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Adverse Selection and Moral Hazard in Government Grant Giving

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Abstract: The purpose of this paper is to relate problems of asymmetric information to government grant giving. The innovation in the paper is to extend the asymmetricity to both principal (donor/government) and agent (recipient) unlike conventional models which analyse informational asymmetries emanating solely from the agent. The first model (adverse selection) in the paper has more than one type of principal, as in the common agency problem. In the second model (moral hazard) we extend difficulties of monitoring the agent's effort to the principal as well, hence we have double moral hazard.

I INTRODUCTION

The central role played by government grants in aiding the manufacturing sector in the two economies of Ireland cannot be overemphasised. In the South of Ireland it is part of the overall strategy of industrialisation, whereas in the North it is part of UK regional policy. Government grants can take on a variety of forms, ranging from tax holidays (typically in the South) to capital/profit subsidies. The implicit or explicit *quid pro quo* for these grants, whatever form they take, is the achievement of some social or economic goal(s). Thus, government grants have *conditionality* attached, and there is growing evidence of deepening and increased conditionality (see Roper, 1993; Sheehan and Roper, 1994 on this for Northern

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Ireland). Some of the objectives behind grants include the social objective of raising employment in high unemployment regions or countries; economic aims encompass the desire to promote productivity (value added per employee) or the quality of the human capital so as to be able to pick "winners" in the zero sum game of dynamic comparative (competitive) advantage.

The purpose of this paper is to relate problems of asymmetric information to the strategic interaction (bargaining) between government agencies and firms when the giving of grants involves the fulfilment of certain conditions. We will refer to the former group as principals or donors, and the latter as agents or recipients. The problem of asymmetric information arises when the (two) sides to a bargaining process do not have equal access to information. The paper will present two models dealing with the two generic types of problems emanating from asymmetric information: adverse selection and moral hazard, see Murshed and Sen (1995) for a similar application to international aid.

The first model, in Section II, is an application of the problem of adverse selection when there is more than one type of principal (donor) in addition to the standard case of having more than one type of agent (recipient). The innovation here is that the principals possess *private* information of their type. Adverse selection, with more than one *type* of principal, arises more often in multilateral situations when several principals deal with a single agent. In Northern Ireland, for example, the Industrial Development Board (IDB) (or Local Enterprise Development Unit (LEDU)) as well as the Training and Employment Agency (TEA) and Industrial Research and Technology Unit (IRTU) could be negotiating with the same client. These different principals may have slightly differing attitudes, or the intensity with which they want the conditions of grants met may differ. The second model, in Section III, extends the moral hazard problem — where the effort level of the agent is unknown to the principal due to informational asymmetries — to the case of *double* moral hazard. In this case, the action of the principal is not fully transparent to the agent, at the same time that the principal cannot monitor the effort of the agent. Double moral hazard arises more often in bilateral negotiations.

II ADVERSE SELECTION IN GRANT GIVING: MANY TYPES OF PRINCIPAL

Adverse selection arises because of informational asymmetries; some information, about innate abilities for example, is private — usually to the agent. In our model *both* the principal and the agent posses information private to themselves. We adopt this approach following Maskin and Tirole (1990). We will assume two types of principal and agent which can be extended to n number of cases without loss of generality. The principal (donor) provides a grant or aid, in return for which the agent (recipient) is expected to meet the conditions outlined above (employment creation, increased productivity, train the work-force more). Since two types of principal could be dealing with the same agent, we can refer to this situation as a common agency problem. In what follows, we use the terms principal and donor, as well as agent and recipient, interchangeably.

Let α^i index the type of principal where i=1,2 similarly let β_j, where j=1,2 index the agent. Let p^1 and p^2 denote the probability of the principal being of type 1 and 2 respectively ($p^1+p^2=1$); π_1, and π_2 indicate the probability of the type of agent being of type 1 and 2 respectively, $\pi_1 + \pi_2 = 1$. Superscripts refer to the principal and subscripts to the agent. The utility of the principal, V is:

$$V = V(A, B, \alpha) \tag{1}$$

A stands for the transfer made by the principal to the agent, grant aid and B denotes the pecuniary value of the activities of the agent in meeting the conditions of the principal, from which the principal derives utility. The principal's utility is increasing in B and decreasing in A. Let U indicate the utility of the agent:

$$U = U(A, B, \beta) \tag{2}$$

The agent's utility is increasing in A and decreasing in B. The type 1 agent derives higher utility for all values of A and B. One could therefore say that the type 1 agent is the "good" type and the type 2 agent is the bad type as he would require a higher level of A and lower B to obtain the same utility levels as the type 1 agent. Note that the agent is unconcerned about the principal's type (α) in (2), defined as private values by Maskin and Tirole (1990).

