint (8) is not satisfied,and the slack Δ >0 exists.

Note that Δ is the net benefit which the type 2 agent obtains from the collusion with the supervisor. If $\Delta \leq 0$, such an initial incentive scheme $\{a_1, a_2, e\}$ is exactly "collusion proof" in an organization consisting of supervisor and two agents[18] . It $\Delta > 0$, the efficient type agent must counter offers against agent 2's offer, ie, *his "political activities(rent- seeking activities)"* in the ex ante stage(the side contracting game), so as not for the supervisor to misreport the information discretionarily and collusively with the rival agent 2.

It is in the interest of type 1 agent to collude with(bribe)the supervisor to tell the truth X=1 if and only if

$$U(a_1, e;1) - U(a_2, e+\Delta e;1) \geq (1+\lambda_c)\cdot\Delta \tag{10}$$

λ_c is the marginal transfer cost from agent to supervisor. The first term of the left hand is the gain he gets when he is assigned to the good task: and the second term is the gain he gets when he is deprived of the good task .Hence, the difference is the net benefit which good type 1 gains from the truth reporting. The right hand is the cost which is required to let the supervisor (coordinator) report the truth when the rival agent tries to collude with the supervisor. Note that, after all, $U(a_1, e;1) - U(a_2, e+\Delta e;1) = U(a_{1,}e+\Delta e;2)-U(a_{2,}e;2)$ is satisfied.Hence,the relative gain of the good task to the bad task is the same for both types. (i=1,2)

Using this fact, (10) means from (9) the following inequality.

$$\varphi\left(e+\frac{2d(a_1-a_2)}{a_1+a_2}\right)-\varphi(e)\geq 0 \tag{11}$$

---

[18] This implies that the principal proposes an allocation belonging to the 'core' in the organization of the supervisor and two agents.

Note that for $a_1 > a_2$, (11) is always satisfied. So, full separation is feasible even for a small positive d. However,in equilibrium,there is a cost associated with having type 1 agent transfer the amount of Δ to the supervisor, equal to $\lambda_c \Delta$. This can be called the cost of collusion and hidden gaming.[19]

Thus, there exists a dead weight cost in relaxing the collusion-proofness constraint[20], thereby having the type 1 agent bribe the supervisor and creating costly side transfers in the ex ante stage. The organization takes this dead weight cost on the equilibrium path in this equilibrium collusion regime, but this type of cost does not exist in the collusion- proof regime mentioned above. As for the ex ante incentives,we are envisoning the equilibrium outcome in the competition between two heterogeneous agents in an auction before signing the vertical side contract with the supervisor. The supervisor reports the $\hat{X}$ which is favourable to the highest bidder in the auction (the winner in the rent -seeking competition), where the bid of the inefficient agent is always deflated by the extra disutility of effort engendered by lying collusively with the supervisor.(This corresponds to the shaded area in Figure 2).

Though the principal must choose one of these two regimes.Before that, we will distinguish these two regimes by means of the sign of Δ. Δ ,defined in equation (9), is the net benefit the bad agent can obtain when he is assigned to the good task.This has a function as the source that induces the rent seeking competition in the ex ante stage. If $\Delta \leq 0$, we can consider such a regime as "no-side-transfer regime". If $\Delta > 0$, we can consider such regime as the "side-transfer-regime".[21]

The supervisor and the efficient type agent forms a more efficient joint production team than the other one. The cost differential (technological asymmetry) between two teams

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[19] We present the following interpretation. The good agent must overcome the incentive for the bad agent to collude with the supervisor, by exerting the rent seeking investment in the ex ante stage,and then the rent seeking by the bad(rival) agent is done in a hidden fashion(unobservably to the good agent).In such situations,the good agent is forced to invest in the ex ante rent seeking in the amount of Δ in order to get the good task intended for him ,accompanied by the dead weight cost mentioned above.

[20] Theoretically,it is equivalent to adding the slack to the collusion proof incentive constraint of the supervisor and the bad agent.

[21] The readers who are familiar with the literatures on the 'Tournament',will recognize that the former can be viewed as the 'non-tournament' regime,and the latter as the ' tournament'one,in the sense that the positive incentives are induced on the equilibrium path in the ex ante stage.

is (B-e+d)-(B-e-d)=2d.[22] One type of these two kinds of systems corresponds to $\Delta > 0$. Theoretically,it is equivalent that there is no collusion-proof constraint in such a regime. We understand the following trade offs. In the ex ante side contracting stage,the collusion-cost, ie the cost of collusion and hidden gaming is increased, but a better ex post incentive scheme is possible with full separation of two types.This is *the trade- off between the ex ante incentive cost and ex post benefit.*

Let us consider this regime further. The principal (center) allows the equilibrium vertical side-contract between supervisor and agent one. This implies that the principal substantially allows the supervisor's discretionary power in equilibrium, and 'really' uses his report on the 'type'information . The principal publicly announces an allocation to the supervisor and two agents through the initial contract. The supervisor as a delegated referee auctionize the two contracts intended for them. Then, the two agents are engaged in the sealed bid auction (make the side contract proposal to the supervisor simultaneously). The bad type 2's bid induced on the equilibrium path is,then,

$$\Delta \equiv \left[\frac{U(a_1, e+\Delta e;2) - U(a_2, e;2)}{1+\lambda c}\right] - [\varphi\left(e + \frac{2d\cdot(a_1 - a_2)}{a_1 + a_2}\right) - \varphi(e)]$$

The interpretation is as follows. The first term is the "carrot"(gross prize) when he wins the auction in the ex ante stage, and the second is the compensation for the supervisor's extra effort, which is not compensated by the principal.As analyzed above,the bid by the efficient type will be more than the bid by the inefficient one. (If we envision the second price auction ,the good agent bids his net valuation to the good task in the equilibrium[23] .)

Since the supervisor is delegated the substantial responsibility of recommendation of two agents to each task in this regime, the supervisor as a strategic coordinator lets them

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[22] Such consideration is important when we consider the Japanese joint production system. For example, in the Japanese subcontracting system, the principal delegates the responsibility of supplier selection to the "planning and coordination section". Japanese product development organizations can also be viewed as a similar system.

[23] We consider the pair of net variations are bidden on the equilibrium path,and the valuation of the bad type are paid by the good agent.We can consider the several games that brings about such outcomes in equilibrium.Examples are iterative elimination of weakly dominated strategies in the second price auction,a Nash equilibrium in the second price auction ,and an extensive form bargaining game of the alternative offers by the supervisor and two agents presented in the appendix 3

compete for good task a_1. This logic includes the flavour of rank-order-tournament in the ex ante stage.

In equilibrium of this regime, the efficient type always wins and sends Δ to the supervisor, after the supervisor reports the truth:X= $\hat{X}$ =1 to the principal and he is really offered a good task. a_1.The equilibrium transfer payment recieved by the supervisor is the sum of the payments both from the principal and from the good agent.It is as follows.

$$T = \varphi(e^*) + \left[\frac{U(a_1, e+\Delta e; 2) - U(a_2, e; 2)}{1+\lambda c}\right] - [\varphi\left(e + \frac{2d(a_1 - a_2)}{a_1 + a_2}\right) - \varphi(e)] \qquad (12)$$

In summary, the supervisor (referee) has two gains from the equilibrium vertical collusion regime. The remarkable point is that we rule out the possibility that the supervisor's report (judgement) must be incentive compatible (self- enforcing) after recieving the side payment from the agent. In other words, we rule out the ex post opportunism by the supervisor through his reporting, and allow the binding (vertical) contract [24]. Thus, in our model, the(vertical) side-contract has an implementability, or binding, and so the soft (unverifiable) information affects the equilibrium allocation .

Now we formulate this regime. In this equilibrium vertical collusion regime, there is no collusion-proofness constraint, i.e, in equilibrium, collusion or recontracting occurs between the vertical parties. Since the principal takes into account the side transfer cost or the cost of side contract negotiations $\lambda_C \Delta$, his problem is as follows.

[Equilibrium Vertical Collusion Problem]

$$\max_{\{a_1, a_2, e\}} F(a_1) + F(a_2) - [(B-e)(a_1 + a_2) + d(a_2 - a_1) + \varphi(e)] + 2\bar{E}$$

$$-\lambda c\left[\left[\frac{U(a_1, e+\Delta e; 2) - U(a_2, e; 2)}{1+\lambda c}\right] - \left[\varphi\left(e + \frac{2d(a_1 - a_2)}{a_1 + a_2}\right) - \varphi(e)\right]\right]$$

subject.to $\quad \Delta \geq 0$

---

[24] This is an important assumption in the standard 'collusion' literatures ,which follows the model of Tirole(1986,1992)and ,at the same time, one implicit assumption of the standard cooperative games.

The last term is the equilibrium side payment (bribe)in the interim renegotiation game (resource loss from the side contract). The size takes into account the reduction in the center's transfer to the supervisor in amount equal to the side payment he receives from his agent. This is the source of inefficiency in this regime. Since there is nothing like this in the 1-best contract, we see that this regime cannot exactly achieve the first best efficiency.

The principal offers the initial contract which has the target level of the input pair$\{a_1, a_2, e\}$, and let the supervisor and two agents renegotiate at the ex ante side-contracting stage. The principal always induces true information X=1, but the cost of control loss or the cost of the ex ante bargaining must be taken into account .This is the very source of inefficiency, and so the principal mitigates this through marginally adjusting the target level of jobs$\{a_1, a_2, e\}$.