The principal-agent relationship follows a three-stage process (game). In the first stage the principal proposes a contract with transfers and conditionality. Recall that the principal also has private information about her type. She can choose to reveal information about her type in stage 1, either explicitly, or implicitly via the type of contract she proposes. In the second stage of the game the agent either accepts or rejects the proposed contract. The agent's decision to accept or reject the contract in stage 2 will depend upon whether his reservation utility has been met by the proposal — the individual rationality (IR) constraint. Since the type 2 agent derives less utility from every combination of A and B, it is his IR constraint which is binding:

$$U_2(A_2^i, B_2^i) \geq u \tag{3}$$

where u is the reservation utility of the type 2 agent.

In the third (pay-off) stage of the game the principal pays out A and receives B from the agent. The type 1 agent gives more B for every level of A. The better type (1) agent has to be given the correct incentives to truthfully reveal his type — the incentive compatibility (IC) constraint. This means his utility from telling the truth must be at least as high as from falsifying his type:

$$U_1\left(A_1^i, B_1^i\right) \geq U_1\left(A_2^i, B_2^i\right) \tag{4}$$

The IC constraint of the type 2 agent will not be binding in the solution to our problem, as the type 2 agent derives no benefit from falsifying his type which would result in his receiving a lower net transfer.

The full informational problem for the principal in stage 2 of the game is to maximise (for the type 1 principal, say)

$$\begin{aligned} &\pi_1 V^1\left(A_1^1, B_1^1, r^1, c^1\right) + \pi_2 V^1\left(A_2^1, B_2^1, r^1, c^1\right) \\ &\quad \text{s.t. } \lambda^1\left[U_2^1\left(A_2^1, B_2^1\right) \geq u\right] \\ \text{and} \quad &\quad \mu^1\left[U_1^1\left(A_1^1, B_1^1\right) \geq U_1^1\left(A_2^1, B_2^1\right)\right] \end{aligned} \tag{5}$$

where: λ and μ are the Lagrange multipliers associated with the agent's IR and IC constraint respectively; r and c represent slack to (or the violation) of the IR and IC constraints respectively from which principals derive greater utility. These lead to the following first-order conditions for the associated Lagrangian, L:

$$\frac{\delta L}{\delta A_1^1} = \pi_1 \frac{\delta V^1}{\delta A_1^1} - \mu^1 \frac{\delta U_1^1}{\delta A_1^1} = 0 \tag{6}$$

$$\frac{\delta L}{\delta A_2^1} = \pi_2 \frac{\delta V^1}{\delta A_2} - \lambda^1 \frac{\delta U_2^1}{\delta A_2^1} + \mu^1 \frac{\delta U_1^1}{\delta A_2^1} = 0 \tag{7}$$

$$\frac{\delta L}{\delta B_1^1} = \pi_1 \frac{\delta V^1}{\delta B_1^1} - \mu^1 \frac{\delta U_1^1}{\delta B_1^1} = 0 \tag{8}$$

$$\frac{\delta L}{\delta B_2^1} = \pi_2 \frac{\delta V^1}{\delta B_1^1} - \lambda^1 \frac{\delta U_2^1}{\delta B_2^1} + \mu^1 \frac{\delta U_1^1}{\delta B_2^1} = 0 \tag{9}$$

$$\frac{\delta L}{\delta r^1} = \frac{\delta V^1}{\delta r^1} - \lambda^1 = 0 \tag{10}$$

$$\frac{\delta L}{\delta c^1} = \frac{\delta V^1}{\delta c^1} - \mu^1 = 0 \tag{11}$$

λ^1 and μ^1 can be interpreted as the shadow prices of r and c.

The above problem and equilibrium allocations of A, B are referred to as full informational as the principal has revealed her type in stage 1, thus the agent's IR and IC constraints have to bind for *each* principal (1 and 2) individually. Consider an example from (10) and (11):

$$\begin{aligned}&\left(\delta v^1 / \delta r^1\right) / \left(\delta V^1 / \delta C^1\right) = \lambda^1 / \mu^1\\ &> \lambda^2 / \mu^2 = \left(\delta V^2 / \delta r^2\right) / \left(\delta V^2 / \delta r^2\right) \text{ (for principal 2)}\end{aligned}$$

This suggests gains from trade in r and c between principals, but *cannot* take place with full information as for each principal the constraints on IR and IC of the agent are fully binding and no violations or slack are allowed on these constraints. If, however, principals postpone the revelation of their type to the last stage of the game they could gain from trading in IR and IC of the agents. To do this they must pool their offer at the proposal stage, co-ordinate their proposals and in effect make a joint offer. Then the agent does not know their type for certain, he has only priors with regard to their type. Principal 1 for example maximises:

$$\begin{aligned}&\pi_1 V^1\left(A_1, B_1, r^1, c^1\right) + \pi_2 V^1\left(A_2, B_2, r^1, c^1\right)\\ &\quad \text{s.t. } \lambda^1\left[U_2(A_2, B_2) \geq u - r^1\right]\\ \text{and} &\quad \mu^1\left[U_1(A_1, B_1) \geq U_1(A_2, B_2) - c^1\right]\end{aligned} \tag{12}$$

for prior, p^1 on the part of the agent.

Trade in slack on the constraints is possible if (3) and (4) become:

$$\sum_{i=1}^{2} \bar{p}^i U_2\left(A_2^i, B_2^i\right) \geq \bar{u} - \sum_{i=1}^{2} \bar{p}^i r^i \tag{13}$$

$$\text{and } \sum_{i=1}^{2} \bar{p}^i U_1\left(A_1^i, B_1^i\right) \geq \sum_{i=1}^{2} \bar{p}^i U_1\left(A_2^i, B_2^i\right) - \sum_{i-1}^{2} \bar{p}^i c^i \tag{14}$$

(13) and (14) imply that the constraints must hold only in expectation, where $\bar{p}$ is the agent's prior about the principal's type. One principal can violate a

constraint as long as they hold in aggregate. After solving (12) the principal will maximise an indirect utility function, Z

$$Z^i\left(r^i, c^i\right) \text{ s.t. } \lambda r^i + \mu c^i \leq 0 \tag{15}$$

leading to:

$$\left(\delta Z^i / \delta r^i\right) / \left(\delta Z^i / \delta c^i\right) = \lambda / \mu \tag{16}$$

Let us take the case where principal 1, found the IR constraint more costly than principal 2, for her $\lambda^1/\mu^1 > \lambda^2/\mu^2$ she will give up slack on the IC constraint for more slack on the IR constraint:

$$\begin{aligned} & r^1 = u - U_2(A_2, B_2) \\ \text{and} \qquad & c^1 = U_1(A_2, B_2) - U_1(A_1, B_1) \end{aligned} \tag{17}$$

For principal 1, r^1 is positive and c^1 is negative and vice versa for principal 2. It means that she gives agent 2 less than his reservation utility implying she dislikes type 2. She also gives the type 1 agent more utility than warranted by his incentive compatibility constraint. She has a preference for the type 1 agent and is like say, IRTU or TEA , a small government body more interested in the narrower economic aspects of conditionality. This would imply a stronger preference for meeting training and productivity goals. The other principal (type 2) is the opposite, implying that she is more like say IDB with relatively more concern about the broader (social) aspects of conditionality such as employment creation.