The first order conditions (the marginal conditions) for the optimal incentive scheme are

$$F'(a_1) - (\mathrm{B} - \mathrm{e} - \mathrm{d}) = \frac{\lambda c}{1+\lambda c}\frac{\partial \Delta}{\partial a_1} \tag{13}$$

$$F'(a_2) - (\mathrm{B} - \mathrm{e} + \mathrm{d}) = \frac{\lambda c}{1+\lambda c}\frac{\partial \Delta}{\partial a_2} \tag{14}$$

$$\varphi'(e) = (a_1 + a_2) - \frac{\lambda c}{1+\lambda c}\frac{\partial \Delta}{\partial e} \tag{15}$$

where,

$$\frac{\partial \Delta}{\partial a_1} = F'(a_1) - (\mathrm{B} - e - \Delta e + d) + \frac{\partial \Delta}{\partial a_1} a_1 + \mathrm{E} - (1+\lambda c)\varphi'(e+\Delta e)\frac{\partial \Delta e}{\partial a_1}$$

$$\frac{\partial \Delta}{\partial a_2} = -F'(a_2) + (\mathrm{B} - e + d) + \frac{\partial \Delta}{\partial a_2} a_2 - \mathrm{E} - (1+\lambda_c)\varphi'(e+\Delta e)\frac{\partial \Delta e}{\partial a_2}$$

$$\frac{\partial \Delta}{\partial e} = a_1 - a_2 - (1+\lambda c)[\varphi'(e+\Delta e) - \varphi'(e)]$$

and

$$\frac{\partial \Delta e}{\partial a_1} = \frac{4da_2}{(a_1+a_2)^2} > 0$$

$$\frac{\partial \Delta e}{\partial a_2} = \frac{-4da_1}{(a_1+a_2)^2} < 0$$

These conditions are intuitive.(13) and (14) mean that the marginal profits of the efforts a_1 and a_2 equal to the marginal cost increase of collusion and hidden renegotiation game. Similarly, (15) means that the marginal cost of the supervisor's effort equals the marginal cost reduction plus marginal reduction of the control-loss-cost.

This regime resembles the tournament in its game structure. In this regime, the rent-seeking activities are induced on the equilibrium path, but it results in the dead weight loss in terms of the whole organization. Hence, as a second best mechanism, the underprovision of incentives will occur[25]. In summary,

[Proposition 2]

(a) The marginal property of the optimal contract without a collusion- proof constraint(the optimal initial contract with equilibrium vertical side contract) is ,as a whole, characterized by(13)-(15)

Suppose that the condition of lemma 1 is satisfied.Then,

(b)For the most part of the set of the exogenous parameters (λ, d, E),the *low powered but separating incentive schemes* are optimal.This reflects the basic trade off between the ex post incentives (surplus)and the ex ante incentive cost.

(c)For some parameters of$\{\lambda_c, d, E\}$,the pooling contract is still a solution to the equilibrium collusion problem.

The proof is done by the same procedure as the alternative proof of proposition 1 and so is omitted.The intuition of (b)and (c)is as follows. If the incentive spread $a_1 - a_2$ is purturbed around $a_1 - a_2 = 0$,the positive marginal surplus from the main contract is induced by the amount of the value of the information:d.However ,the *incentive cost* (dead weight cost) is also induced by the amount of $\frac{\lambda_c}{1+\lambda_c}E$.If the former is larger than the latter ,the internal (separating)solution is optimally chosen.In the opposite case,the pooling (corner)solution is chosen.The latter case is noticeable,but the F.O.Cs(13)-(15)are simultaneously satisfied at the pooling solutlon : $a_1 = a_2 = a, \varphi'(e) = 2a$ only for the more

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[25] Two remarks should follow this.One is that this marginal property depends upon the size of the negative externality,and the other is that the standard 'Tournament' literature,Nalebuff -Stiglitz(1983) shows that the under provision of the optimal incentiveswill occur due to the trade off between incentive and risks.

restricted parameters.

3.3 Equilibrium Collusion 2 : Lateral Collusion among Agents.

Until now, we investigated the "vertical collusion" between supervisor and agent. In this section, we consider the "lateral" collusion among heterogeneous agents. The problem is whether the cooperation (collusive behaviour) among agents can improve the overall efficiency. In this regime, the two agents share the private information which the principal does not have. One of them is the state of nature X, and the other is the action (bid) pairs (Δ_1, Δ_2), which is the outcome[25] of second price auction among the supervisor and two agents. Since two agents can substantially monitor (observe) the process of each other's bidding, we should consider the side contracting among them. In other words, we can distinguish the hierarcy (especially, the two equilibrium collusion regimes) by the degree of information sharing between two agents. In this equilibrium with lateral collusion, the information flow on their actions between two competing agents is introduced, while in the vertical collusion, we implicitly assume the exclusive information[26] on actions (rent-seeking activities). Information Sharing (Action Observability) affects the incentives of agents because it affects the distribution conditions of the surplus at the side contract negotiations.

Now, we consider the following timing in this indirect mechanism. After the principal offers the initial contract and precommits himself to it, but before signing the vertical side contracting between the supervisor and each agent, in other words, in the first half of the stage (4) two agents negotiate over a collusive agreement among them. We assume that the negotiation among agents is described by the Nash bargaining.

The threat point (status quo) of the bargaining game among them is

$$(\overline{U}_1, \overline{U}_2) = (U(a_1, e;1) - (1+\lambda c)\Delta, U(a_2, e;2))$$

This is a unique Nash (dominant strategy) equilibrium payoff allocation in the

[25] In this case,we imagine the setting that the agents can re- offer their bids after observing the bids in the first round,but before the final reporting of the type information by the supervisor.

[26] It implies that the bid (ex ante rent- seeking for the good task)is observable only between the supervisor and the agent who is making the action.In other words, the supervisor does not tell or does not have the time and means to tell the rival agent the process of the rentseeking behaviour.

absence of collusive agreement among agents, in other words, the equilibrium payoff allocation which two agents can get in the equilibrium collusion regime between Supervisor and the efficient agent. On the other hand,the collusive surplus is $(1+\lambda_c)\,\Delta$, because the sum of the payoffs of the two agents is $U(a_1,e;1)+U(a_2e;2)$ in the case of agent cooperation. This is due to the fact that two agents can increase the sum of their payoffs by stopping (the ex ante rent- seeking)competition. Now the two agents can mutually observe the bids by them as well as the type information, and so, they can sign the agreement contingent on their bids (actions) and the type information observable among them.Hence, the problem facing a group of collusive agents is to decide the selection of a sole bidder and the appropriate side payments among them. In this game, the sole bidder is the efficient type agent one, because it maximizes the collusive surplus. The side payment from the efficient agent to the inefficient one is determined by the following Nash bargaining solution.

Agents 1 and 2 can get the following payoffs U_1^* and U_2^* as a Nash bargaining solution.

$$\left(U_1^*,U_2^*\right)=\text{argmax}\{U_1-[\;U(a_1,e;1)-(1+\lambda c)\Delta\,]\}\{U_2-\;U(a_2,e;2)\;\}$$
$$U_1\geq\overline{U}_1,U_2\geq\overline{U}_2$$
$$\text{s.t}\;\;U_2=\frac{1}{1+\lambda c}\left[U_1-U(a_1e;1)\right]+U(a_2,e;2)$$

The Nash solution is as follows from the simple calculation.

$$U_1^*=U(a_1,e;1)-\frac{1}{2}(1+\lambda c)\Delta$$
$$U_2^*=U(a_2,e;2)+\frac{1}{2}\Delta$$

Thus, the side payment from the efficient agent to the inefficient agent under the agents side contracting is $\xi^*=\frac{1}{2}(1+\lambda c)\Delta$.

In the equilibrium, the sum of agents payoffs is

$$U(a_1,e;1)+U(a_2,e;2)-\frac{\lambda c}{2}\Delta$$

Hence, the dead weight cost of the amount of $\frac{\lambda c}{2}\Delta$ occurs.This is illustrated in Figure5.

However, the dead weight cost in this regime becomes one- half of the "vertical" equilibrium collusion case, we obtain the following proposition.

[Proposition 3]

Under the conditions where (i) side payment is socially costly $\lambda c > 0$ and (ii) two agents can mutually observe (or monitor) each other's bid and so coordinate their choice of bids and side payments among them, *the equilibrium with lateral side contracting improves the overall efficiency as a second best mechanism* relative to the equilibrium with the supervisor-efficient agent "vertical" collusion.

Next, we consider the implication of lateral side contracting among agents. In the "vertical" equilibrium collusion, two agents compete for the favorable supervisory report and the winner at the competition (auction) get the good task. In the "lateral" equilibrium collusion, however, two agents cooperate with regard to the task assignment. Though the principal loses control over the agent's task allocation in both regimes, in the "lateral" collusion the principal delegates the authority of task assignment to the agents. And the dead weight cost of contracting or the control loss cost is reduced by one- half of that in the "vertical" equilibrium collusion regime. Therefore, when $\lambda c > 0$, the second best mechanism is either the collusion-proof mechanism or "lateral" equilibrium collusion, not "vertical" collusion.

We can interpret these two equilibrium collusion regimes as follows.In the vertical collusion regime, two divisions compete for the good task in the ex ante stage,because it brings about the additional prize to the party(division)who was assigned to the good task in the first period.This leads to the ex ante inefficient rent- seeking and as a result the cost of bargaining.For example,imagine that divisional managers tempt the supervisor (product manager) by playing golf which wastes "time" and "money".This implies the cost of the conflict between two divisions.On the other hand,the lateral collusion can be understood as a cooperation among two divisions.In this case,side payments may be interpreted,for example,as an invitation of the rival manager to drinking and food,which are less expensive than the vertical collusion case.In good performance firms, divisions communicate mutually and coordinate their actions based on their shared information.This would result in less cost (inefficiency)for the firms,giving the firm a competitive advantage.

4. Comparison of organizational forms* : The Solution to the overall problem.

Mitigating competition (conflict of interests) among the agents (units, plants, divisions) is a key function that is common in the efficient contract proposed in 3.1 and 3.2 (and 3.3). However, it is useful to identify the situations under which one incentive scheme is more variable than the other.

Given the values of parameters E, d and λc, the principal computes the efficiency of two(or three) regimes. He is a Stackergerg leader,and is fully commited to the initial contract. He faces the trade- off between the ex ante incentives leading to the dead weight cost and the ex post incentives when designing the initial contract. He does not know which state has realized, cannot prohibit the ex ante conflict between two agents,and so must mitigate the ex ante competing behaviour indirectly,using the ex ante contract. This may result in the non-attainability of the first best efficiency.