Maskin and Tirole (1990) demonstrate that there is a competitive equilibrium in the above case of trades in r and c where the demands for r and c, D would equal average supply of r and c, which is zero. This competitive equilibrium is also Pareto optimal and dominates the full informational outcome from (5) where, of course, trade in r and c is impossible. From (13) and (14) we can write this as:

$$\begin{aligned} \sum_{i=1}^{2} \bar{p}^i r^i &= 0 \\ \sum_{i=1}^{2} \bar{p}^i c^i &= 0 \end{aligned} \tag{18}$$

III MORAL HAZARD IN GRANT GIVING: DOUBLE MORAL HAZARD

Moral hazard is said to arise when there is an effort associated with a task, and the effort level is unobservable or unverifiable due to informational asymmetries. This informational asymmetry is due to the fact that the effort level is only known, fully, by the person carrying out the task. In the conventional principal-agent framework the principal's problem is to design incentives (via the IC constraint) for the agent such that the problem of moral hazard, on the part of the agent, is eliminated or minimised. There could, however, be cases when the action by the principal is not fully transparent to the agent, in addition to the agent's effort level being imperfectly known to the principal. We then have *double* moral hazard. If we combine this feature with outcomes depending on the state of "nature" it alters the sequential game of the last section to a Cournot-Nash game between donor and recipient. Both parties to the process can affect, by their actions, the probability of the states which determine outcomes, but neither can fully observe the other's action. The analysis in this section is more applicable to the process of bilateral negotiation, unlike the multilateral framework in the previous section with many principals. Thus, in this model, there is only one type of donor and recipient.

We assume two states of the world: good (g) and bad (b), which occur with probability ϕ and $1-\phi$, respectively. These probabilities depend on factors exogenous to the individual donor and the recipient such as the state of aggregate demand, external demand, events in other industries, as well as other competing domestic and regional candidates for transfers, political attitudes about industrial grants and so on. These exogenous factors are also affected by the inputs of the parties concerned. Thus we could argue that the probability of the good state is an increasing function of effort (e) on the part of recipients, and action (a) undertaken by donors. It is assumed that in the good state both the grant (A) and fulfilment of the conditions (B) is higher than in the bad state. Effort by recipients encompass the costs of meeting the grant conditionality. Actions by donors (grant giving agencies), include lobbying and liaising with other government agencies and ministries, activities to promote the continuing importance of industrial grants amongst politicians, in addition to the cost of monitoring the recipient.

The expected utility, V, of the donor, the principal in the previous section is:

$$V(A,B,e,a)=\phi(e,a)V^{g}\left(A_{g}^{g},B_{g}^{g}\right)+\left(1-\phi(.)\right)V^{b}\left(A_{b}^{b},B_{b}^{b}\right)-C(a) \tag{19}$$

where C(a) is the cost or disutility of engaging in actions. $C_a > 0$ and $C_{aa} > 0$.

The expected utility of the recipient, U, the agent of the previous section is:

$$U(A,B;e,a) = \phi(e,a)U_g\left(A_g^g, B_g^g\right) + \left(1-\phi(.)\right)U_b\left(A_b^b, B_b^b\right) - E(e) \tag{20}$$

where E(e) represents the cost of engaging in effort on the part of the recipient, $E_e > 0$, $E_{ee} > 0$. We assume that both actions(a) and effort(e) by donors and recipients increase the probability of the good state but at a diminishing rate. So $\phi_a > 0$ and $\phi_e > 0$; but $\phi_{aa} < 0$ and $\phi_{ee} < 0$.

Consider the full informational outcome. This is where the actions and efforts of both parties are known to the other as a result of *co-operative behaviour*. Co-operation involves maximising some joint welfare function, W, the sum of (19) and (20) with respect to a and e, the two choice variables. Hence

$$\frac{\delta W}{\delta a} = \phi_a\left(V^g(.) + U_g(.)\right) - \phi_a\left(V^b(.) + U_b(.)\right) - C_a = 0 \tag{21}$$

$$\frac{\delta W}{\delta e} = \phi_e\left(V^g(.) + U_g(.)\right) - \phi_e\left(V^b(.) + U_b(.)\right) - E_e = 0 \tag{22}$$

Equations (21) and (22) imply that the marginal costs of undertaking action and effort are equal to the *total* marginal benefits to both parties from them. Action by donors will be greater than effort by recipients if, given the cost associated with it is more socially productive in terms of raising the probability of the good state. The converse will apply if effort is more socially productive.

We can, assuming linearity in the relationship between a and e, obtain first best levels of one given fixed amounts of the other:

$$a^*(e) \tag{23}$$

$$e^*(a) \tag{24}$$

Once double moral hazard is introduced, neither party can fully observe or verify the other's activities Cournot-Nash type of *non-co-operative* behaviour emerges. As in Cooper and Ross (1985) a two-stage game appears. In the first stage the two sides decide upon levels of A and B associated with the good and bad states of the world. Each side will have to offer the other party a level of reservation utility, corresponding to the individual rationality (IR) constraint. Otherwise the game ends at stage 1. Stage 1 corresponds to the contract proposal stage in Section II, except here both players move simultaneously (Nash perfect strategies). Stage 2 of the game involves choices of a and e given some conjecture about the other. The backward solution to the game involves maximising (19) and (20) with respect to a and e, respectively. This yields:

$$\phi_a\left(V^g(.)-V^b(.)\right)-C_a=0 \tag{25}$$

$$\phi_e\left(U_g(.)-U_b(.)\right)-E_e=0 \tag{26}$$

It is apparent from comparing (25), (26) with (21), (22) that the equilibrium quantities of a and e with double moral hazard (non-co-operative behaviour) are lower, as the marginal benefit of doing a and e are reduced. This in itself is Pareto sub-optimal.

The next step is to set up reaction function equilibria for a and e. We totally differentiate the first order conditions (25) and (26) with respect to a and e. For donors this is given by:

$$\frac{de}{da/R_D}=\frac{C_{aa}+\phi_{aa}\left(V^b(.)-V^g(.)\right)}{\phi_{ae}\left(V^g(.)-V^b(.)\right)}\gtreqless 0 \text{ if } \phi_{ae}\gtreqless 0 \tag{27}$$

and for recipients it is:

$$\frac{de}{da/R_D}=\frac{\phi_{ae}+\phi_{aa}\left(U_g(.)-U_b(.)\right)}{E_{ee}+\phi_{ee}\left(U_b(.)-U_g(.)\right)}\gtreqless 0 \text{ if } \phi_{ae}\gtreqless 0 \tag{28}$$

Note by symmetry, $\phi_{ae}=\phi_{ea}$.

In Figures 1-3, the point C is Pareto optimal. By contrast the point N is the sub-optimal non-co-operative point associated with moral hazard. The reaction functions will be positively sloped if actions and efforts by donors and recipients are complements, if $\phi_{ae} > 0$, (Figure 1). This situation would arise if steps taken by the donor to increase the probability of the good state led to more effort on the side of the recipient. If the two strategies are substitutes, $\phi_{ae} < 0$, the reaction functions will be negatively sloped (Figure 2). In this case costly effort by recipients to raise the probability of the good state leads to a reduction of action by donors. In all cases, however, the co-operative outcome denoted by C shows greater levels of action, a, and effort, e, than with non-co-operation. The elimination of moral hazard will therefore increase social welfare and is Pareto improving.

Yet another possibility exists when a and e are substitutes (Figure 3). This is where one of either a or e is lower than the co-operative case but the other