If he selects the delegation of the'real' responsibility of selection of two agents to the supervisor, it implies that the supervisor is appointed to the referee of the competition of two agents. His instrument is an unverifiable judge or report, and we let $\hat{X} = \{1, -1\}$.In other words, "Which is the efficient agent?". Given the compensation schemes designed by principal at the time when he selects the equilibrium collusion regime, the supervisor lets two agents play the 2 - price auction[27] game for his favorable reports.In second price auctions, the highest bidder wins and pays the second highest bid. The auction between the two results in the following outcome $\left(\Delta + \left[\varphi(e+\Delta e) - \varphi(e)\right], \Delta\right)$ if the agent 1 is the efficient type. Here, Δ is the inefficient agent's bid approximately equal to the following value.

$$\Delta \cong \left[\frac{U\left(a_1^{EC}, e^{EC} + \Delta e; 2\right) - U\left(a_2^{EC}, e^{EC}; 2\right)}{1+\lambda_c}\right] - \left[\varphi'\left(e^{EC}\right)\left(\frac{2d \cdot \left(a_1^{EC} - a_2^{EC}\right)}{a_1 + a_2}\right)\right]$$

In this no uncertainty case, the true information is revealed. Then, the supervisor (delegated referee) reports the winner in the competition and the principal selects him as an efficient agent and assigns the good task. As mentioned above, supervisor's report : $\hat{X} = X$ is assumed to be incentive compatible[28]. According to the task assignment,the efficient product

* Aoki.M states that the *comparative institutional analysis (C.I.A)*investigates this problem explicitly.

[27] In the appendix 3,the other extensive form game ,the outcome of which will be the same as the one of the second price auction in the unique equilibrium ,is contrived.

[28] As far as the 'vertical' collusion *after the ex ante competition* is concerned,this assumption is supported by the many published papers.See,for example, Kofman-Lawaree(1993).

team and inefficient one are formed. Expecting this renegotiation game,the principal solves the Equilibrium collusion regime problem at the beginning of the game, and the solution is $\left(a_1^{EC}, a_2^{EC}, e^{EC}\right)$ in the above equation.

These are (secretly) renegotiated by the supervisor and 2 agents. Usually, in rank-order-tournament literatures, λc= 0 is assumed. However,in our model, "the delegated decision of the task assignment problem" has a cost of λcΔ, which implies in its essense *the cost of control = loss, or cost of collusion and hidden gaming.* In other words, this is *a cost of inefficient rent seeking (conflict of interests) which occurrs in the ex ante stage.*[29]

If the principal (center) selects the centralized transfer regime(collusion proof regime), he does not effectively use the supervisory 'report' or' message' ($\hat{X}$), but let two agents *directly reveal his type subject to the collusion proof constraint.* Hence, the principal substantially lets two agents reveal their information *without supervisory discretion.*

The principal compares the efficiency of these regimes given E,λc and d, and selects the regime which gives the higher efficiency.The following is a partial characterization of the overall problem.

Note that λc means the marginal dead weight cost by the ex ante investment.So, <u>when λc is close to zero</u>, the principal (center) can reach the collusion-free first best welfare approximately, while he cannot do so in the collusion- proof problem ,due to the cost of the incentive constraint. Hence, the equilibrium collusion regime is optimal.

Fixing λc > 0, when d tends to zero, the no side-transfer(collusion proof) regime is optimal. In this case ($d \to 0$), we know that <u>the flat incentive scheme (pay equality)</u> is applied as the solution. We can interpret this case as an extreme form of cross-subsidization.[30] This result has been obtained <u>from the collusion- proof problem</u> .To show the theoretical intuition of this result, it suffices to take the derivative of the constrained problem, with respect to a_1 and a_2 and note that the power of the incentive scheme $a_1 - a_2$ becomes negative $(a_1 < a_2)$ when d tends to 0^+, while $a_1 \geq a_2$ for the global incentive constraint (8)to be relevant.That is, as d tends to 0,*the reversal of the virtual cost*[31] between the two agents occurs.Only for the

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[29] Since this cost can viewed as the ex ante inefficiency in the incomplete contract situations,this is the same setting as the 'hold ups' literatures.See,Milgrom-Roberts(1992),for an integrated discussion of hold ups and such 'influence costs'(ex ante overinvestments).

[30] This may be viewed as an 'equalitarianism'or'egalitarianism' sulution to the problem.

[31] This is a concept of the mechanism design literature.Tirole(1986)Laffont-Tirole(1990,91)and Dourough-Stoughton(1989) used this concept in the analysis, but they do not derive *the reversal phenomena of the virtual cost*.

pooling solution $a_1 = a_2 = a$,both the local and the global incentive constraints are satisfied.

The pooling solution can be obtained also from the equilibrium collusion problem. Choosing the effort spread $a_1 - a_2$positive and of order d yields *the two gains that are small order* in d : the cost reduction of the team production: $d(a_1 - a_2)$and the increase of the cost for the supervisor of misreporting,which is approximately $\simeq\varphi'(e)\frac{2d(a_1 - a_2)}{a_1 + a_2}$.This also induces the benefit because it makes the collusion difficult to form.These are *the indirect effects* through the change of the incentive schemes $\{a_1, a_2, e\}$. While, this effort spread: $a_1 - a_2$ imposes *a first-order-loss* $\lambda_c E(a_1 - a_2)/1 + \lambda_c$ in the ex ante stage due to an inefficient side-transfer (rent seeking), and the term gives to the overall efficiency the negative effect *discretely* ,which dominates the the *marginal* increase of the ex post benefit.Oppositely, when λ_c is close to zero and d is discretely positive, the *discrete* increase of the ex post benefit from the positive incentive scheme dominates the *marginal* increase of the negative effect by the ex ante incentive.The point is as follows.When λc >0,the dead weight cost by the ex ante incentive is *discrete at* $a_1 - a_2 = 0$.Concretely,the discrete kink,the size of which is $\lambda_c/1 + \lambda_c\ E$,occurs at $a_1 - a_2 = 0$.The linearity assumption on $E(\cdot)$(and so $E'(0) = E > 0$) plays an crucial role.While the net benefit function is *concave* in $a_1 - a_2$.So,the marginal increase of $a_1 - a_2$ generates the positive indirect (marginal) effect, consisting of the above two terms.So,if the positive indirect effect is dominated by the negative direct effect at $a_1 - a_2 = 0$,the pooling solution is optimally chosen.

Remark

In the usual rank-order-tournament framework, when two type agents are almost equal type, a wage spread occurs. (See, Lazear (1989)) In our model, in the case of d $\rightarrow$ 0,however, wage compression or a flat wage is better. If the principal aims at first-best, he falls into the third-best efficiency, because the discrete threat of collusion is larger than the marginal efficiency induced by the high-powered scheme. So, he gives up 'exactly' inducing true type information, and rather lets the *two types be fully pooled.*

We present the following proposition. The optimal contract can be divided according to the values of λc, E and d,though it is characterized only partially.

[Proposition 4] Assume that λc >0.

(a) When λc is close to 0, it is totally optimal (efficient) to practice the discriminatory incentive scheme and let the more efficient agent give to the supervisor the sidepayment. (side-transfer occurs in equilibrium). This implies that allowing collusion ex post is optimal. The incentive schemes applied are approximately the first best ones.

(b.1) If we allow the *agents side contracting*, the second best efficiency can be enhanced *discretely* more than in case (a). *The "vertical" collusion cannot be optimal.*

(b.2) When the collusion- proof incentive scheme dominates over the equilibrium vertical collusion scheme in terms of the attainable efficiency, a reversal of the efficiency can occur *if the lateral collusion can be adopted (e.g. through the sharing of action information in the ex ante stage).* The Lateral equilibrium collusion can be the second best regime.

(c.1) When d is small, the flat wage scheme (pay equality) and the absence of side transfers are optimal. In this case, the principal prevents two agents from competing for good rank job , a_1, and lets the two types be fully pooled. The principal chooses a pooling schedule as a second best mechanism.

(c.2)The pooling solution can be obtained from both the collusion- proof problem and the equilibrium collusion problem under certain conditions.

These conclusions are both striking. Particularly, in part (a), equilibrium secondary transfers (ex ante overinvestment, "side-contracting in equilibrium") may arise. This implies that the center (principal) delegates the responsibility of selection of the agents effectively.One agent is then used as a competing force (rival) to the other agent. This is possible because the supervisor is the common factor of production and he is 'formally' given the authority of selection of them. *In the latter, the equivalence principle (1986) does not hold.*

As for (b.2), the ex ante inefficiency (rent- seeking activity) is reduced by half, *not marginally.* This result is analytically clear, but there is a large difference in *the amount of the* *shared information* between the two equilibrium collusion regimes. In the lateral collusion, *the observability in detail about each other's action (cheating behaviour from the lateral collusive agreement) plays a crucial role.* However, this is equivalent to adding a different source (factor) to the vertical collusion regime, in the sense that not only the incentive scheme but also the information structure induces the higher efficiency (surplus) discretely. This is a new theoretical point in these collusion models with incomplete contracting.

In (c.2),we obtained the interesting result that the 'egalitarianism'(pooling)can be derived as an optimal solution of each of two regimes . This is an important result.

1. We remark here the interpretation of the results in terms of the organization structure. We can interpret the collusion - proof - regime as *the centralized firm*, where the center(principal) allocates effectively the tasks to the divisions. Similarly, we can interpret the lateral equilibrium collusion as *the decentralized firm*, where two divisions negotiate efficiently about the task assignment and the side payment among them.

2. As for the theoretical remark, we can refer to the relation with *the solution concept of the Cooperative Games.* In the collusion proof solution, the initial allocation publicly proposed by the collusion proof mechanism belongs to the core and the stable set. of the economy consisting of the supervisor and two agents. In the equilibrium (vertical and lateral) collusion regime, the initial allocation does not belong to the core and the stable set, because the allocation (secretly)proposed among the supervisor - Agent 2 coalition dominates it among them. The side transfer proposal by agent 2 can be viewed as *the objection*[32] by him to the initial allocation. The final allocations in the equilibrium collusion regimes belong to the core[33] and the stable set. This case corresponds to the situation where parties announce their objections to each other, and as a result, they reach a stable bargaining outcome.