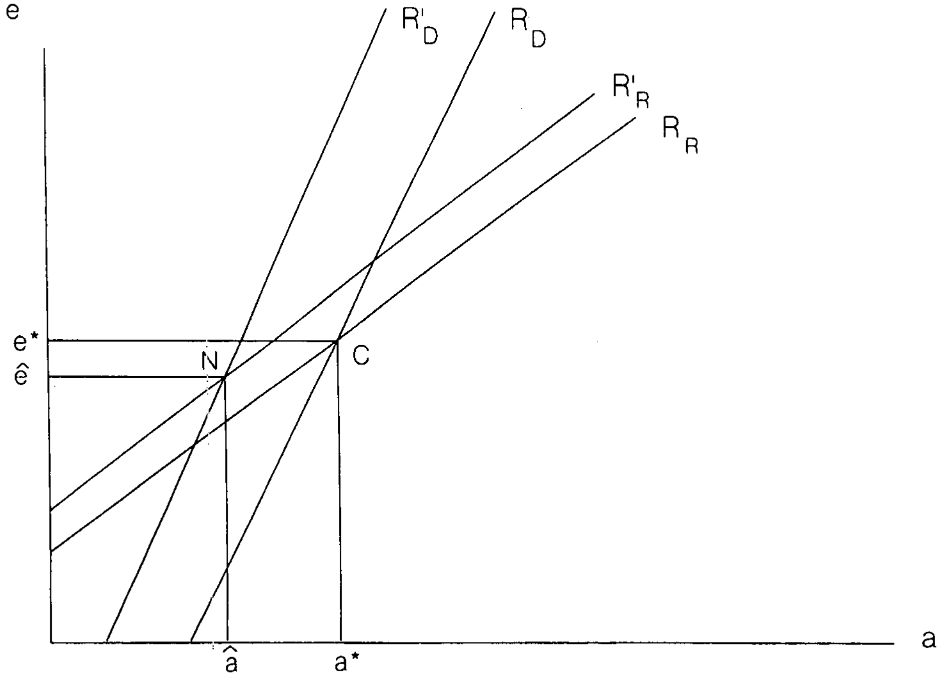

Figure 1.

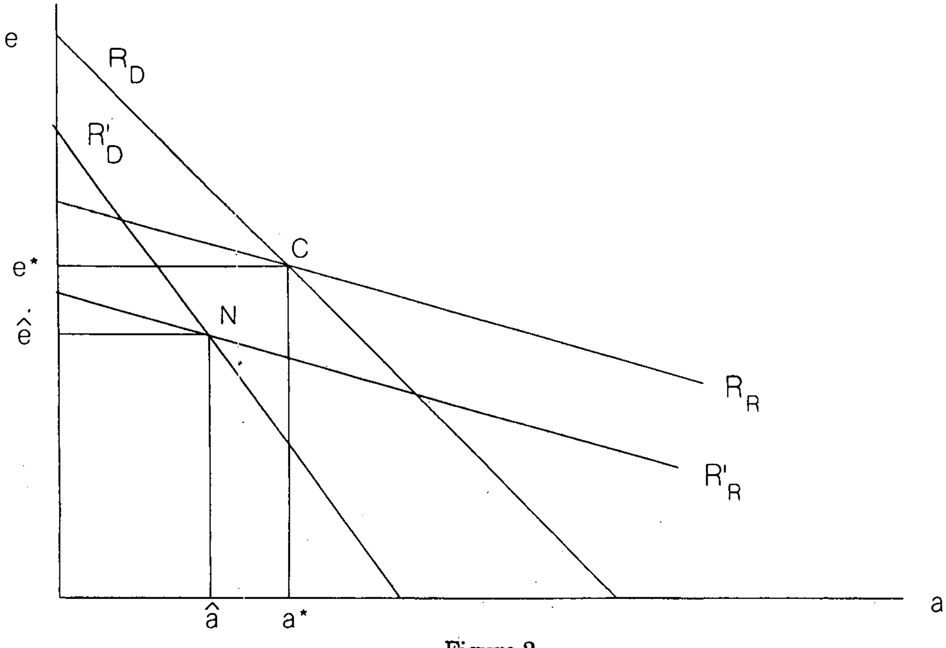

Figure 2.