3.One more important remark is as follows.Indeed,this paper investigates the solution

[32] This can be also interpreted as the 'voice'of Hirshman(1970)

[33] This depends upon the conjecture that the increase of the degree of the information sharing extends the set of the allocations belonging to the core. In the 'lateral 'collusion regime,the collusive agreement is not deterred by *any deviation* by the bad agent from it.,because the the cheating behaviour from the agreement is always detected and deterred by the good agent. This shares the same theoretical intuition as the" ε-preemption"in the theoretical I.O fields.

or the mitigation of the inefficiency originating in the strong (negative)externality in organizations,which is considered as a task assignment problem in the model.In the context, the *lateral collusion* can be viewed as the solution of the externality problem through the negotiation among the agents.The rent- seeking or the ex ante investment or the bid[34] by the bad type agent is generated out of his *right* to do so.So,the joint action in the lateral collusion can be interpreted as *the good type agent's having bought the control right of the bad type to declare the voice and the objection at the price of the side payment(the compensation)* .This procedure increases not only their joint payoffs,but also the total surplus.

5. Related papers in the fields of Authority Delegation and Renegotiation Design.

The motivation of this paper is in a sense the same as that of *the "Hold up" problem* in the incomplete contract situations. In the presence of "negative" externality, the agent can extract the future large rent (prize) from the rival agent in the fixed sum games, unless the rival invests more. This "indirect externality" was the very focus of both Williamson (1975,79) and Grossman-Hart (86). We have built this type of externality into this model as the source of the ex ante competing behaviour (conflict of interests). Hence, we can interpret our model as the mitigation by the uninformed principal of the overinvestment (hold-up) problem, through designing the ex ante (initial) contract and the interim renegotiation process. If we consider the ex ante inefficient rent seeking as *the organization failure*, which the principal can mitigate through the ex ante incentive contract depending upon the verifiable signals (e.g. y_1, y_2 and C) obtained ex post, our model is very much related to that of Hart -Moore (1988).

Next, the ex ante contract in each regime (Collusion - Proof solution, Equilibrium with vertical collusion and Equilibrium with lateral collusion) has the economic implication about the "real" authority delegation. In the collusion proof regime, the real authority over the solution of the task assignment problem is held by the principal. He decides really the human resource allocation problem, through imposing the collusion proof constraint. In the equilibrium vertical collusion regime, the real authority is held by the supervisor (intermediary). Hence, in such cases, the incentive to collude with supervisor and manipulate the information (or try to deter it) would be very strong. Finally, in the lateral collusion regime, the two agents jointly have the real authority over the solution of the task

[34] Only after the ex ante bargaining(only when the agent is determined to be the winner),the bid is sunk as a side payment in the vertical collusion.

assignment problem. They communicate, mutually understand each other, and decide the solution of the task assignment problem by mutual consent. In this case, the ex ante competing behaviour for the good task (inefficiency) is largely mitigated, leading to the good performance (competitiveness) of the firm. This interpretation implies *the efficient allocation of control rights over the problems* for improving the efficiency in organizations. This is the focus or essence of the paper of Grossman - Hart (1986).

Last, let us give the conjecture on the case where the third party (principal) can obtain no verifiable signals ex post. In these cases, the principal cannot offer an ex ante contract depending upon the ex post verifiable signals, and there will exist some Nash equilibria (self - enforcing contracts), where the agents would expenditure no rent seeking (unverifiable bids), in the ex ante stage, and there would exist multiple equilibria in the ex post incentives.However, there does not exist any assurance that the first best ex post incentive would be induced. If we change the setting of this model such that the supervisor can allocate his efforts between two agents, then the ex ante rent seeking behaviour for the coalition formation in the ex post stage would be overdone, and the ex post overincentives and a cost overrun would also occur. Though this is only conjecture and depends on the details of the modification, we can understand that this model has the same flavour as those of Grossman - Hart - Moore, in the sense that *the ex ante (initial) contract can partially alleviate these inefficiency (Hold up problems).*

6. Concluding Remarks

In this paper, we formulated a hierarchy in the form of the two - divisional firm consisting of two- productive teams as a four player game, and modeled a task design - task assignment process until the task implementation. We provided a partial characterization of an equilibrium of this four- player game,and showed which regime improves welfare between the collusion proof incentive scheme and the lateral collusion regime as a second best mechanism, under the assumption that(1) the principal faces a cost to intervene when he or she has less information than the supervisor and the two agents, and(2)the bargaining between the parties is costly. Also, this paper presents a new model on the structure of intra - bargaining firms, different from those of Aoki and Miyazaki.H, though challenging essentially the same kind of problems.

A few remarks should follow before closing this paper. First, as for the function $E(a_{1,}a_2) = E \cdot (a_1 - a_2)$which implies the additional prize obtaining from the good task in the first- project, this is just the source that generates the interaction between the profit functions of the two agents (divisions) and brings about the conflict of interests in the form of ex-ante rent seeking activities or demand competitions. In addition to it, the marginal property of E>0 for $a_1>0$ is the crucial factor that generates the pooling region in the collusion proof contracts. This type of externality can be endogenized in an alternative way, though we formulated it in the two- period two - project (basic and applied project)setting in this model. The problcm of the model can be viewed as an updated and improved version of the traditional decomposition and decentralization problem, by introducing information asymmetry and the possibility of manipulation of it by collusive behaviours. Recently, Aoki (1995) addressed the same kind of problem, but he does not consider the collusion problem and his model is a two - tier' team' model ,while this paper belongs to the contract theory with collusion.

Second, we assumed the complete substitutability between two tasks. If we introduce the complementarity between two tasks, the stake in collusion decreases and so the inefficiency also decreases.

Third, this is a "no grand contract" ,that is ,an incomplete contract model. If we allow the principal to directly contract with agent 1 and 2 without depending upon the 'report' or 'message'of the supervisor, this model becomes a fundamentally different one. Next, unlike Tirole, we also consider the 'lateral' collusion between Agent 1 and 2. In general, coalition incentive constraints can be very complex because they involve every possible coalition of agents. However, at first in our model, the possibility of communication[35] between Agents 1 and 2 is not considered, since the common supervisor and each agent form one productive team in the vertical relationship. Next, we allow the possibility of collusion between the two agents,in the stage before the side contracting offers by both agents to the supervisor. When the inefficient agent has an incentive to offer the side payments to the supervisor, it amounts to the side trade and the distribution problem of whether the efficient agent 1 gives the bribe to the inefficient agent 2 or to the supervisor, when side contracts can be written explicitly among them.

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[35] We consider the *direct* communication among agents and in the main text assume that, after that, they can make a binding commitment .We call this process *lateral collusion* and investigated how it enabled the efficiency improvement.This is substantially equivalent to the *lateral integration* of Grossman-Hart(1986).The author thinks that this in itself has an important implication in this kind of context.Furthur,even if we allow only the self - enforcing coordination among agents,the conclusion that the lateral collusion improves efficiency *discretely* is virtually valid if we note that the game structure in the model is the same as the Nash Bargaining problem (1953) and consider the same extensive form game as described in his paper.

Fourth,we suppose a complete (symmetric) information among supervisor and two agents. Now consider the case where only one agent knows the state of nature X. and suppose that only agent 2 knows that X = 1. In this case, I conjecture that the coalition interim inefficient outcome will occur in equilibrium. Agent 2 can offer the side contract proposal to agent 1, concealing his type, and he will get the good job. In this case, the person who has a private information has power. To eliminate this, we should investigate the side contract proposal and experimentation by the supervisor. He may be able to convert the situation into the symmetric one. In this case, the another role of supervisor will be important.If we assume that the agents privately know their own types ,they negotiate the collusive agreement under the asymmetric information.In such cases ,it is possible that the wrong vertical collusion would be stochastically formed in the ex post stage.Hence, the induced efficiency would be intermediate between the lateral and vertical collusion regime in this model.

In our model, side payment is costly and this is a cost of bargaining (side contract negotiation). As mentioned in the text, it is a key to the firm competitiveness to reduce such a cost. (For example, golf and wining and dining should be organized efficiently so as not to waste time and money.) If the efficient agent has equal bargaining power to the inefficient one, the side payment sent from the efficient agent to the inefficient agent is halved in equilibrium which will result in the discrete enhancement of the efficiency.This has an important implication also from the practical point of view.

Finally, a remark must be made about the side contract between the supervisor and the agent. Since this contract is usually nonenforceable, it must be self - enforcing. That is, for the most part of this paper, we assume that the parties can communicate with each other and can make a binding contract with regard to the outcome of the solution of the task assignment problem, that there exists some mechanism making the side contract self - enforcing. Making collusion endogenous in multi - period games in such multi - layer organizations is easy. If their relationship is repeated, their lateral collusion outcome is sustained in equilibrium by the threat of vertical collusion outcome, which is also sustained off the equilibrium path. It is natural because the game structure is a prisoner's dilemma game in the strong negative externality case.

[Appendix 1] : Two agents' Incentives and the possibility of Collusion when they consider the prize in the second period.

We investigate the incentive compatibility constraints of both agents : i = 1, 2. We assume the state of the world is X = 1, which implies that agent 1 is efficient (good) and agent 2 is inefficient(bad).

Now let a (+d) and a (-d) be the jobs (tasks) specified for the good type and bad type ,respectively. For simplicity, we will write a_1 and a_2 for a (+d) and a (-d), respectively. We define W (+d) and W (-d) similarly. In this model, we consider a principal operating in a competitive market with identical (more than two) firms before entering into the binding short- term relationship. So, in equilibrium, the principal gets no profit (more correctly ,the sum of the payoffs of the principal and the supervisor is zero) and two agents get total revenue minus supervisory wage, that is,

$W_1 = W(+d) = F(a_1) - D$

$W_2 = W(-d) = F(a_2) - D$

where $D = \frac{1}{2}W_s = \frac{1}{2}\varphi(e)$ is a lump sum transfer for the supervisor.[36]

First, we check the incentive of agent 2.

By construction, the gross utility when he is assigned to the top ranked job a_1 is in equilibrium $U(a_1, e+\Delta e; 2) = F(a_1) - (B - e - \Delta e + d)a_1 + \overline{E} + \frac{E}{2}(a_1 - a_2) - D$

and the utility when he is assigned to the bottom- ranked job a_2 is

$U(a_2, e; 2) = F(a_2) - (B - e + d)a_2 + \overline{E} - \frac{E}{2}(a_1 - a_2) - D.$

Thus, the difference (the prize gross of side transfer for the supervisor) is,

$$U(a_1, e+\Delta e; 2) - U(a_2, e; 2) = [F(a_1) - F(a_2)] - (B - e + d)(a_1 - a_2) + \Delta e \cdot a_1 + E(a_1, a_2)$$

$E(a_1, a_2)$ is assumed to be equivalent to $E\bullet(a_1 - a_2)$ and can be interpreted as follows. *Independent of d,* when an agent is assigned to the top - ranked task a_1, he can get the prize $E\bullet(a_1 - a_2)$ from the second period.[37] In such cases, inefficient type's (gross) gain is as mentioned above. Then,the Coalition Incentive constraint is,

$$U(a_1, e+\Delta e; 2) - U(a_2, e; 2) - (1+\lambda_c)[\varphi(e+\Delta e) - \varphi(e)] \leq 0$$

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[36] Some readers may have doubts about this "equal cost sharing" assumption. Even if we consider a cost - sharing such that $\gamma_1 \geq \frac{1}{2} \geq \gamma_2$, where γ_i, $i = 1,2$ represents the cost share of i, the essence of this paper does not change qualitatively.

[37] This is a source that generates the adverse -selection phenomenon (collusive moral hazard) in the model.

From the convexity of $\varphi(e)$, a sufficient condition for this inequality is as follows.

$$[\mathrm{F}(a_1)-\mathrm{F}(a_2)]-(\mathrm{B}-e+d)(a_1-a_2)+[a_1-(1+\lambda c)\phi'(e)]\Delta e+\mathrm{E}(a_1,a_2)\leq 0$$

[Lemma 1]

Suppose $E(a_1,a_2)=0$ for all $a\in$R+.Then, at the 1-best solution$(a_1^{FB},a_2^{FB},e^{FB})$, $\Delta(a_1^{FB},a_2^{FB},e^{FB})<0$.

where $\Delta \equiv U(a_1,e+\Delta e;2)-U(a_2,e;2)-(1+\lambda_c)[\varphi(e+\Delta e)-\varphi(e)]$

Proof.

At the best allocations $(a_1^{FB},a_2^{FB},e^{FB})$, local conditions (2)-(4) are satisfied.

At first, $F(a_1)-F(a_2)-(B-e+d)\cdot(a_1-a_2)$ is equal to $-d(a_1-a_2)$ from the figure in the back. So,the above equation is transformed as follows:

$$-d(a_1-a_2)+a_1\cdot\Delta e-(1+\lambda_c)\varphi'(e)\cdot\Delta e$$
$$=(a_1-a_2)\left[-d+\frac{2d\cdot a_1}{a_1+a_2}-(1+\lambda_c)\cdot 2d\right]<0$$

We used local conditions (4) in the calculation of the third term in the last bracket.

Q. E. D

In this case, the first best allocation can be always implemented because the inefficient type does not have an incentive to collude. The global incentive constraint is always strictly satisfied . Figures 1 and 2 in the back of this paper describe this statement.

We want to investigate the situations where both agents compete in the ex ante stage for the good task. So, we introduce a function E (a_1,a_2), which represents the externality in the 1st period, satisfying the following condition for a subset of parameters λc and d

$$-d(a_1-a_2)+[a_1-(1+\lambda c)(a_1+a_2)]\Delta e+\mathrm{E}(a_1,a_2)\geq 0 \Leftrightarrow \Delta(a_1^{FB},a_2^{FB},e^{FB})\geq 0$$

at $(a_1,a_2,e)=(a_1^{FB},a_2^{FB},e^{FB})$.

Notice that E(a_1,a_2)=E$\cdot$(a_1-a_2)and E'(a_1,a_2)=E, where E is a marginal prize(externality)

Then, the above condition is, $\mathrm{E}(a_1^F-a_2^F)\geq[(1+\lambda c)(a_1^F+a_2^F)-a_1^F]\cdot\Delta e\ +d(a_1-a_2)$.

Hence, we obtain lemma 2 .In such cases, at the first-best allocation, inefficient type agent 2 has an incentive to collude with the supervisor. In other words, the coalition proof constraint is not satisfied,and *the slack occurs.* (This condition plays a similar role in the paper of Aghion-Bolton (1992)).

We restrict our attention to the case where the above condition is satisfied at the first best, that is, the inefficient type 2 has an incentive to collude with the supervisor, considering the prize in the second period.

In this case, there are inefficiencies impossible to remove. The common prize or the promise of promotion strongly induces the agents' ex ante competing behaviour (from the firm's perspective), causing them to behave collusively with the supervisor.

Fix a given d, and let such d be d_2 which corresponds to d_2 in the following proposition 1. Then, define E_2 as the value of E at which CIC (8) becomes binding, that is $\Delta = 0$. First, in the main text we fix the E_2 as E, and shift the values of λc and d for the comparative statics.

The good type's global incentive constraint is consideredbelow.

Now, we introduce this prize function (the differential of the rent distribution in the ex post renegotiation game) into our model, that is, consider the two- period case explicitly, in order to make the analysis sensible and interesting. Notice that *only as a second best mechanism*, allowing collusion can be welfare - enhancing.

Appendix 2 : proof of proposition 1:Characterization of the Collusion Proof Schemes

Let K be the Kuhn -Tucker multiplier associated with the collusion-proof problem. The first-order condition for that problem for an interior solution is

$$(16): F'(a_1) - (B - e - d) = K\left[\frac{\partial\Delta}{\partial a_1}\right]$$

$$(17): F'(a_2) - (B - e + d) = K\left[\frac{\partial\Delta}{\partial a_2}\right]$$

$$(18): \varphi'(e) = (a_1 + a_2) - K\left[\frac{\partial\Delta}{\partial e}\right]$$

where $\Delta \equiv U(a_1, e + \Delta e; 2) - U(a_2, e; 2) - (1 + \lambda)[\varphi(e + \Delta e) - \varphi(e)]$

These local conditions are the ones that the collusion-proof solution must satisfy. These are familiar conditions that the values of marginal product of efforts equal those of control costs. But, these marginal conditions result in a non - standard result with regard to the compensation schemes.

If X is public(verifiable) information, then, the right hand is zero compulsorily by the principal Then, the first best allocation can be implemented. In our case, X is soft (non-verifiable) information,and so extra collusion incentive compatibility cost must be considered by the principal. The right hand side of (16) and (17) is the marginal cost resulting from the change of collusion incentive compatibility constraint. That is called the *control cost.* (18) is the local condition of the supervisor's cost - reducing effort. The second term on the right hand side is the extra cost suffered by the organization , so as to prevent the collusion. We here investigate the second best efficiency which this mechanism can reach, given that the principal selects the collusion-proof (deterring) mechanism, not the equilibrium collusion regime. Now, we progress the proof.

(a) Let us first assume that d (the size of type space) is small. We see that $(a_1 = a_2 = a, e, K)$ is satisfied if

$$(19): F'(a) = B - a$$

$$(20): \varphi'(e) = 2a$$

$$(21):\ K = \frac{2d}{\left[\frac{\partial\Delta}{\partial a_1} - \frac{\partial\Delta}{\partial a_2}\right]}$$

Now, note that {a and e} are independent of d. The proof that the flat incentive scheme is optimal proceeds in two steps. First, $a_1<a_2$ (which means that inefficient type 2's effort (at his job, task) is larger than efficient type 1's effort) is dominated by $a_1=a_2$ from the concavity of the total welfare function in a collusion-free regime. Further,the flat wage scheme(pay equality) is collusion-free. Thus, $a_1<a_2$ is dominated by $a_1 = a_2 = a$.

Second, for any $\varepsilon > 0$, there exists do >0, such that for any $d<d_0$, the optimal effort a_1 and a_2 satisfy max ($|a_1-a|$, $|a_2-a|$)< ε, where a is the solution to (19)and (20)and is the optimal effort for each type of agent dn=0. If this property were not satisfied, for some $\varepsilon > 0$, there would exist a sequence d $\rightarrow$ 0, with optimal effort (a_1^n ,a_2^n) such that for all n, max ($|a_1^n-a|$, $|a_2^n-a|$)> ε.Because in the absence of collusion, efforts must tend to a when d tends to zero, total welfare along this sequence would be bounded away from the collusion-free welfare (first-best efficiency). However,the difference between the collusion-free welfare and welfare obtained under a flat wage scheme tends to zero as d tends to zero. Hence, (a_1^n, a_2^n) must be strictly dominated by the flat wage scheme for large n. Because we above assume that (a_1^n, a_2^n) were optimum, this is a contradiction.

Lastly, now that we have established that a_1-a_2 tends to zero when d^n tends to zero, which implies that K tends to zero, i.e., the collusion incentive constraint tends to be non-binding, we can make a first-order Taylor expansion of the collusion incentive constraint. Using (18), the left hand side of the collusion incentive constraint is equal to

$$\varphi\left(e^{n}(d)+\frac{2d(a_1^n(d)-a_2^n(d))}{a_1^n(d)+a_2^n(d)}\right)-\varphi\left(e^{n}(d)\right)$$

$$=\varphi'\left(e^{n}(d)\right)\frac{2d(a_1^n(d)-a_2^n(d))}{a_1^n(d)+a_2^n(d)}+o\left(\frac{2d(a_1^n(d)-a_2^n(d))}{a_1^n(d)+a_2^n(d)}\right) \text{ to the first order,}$$

and the right hand side is equal to

$$U\left(a_1^n(d),e^n(d)+\Delta e;2\right)-U\left(a_2^n,e^n(d);2\right)$$

$$=F\left(a_1^n(d)\right)-F\left(a_2^n(d)\right)-\left(B-e^n(d)+d\right)\left(a_1^n(d)-a_2^n(a)\right)$$

$$+\frac{2d\left(a_1^n(d)-a_2^n(d)\right)}{a_1^n(d)+a_2^n(d)}a_1^n(d)+E\left(a_1^n(d)-a_2^n(d)\right)$$

$$=\left\{F'\left(a_2^n(d)\right)-\left(B-e^n(d)+d\right)\right\}\left(a_1^n(d)-a_2^n(d)\right)$$

$$+\frac{2d\left(a_1^n(d)-a_2^n(d)\right)}{a_1^n(d)+a_2^n(d)}a_1^n(d)+E\left(a_1^n(d)-a_2^n(d)\right)$$

$$+o\left(a_1^n(d)-a_2^n(d)\right) \text{ to the first order.}$$

Where an expression o (z) denote some function g (z) of Z such that $\lim_{z\to 0}\frac{g(z)}{Z}=0$.