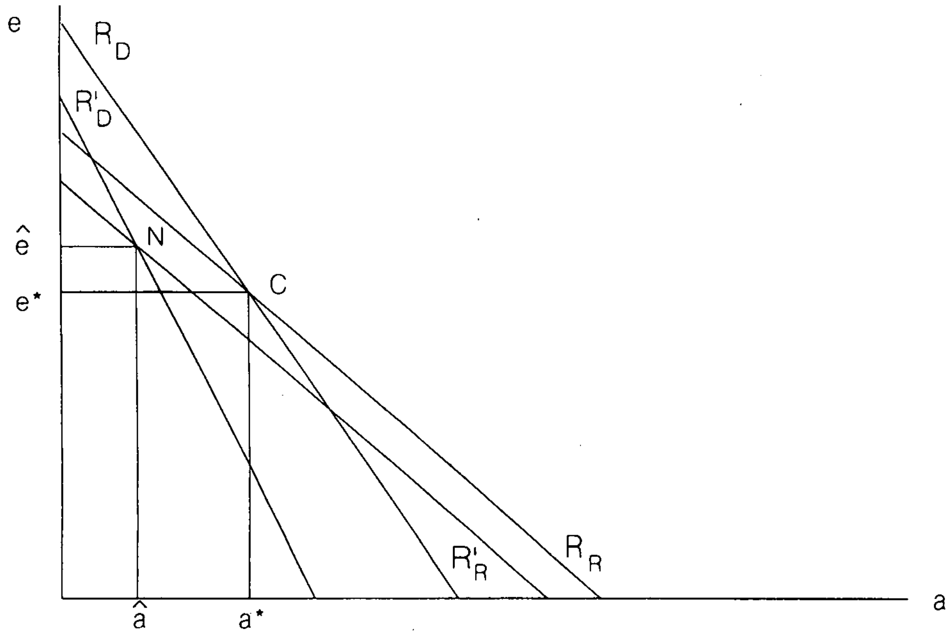

Figure 3.

is higher. Analytically, it implies ϕ_{ae} is very high in absolute value. In Figure 3 we depict a case of higher e but lower a in the non-co-operative case compared to the co-operative case. (The converse is also feasible.) This depicts the situation when the donor can shift part of the burden of making the costly input to the recipient. Thus, a problem of *equity* in addition to the inefficiency is created by double moral hazard and non-co-operative behaviour.

The above analysis is conducted to apply to risk neutral donors and recipients. Thus there is always risk sharing, implying *non-zero* input of action and effort. If one side is risk averse and has access to an insurance market or can recontract with a third (risk neutral) party, risk sharing may cease. This can be verified by an inspection of (25) and (26). In the extreme with full "insurance" state independent utilities appear; either $V^g = V^b$, or $U_g = U_b$, implying a = 0 or e = 0. Thus, if donors could obtain full insurance, because they will be baled out by another government agency, their action would cease and we would be on a point on the vertical axes of Figures 1-3. Conversely, if recipients can get full insurance by re-contracting with a third party or financial institution their efforts will be zero on the horizontal axes of Figures 1-3. Garvey (1993) analyses the second possibility. The possibility of re-contracting is then built in to the game and contract proposal. The recipient of the grant has to be offered state independent utility with no risk (zero effort) or full risk (maximum effort), depending on the level of reward (grant aid). This choice should depend on whose input is *socially* more productive. If the government agency's (donor/principal) action is more valuable then it should bear all risk and engage in maximum action; the reverse would apply if the recipient's input of effort is more productive.

Another possibility arises if the donor or government agency itself acts as an insurer to the recipient. The analysis in this instance would be similar to the work of Azariadis (1976) on implicit contracts. The recipient would either get state independent utility resulting in zero effort; or risk sharing would imply reduced effort (greater moral hazard) by the recipient than if it was not risk averse.

IV CONCLUSIONS

To summarise our results, we have shown that with more than type of principal or grant donor with slightly different objectives, these principals can do better by co-operating and making a joint offer at the contract proposal stage. This will in no way leave the agent worse off. Our model can also be extended to the case of numerous regulators dealing with a common industry to be regulated. The gains from co-operation amongst principals may be small in some instances but are likely to be greater in other cases. In the case of double moral hazard we have pointed to the sub-optimality of non-co-operation producing too little preventive input. This is essentially a problem of economic efficiency. Problems of equity can arise if one group, say, grant donors can pass on some of the burden of preventive activity to recipients. The policy implication here is to induce more co-operation amongst government agencies and grant recipients to minimise the problems associated with double moral hazard; as well as induce a socially optimal degree of burden sharing. When either party to the bargain is able to re-contract with a third party to obtain state independent utility (full insurance), a risk sharing contract with them may not be feasible. The policy objective, once again should be to engender preventive input from whichever party whose input is more productive in promoting the good state of nature.

A further possibility not considered by us is the case of mixed (or the simultaneous existence of) adverse selection and moral hazard on the side of the agent. The standard result in that event is that the incentive contract involves a trade-off between moral hazard and adverse selection (see McAffee and McMillan, 1987). Thus the reduction of adverse selection lowers the incentive to engage in effort and vice versa. Finally, there is the problem of "additionality". This occurs when the agent/recipient would have undertaken some B without any transfers from government. Then we have a situation resembling the "free rider" problem, where the difficulty is to elicit true preferences. The appropriate game forms there would be signalling games not analysed in this paper.

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