Then, the collusion proof constraint is rewritten as follows,

$$\frac{2d(1+\lambda c)}{a_1^n(d)+a_2^n(d)}\left[\phi'\left(e^n(d)\right)+\frac{o\left(\frac{2d\left(a_1^n(d)-a_2^n(d)\right)}{a_1^n(d)+a_2^n(d)}\right)}{\frac{2d\left(a_1^n(d)-a_2^n(d)\right)}{a_1^n(d)+a_2^n(d)}}\right]$$

$$\geq F'\left(a_2^n(d)\right)-\left(B-e^n(d)+d\right)+\frac{2da_1^n(d)}{a_1^n(d)+a_2^n(d)}+E$$

$$+\frac{o\left(a_1^n(d)-a_2^n(d)\right)}{a_1^n(d)+a_2^n(d)}$$

Let d go to zero. Since $\lim_{d\to 0}\left(a_1^n(d)-a_2^n(d)\right)=0$

$$\lim_{d\to 0}\frac{2d\left(a_1^n(d)-a_2^n(d)\right)}{a_1^n(d)+a_2^n(d)}=0 \text{ and}$$

$$\lim_{d\to 0}\left(F'\left(a_2^n(d)\right)-\left(B-e^n(d)+d\right)\right)=F'(a)-(B-e)=0,$$

so, the inequality in the limit is,

$$\lim_{d\to 0}(\text{LHS})=0\geq E=\lim_{d\to 0}(\text{RHS})$$

This contradicts the assumption that $E'(a_1-a_2)$=E>0. (QED).

The pooling contract $\{a_1=a_2=a\}$ is not eliminated, for small d

(b) Consider the case in which the solution to (2)-(4)does not satisfy collusion incentive constraint (8)for any d (so that $d_2 = +\infty$). This solution is the second-best incentive scheme. We want to show that flat wage (pay equality) is not optimal for a large d. (We assume that B is large enough so that B-e-d does not become negative.) For this purpose, suppose that the flat incentive scheme :a is optimal. Now, Consider a small deviation around a flat wage $a_1 - a_2 = \varepsilon > 0$. The left hand side of (8)is equal to $(1+\lambda c)\varphi'(e)\cdot 2d\varepsilon/2a = 2(1+\lambda c)\cdot d\varepsilon$ to the first approximation, where use is made of (20). Similarly, the right hand of (8)is equal to

$$\frac{2da_1^n(d)}{a_1^n(d)+a_2^n(d)} + E + \frac{O(\varepsilon)}{\varepsilon} = d\left(1+\frac{\varepsilon}{a_1+a_2}\right) + E + \frac{O(\varepsilon)}{\varepsilon}.$$

Hence, for large enough d, (8)is satisfied for small amounts of the incentive spread. From the concavity of production function in the collusion-free case, a small amount of wage discrimination ; i. e, effort (Job) spread ,which we just saw is feasible, is preferable to flat wage.

Next consider the case in which there exists d's such that C. I. C (8)is not binding for the collusion free solution given by (2)-(4) Let d_2 denote the smallest such d. We claim that for $d = d_2 - \varepsilon$, (where ε is positive and small) wage spread occurs. (1-best solution is not possible).

We know that at d_2, CIC (8) is just binding.

Because φ is convex, one can increase e to e + δ, where δ is small such that

$$\varphi\left(e+\delta+\frac{2(d_2-\varepsilon)(a_1-a_2)}{a_1+a_2}\right) - \varphi(e+\delta) \cong \varphi\left(e+\frac{2d_2(a_1-a_2)}{a_1+a_2}\right) - \varphi(e).$$

Equation (8) is still satisfied for collusion- free first- best levels. a_1^{FB} and a_2^{FB} This fact implies that principal can obtain *almost* the collusion- free level of welfare when d is close to d_2, which obviously is impossible under a flat wage (pay equality), which implies $a_1 = a_2 = a$.

Next, we observe that if C. I. C (8) is satisfied for the collusion free levels and parameter d, it is also satisfied for the collusion- free levels and parameter d'>d. This means that the set of parameters for which the collusion-free solution obtains is indeed the open interval $[d_2, +\infty)$. That is, if two team's cost differential is spread over d_2, the principal offers the first-best highest- powered scheme without being worried about the possibility of the collusive negotiation among subgroups.

Lastly, we want to show that there exists d_1 such that a flat wage (or $a_1 = a_2 = a$) obtains on $[0, d_1]$ and not elsewhere. To this end, note that the efficiency under a flat wage is independent of d. More generally, the envelop theorem shows that the derivative of the constrained total surplus function with respect to d is equal to

$$-(a_2 - a_1) + K(1+\lambda c)\varphi'\left(e + \frac{2d(a_1 - a_2)}{a_1 + a_2}\right)\frac{2(a_1 - a_2)}{a_1 + a_2} > 0$$

for the incentive spread. The first term means the direct cost reduction and the second term is the cost reduction of the collusion. (i. e, as d increases, collusion (recontracting) tends not to be formed). This is the benefit through the relaxation of CIC constraint. Hence, the region with wage differential (two ranked jobs among agents) and the binding collusion proof constraint is exactly an interval (d_1, d_2) from the above observation.
That is, the collusion-proof incentive scheme is characterized (Fig.3).

Alternative proof of proposition 1

The proof above explicitly shows that the assumption of $E'(a_1,a_2) = E > 0$ is the crucial factor. It should be noted here that we assume that the kuhn -Tucker condition is necessary and sufficient for a main contract to be a solution of the collusion proof regime. Once we assume this way, it is natural to analyze the Kuhn - Tucker condition (16), (17), (18) in order to derive the property of $a_1^n(d), a_2^n(d), e^n(d)$. Thereby, we can get an extra result.

Here, we present the strategy of proof.[38]

Assume that a main contract $\{a_1, a_2, e\}$ is a solution of the collusion - deterrence regime if and only if there exists K such that

(16) $F'(a_1) = (B - e - d) + K\left[\frac{\partial\Delta}{\partial a_1}\right]$

(17) $F'(a_2) = (B - e + d) + K\left[\frac{\partial\Delta}{\partial a_2}\right]$

(18) $\varphi'(e) + K\left[\frac{\partial\Delta}{\partial e}\right] = a_1 + a_2$

and $K \geq 0$, $\Delta \leq 0$, $K\Delta = 0$

The last condition is the complementary slackness condition. Then, we claim that a solution $a_1^n(d), a_2^n(d), e^n(d)$ of the collusion proof regime is $a_1^n(d) = a_2^n(d)$ if and only if the parameters satisfy

$$E > (1+\lambda c)\varphi'(e)\frac{d}{a} = (1+\lambda c)2d$$

where the pair a, e is a solution of the system of equations

[38] If the readers may request the full version of this alternative proof of proposition 1,they will be able to obtain it from the author.

(19) F'(a)= B-e

(20) $\varphi'(e) = 2a$

This will establish Proposition 1-(a) with $d_1 = \frac{E}{2(1+\lambda c)}$.

First, an explicit value of d_1 is induced. Second,the Kuhn-Tucker multiplier as an endogenous variable is explicitly driven.The value is $K^* = \frac{d}{E-(1+\lambda_c)2d}$,and this implies the increase of the attainable efficiency(organizational surplus) through the marginal relaxation (slackening) of the coalition incentive constraint. Thrid,we can verify that the critical assumption leading to the pooling solution is E >0 since the formula shows that d_1 >0 if and only if E' (a_1 - a_2)= E > 0.

Remarks on the characterization of the incentive scheme

The conditions under which the characterization of the incentive contract (local property) becomes the case of Fig.4, are qualitatively as follows. First, the parameter E, which represents the strength of both the negative externality and the extra prize, is large enough to prevent the achievement of the first best allocation. Second, the parameter E is large enough to let the signs of the first and second constituents of the gradient vector of the collusion proof constraint at the optimum each be positive and negative. Remember that since Δ is an extra prize or collusive gain for the bad agent, the gradient vector of it has a meaning that the principal adjusts the incentive schemes and marginally changes the size of the extra prize (bonus), thereby coordinating the ex ante conflict of interests (competing behaviour for the good task). Then, it will become clear why the incentive scheme be low powered. Also, the principal has an incentive to offer the incentive scheme to the supervisor to induce more than the first best level of effort. This can be understood as follows. Under the situations where the marginal cost of the supervisor is very high (e.g. he maybe very busy), the latter effect will dominate the former in the following gradient.

$$\frac{\partial\Delta}{\partial e} \cong (a_1 - a_2) - (1+\lambda c)\varphi'(e)\Delta e$$

In such cases, the principal can mitigate the ex ante competing behaviour by reducing the collusive benefit (prize) by increasing the required effort level of the supervisor. If the following (sufficient) condition is satisfied 1-(1+λc)2d<0,the principal induces from the supervisor more than the first best level of effort.Hence, the incentive scheme is changed like Fig. 4・1 in this case.

Next, we consider the comparative statics of the collusion proof incentive scheme simply. In the case of Fig. 4 and 4・1, as the parameter E increases, $\left[\frac{\partial\Delta}{\partial a_1}\right]$ increases and $\left[\frac{\partial\Delta}{\partial a_2}\right]$ decreases, which we get from these equalities. So first, in the separating scheme existing within the range from d_1 to d_2, the incentive spread : $a_1 - a_2$decreases.

Second, consider the critical value $d_1 = \frac{E}{2(1+\lambda c)}$ simply. We get this explicit value in the alternative proof of proposition 1. Then, when E increases, the critical difference between two agents increases, within which the principal deals with them equally as his optimal solution. This is a natural result that as the source of conflict increases, the range of equal incentives (pooling solution) increases.

In other words, as E increases, over the larger range of d, the virtual costs between two agents tends to reverse. Within the range, the pooling solution is optimally adopted by the principal.

Third, as for the global incentive constraint $\Delta \leq 0$, d_2 increases with E.

Hence, we get the above comparative statics of the increase of parameter E.

We illustrate this in the Figs. 4.1 and 4.2.

Good type coalition's Incentive Constraint

Next, we investigate the good type's incentive constraint, which we supposed to be satisfied at the optimum. In order to drop the incentive constraint for the good agent from the collusion proof problem, we need a global result that is satisfied at the optimum $\{a_1^n(d), a_2^n(d), e^n(d)\}$.

$$U(a_1, e;1) > U(a_2, e+\Delta e;1) - (1+\lambda_c)[\varphi(e+\Delta e) - \varphi(e)].$$

We can show that this inequality is not always generally satisfied. We cannot generally eliminate the possibility of the incentive for the good agent to mimic the bad agent collusively with the supervisor. However, asφ (the marginal cost of supervisor) increases, the above incentive tends to be satisfied (not binding) at the optimum. So, we can affirm that the solution of the main text is applied to the situations where the extra prize (marginal prize) is relatively large and the marginal cost of the supervisor is also relatively large.

remark

If both E and φ are small (but global Incentive constraint is not satisfied at the first best), the case where the good type will mimic the bad type collusively with the supervisor will emerge. However,these cases are somewhat artifitial, because the original game includes the tournament structure (competing structure), and so, each agent wants to beat the rival division (unit) and acquire the good task with the future prize. Even if the incentive problem for the good type to mimic the bad type emerges, it is only the reversal of the main text, and so the second best regime will be divided into two depending upon whether the incentive constraint of the good type agent binds or not.

We do not check the case where both incentive constraints of both types of agents will bind, but at the pooling solution $a_1 = a_2 = a$ both constraints are binding. Hence, we can view this as a special case.

Intuition of Proposition 1.

We can interpret this collusion proof regime in the view of the "Tax - Subsidy" scheme to the externality problem. (Of course, the equilibrium collusion regime can be interpreted similarly.) The first order conditions (16) (17) (18) show that the planner should impose a tax on the bad activity and give a subsidy on the good activity for the whole organization.

Note that we focus on the following case, $\frac{\partial\Delta}{\partial a_1} > 0$ and $\frac{\partial\Delta}{\partial a_2} < 0$, that is, the case where the externality factor or the relative importance of the second project δ is relatively large.

So, the principal should impose a tax rate K• $\left[\frac{\partial\Delta}{\partial a_1}\right]$ on the production of the product 1, and a subsidy rate K• $\left[\frac{\partial\Delta}{\partial a_2}\right]$ on the product 2. Figure 3 can be viewed as this tax - subsidy scheme. At the optimun, only the incentive constraint of the bad type coalition is binding, and noticing that the dead weight cost K$\cdot\Delta$ consists of $\{a_1, a_2, e\}$, one should impose the distortions on the incentive schemes, deviating from the first best solution. As a result, the principal should introduce the low powered incentive scheme, mitigating the mimicking incentive of the bad type coalition {S,2} to the good type coalition. Further, the negative sign of $\frac{\partial\Delta}{\partial e}$ depends upon the condition of $1 < (1+\lambda c) \cdot 2d$. In this case, the principal should increase the task level of the supervisor so as not to give him the room for the extra effort, and should decrease the possibility or the pressure of coalition formation among them.

This solution corresponds to the transfer pricing in the intra firm trading. It shows that the transfer prices should correspond to the virtual marginal costs of activities.

Appendix3 : The Foundation of the Equilibrium with Vertical Collusion

Though in the main text, we envision the second price auction, we can present the some noncooperative game foundations of the equilibrium with vertical collusion.

One of them is a generalization of the Rubinstein Process. Assume that Agent 1 is more efficient than Agent 2. At dates 0, 2, $\cdots$, 2k, $\cdots$ between stages (4) and (5), the agents' make offers (bids).

At dates 1, $\cdot\cdot$, 3, $\cdot\cdot$, 2k+1, $\cdot\cdot$, the supervisor makes offers. The agents' offers (bids) are the side payment (transfer payment) to the supervisor at which they are willing to buy his recommendation for the good task and among which the supervisor may choose. The agent makes an offer to the common supervisor. We consider a stationary equilibrium and show that, if parties have the same discount factor and as the time between offers tends to zero, the perfect equilibrium payoffs converge to $\frac{1}{2}\Delta_1$ for both the good agent 1 and the supervisor, and to 0 for the bad agent 2, if $\frac{1}{2}\Delta_1 > \Delta_2$, and to Δ_2 for the supervisor, $\Delta_1 - \Delta_2$ for the good agent 1, and 0 for the bad agent 2 if

$\frac{1}{2}\Delta_1 < \Delta_2$. This is a uniqueness result of the renegotiation game.

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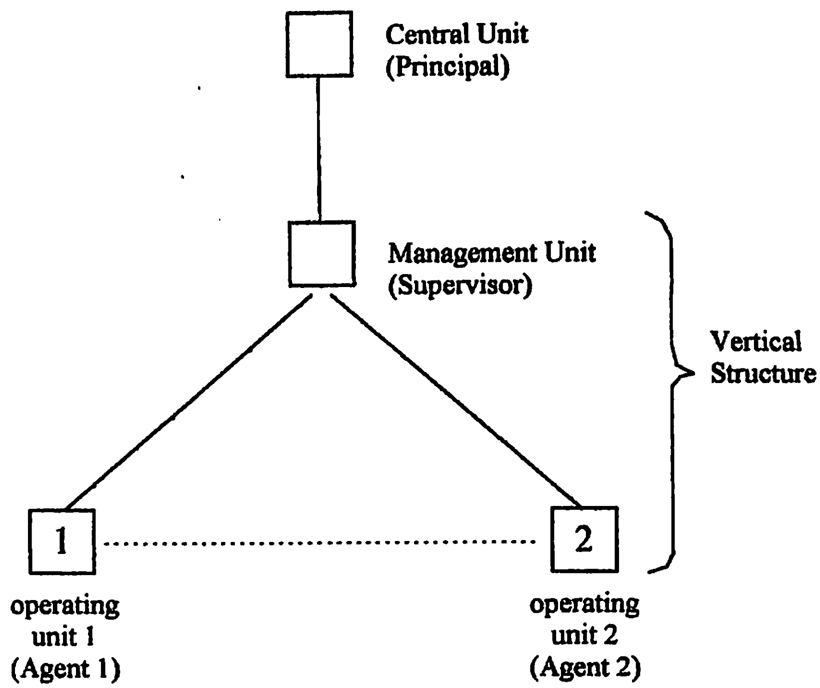

Central Unit
(Principal)
Management Unit
(Supervisor)
Vertical
Structure
1
2
operating
unit 1
(Agent 1)
operating
unit 2
(Agent 2)

Figure 0.

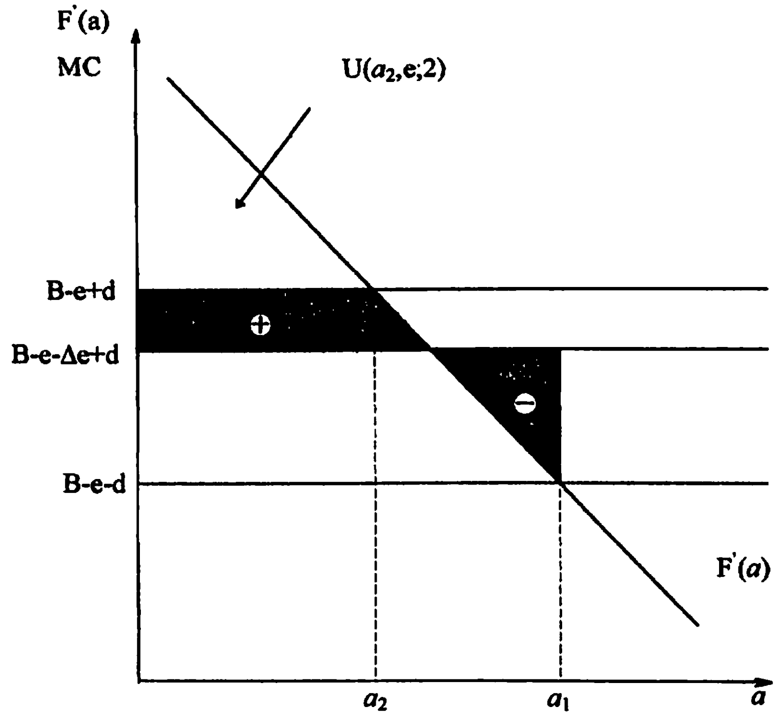


Figure 1. The gain from the task a_1 for the inefficient type

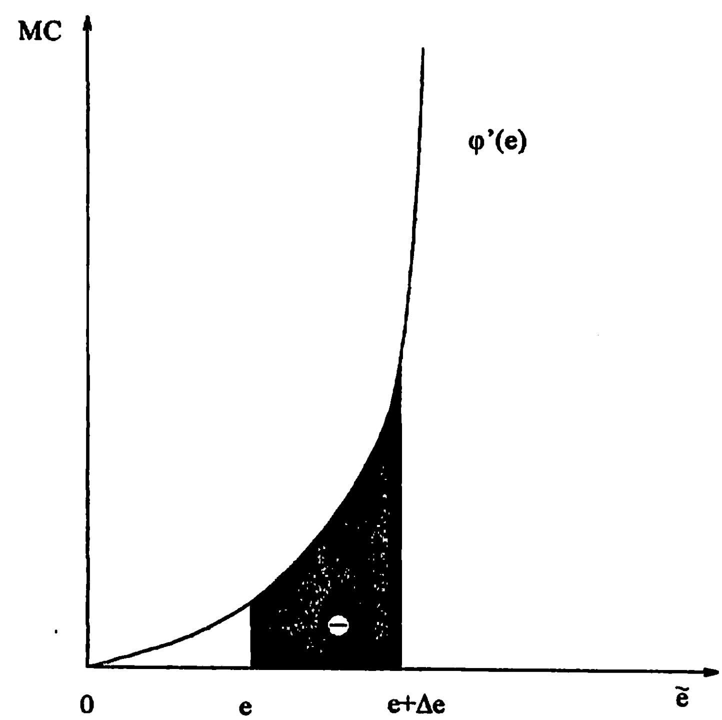


Figure 2. Supervisor's extra effort

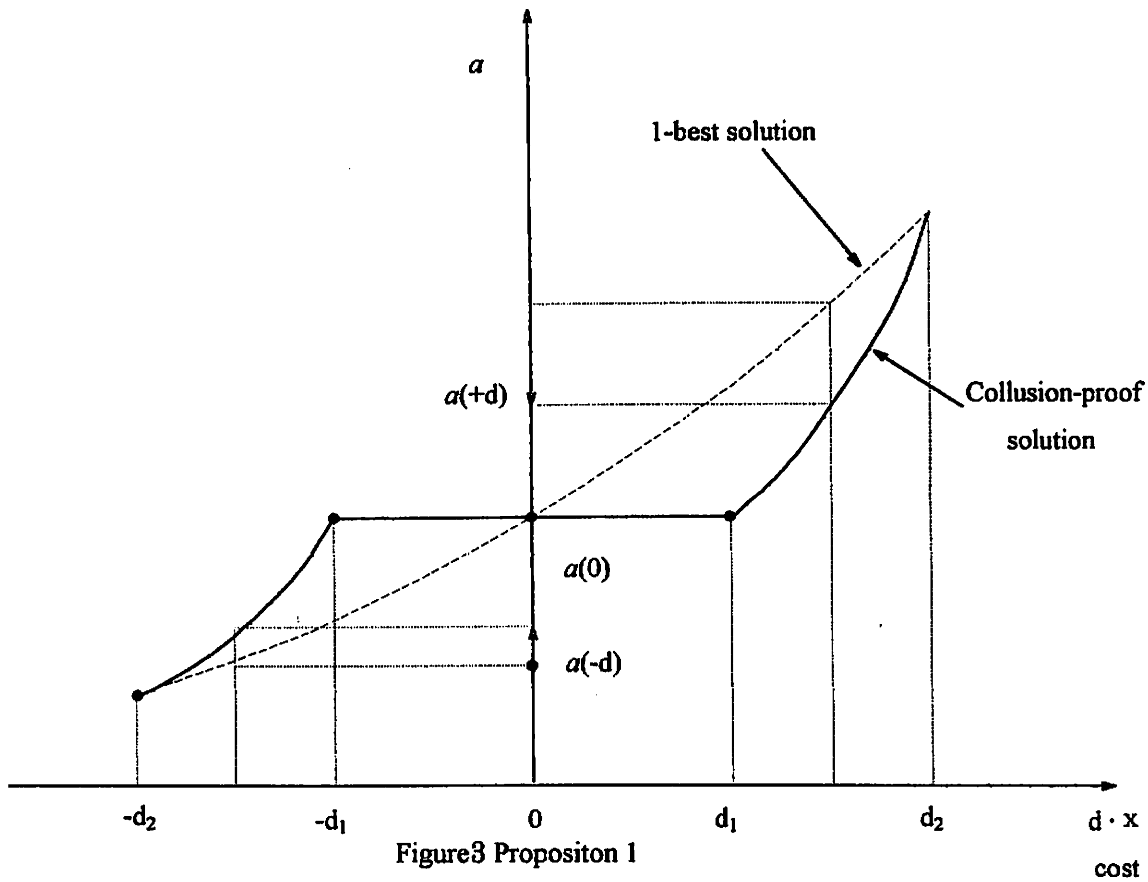
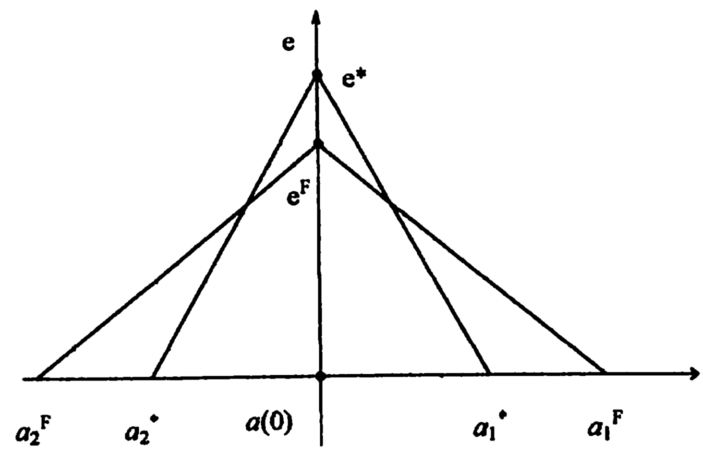
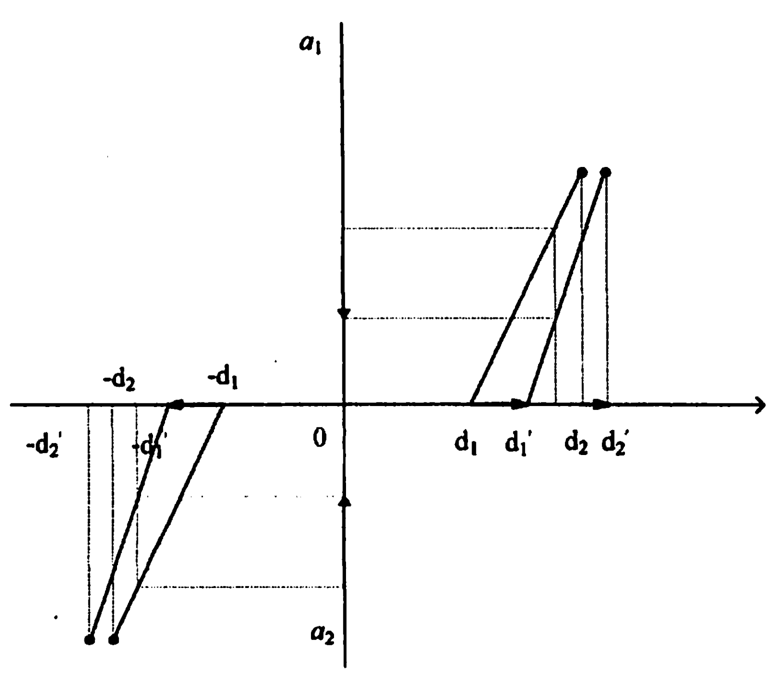


Figure3 Propositon 1



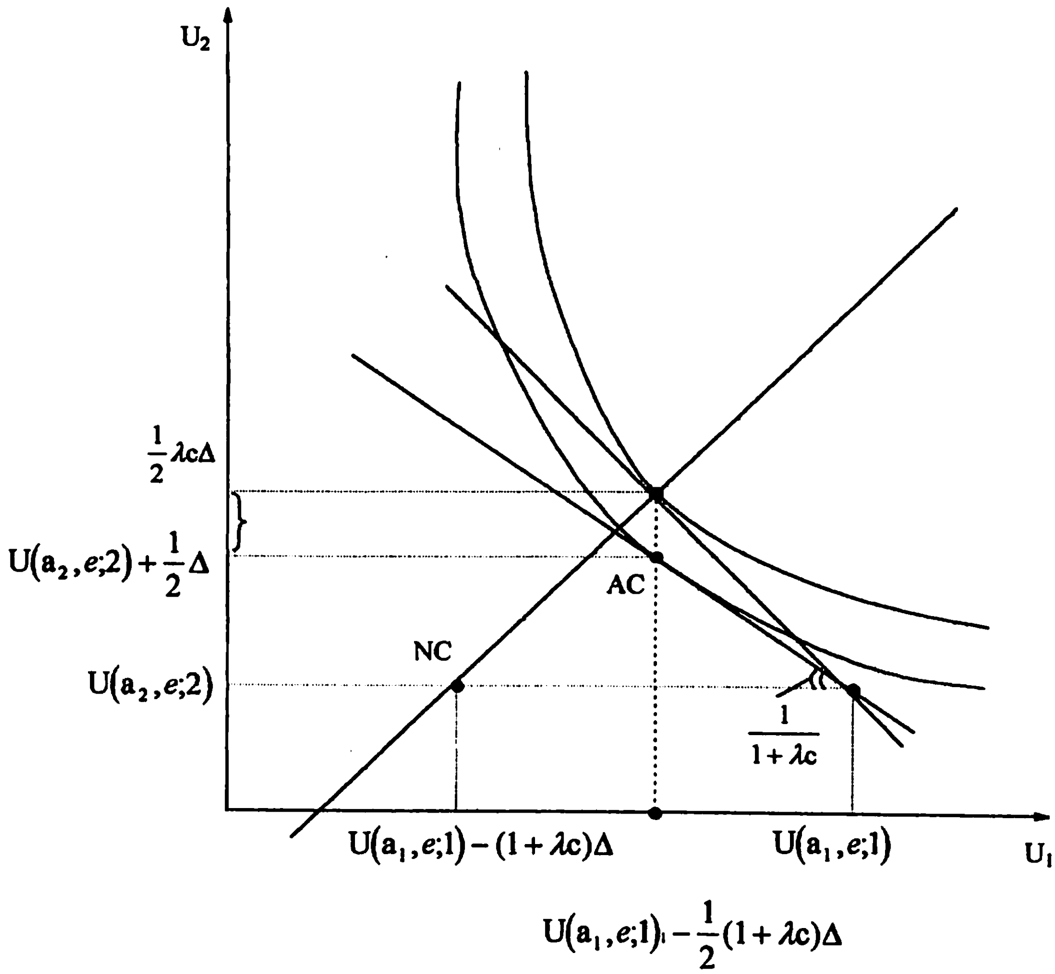
The change of optimal incentive
schemes as a collusion proof solution.

Figure 4.1



The effect of the increase of E

Figure 4.2



NC : Non Cooperation (Threat Point)

AC : Agent Cooperation (The Nash solution)

Figure 5