OVERINVESTMENT WITH RELATION-SPECIFIC CAPITAL

Julio J. Rotemberg
and
Garth Saloner

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Working Paper #1950-87

October 1987

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Abstract

We consider a situation in which one party (the owner) owns a
project. He is better informed than another party (the worker) about
the payoff this project would have if investment specific to their
relationship is undertaken. Initially many workers compete to be the
owner's partner in the project. If the investment is undertaken the
worker gains knowledge which makes him worth more than other workers
and which allows him to capture some of the payoffs of the project.
We show that the equilibrium contract generally involves
overinvestment. We consider both the case in which the owner can
credibly commit never to undertake the project with a different worker
and the case in which he can't. In the former case there is always
overinvestment. In the latter case, there are multiple equilibria.
Overinvestment equilibria always exist, underinvestment equilibria
never exist and efficient equilibria sometimes exist.

When assets are specific to a particular relationship, the contractual forms that are feasible for governing the relationship are crucial in determining the ability of the parties to exploit profitable investment opportunities. The importance of relation-specific assets derives from the quasi-rents they create. These quasi-rents are the difference between the value of the assets in the current relationship and their value if the relationship ceases. Once such assets are installed, at least one party to the relationship earns less, under any original agreement, than the total value of the quasi-rents. By threatening to withdraw from the relationship unless new (more favorable) contractual terms are agreed, that party may be able to improve his outcome.

If the original contract cannot prohibit renegotiation, inefficient investment in relation-specific assets may result. Prices in the original contract may be distorted, some projects not undertaken at all, and others mediated within a vertically integrated enterprise even when a market transaction would otherwise be more efficient. This idea is central to the work of Williamson (1975) and Klein, Crawford, and Alchian (1978) who suggest that in general underinvestment will result. For example, Klein, Crawford, and Alchian (1978, page 301) conclude: "...Less specific investments will be made to avoid being locked in".

Several recent papers have formalized these ideas. Grout (1984) considers the relationship between a union and a firm where the latter must decide whether or not to undertake a relationship-specific

investment. Efficiency requires that the firm be reimbursed at least the cost of the investment if the gains from the investment exceed its costs. Grout points out, however, that if the union cannot commit (through a binding long-term contract) not to attempt to garner an excessive share of the gains once they are realized, the firm may not invest even if it is worthwhile. If, on the other hand, binding contracts are possible, investment will obviously be efficient.[1]

While a binding long-term contract ensures efficiency in this setting, several authors have pointed out that efficiency can be obtained with simpler, less complete contracts.[2] The reason is that farsighted agents are able to anticipate the outcome of the anticipated bargaining and can make transfers before investment must take place that are sufficient to yield efficiency. Thus, for example, if the parties realize that the agent who must make the investment will fall $x short of recouping the cost of the investment in the division of the spoils ex post, they can, ex ante, agree to a transfer of $x to that party in the contingency that the investment is undertaken. (Notice too that if there are many potential noninvesting partners competing for the right to participate in the relationship, competition among them will result in an offer of $x for that right.) In this way the investing party can always be induced to make the investment when it is mutually worthwhile. In order to implement a contract of this kind, it must be possible for the third party enforcing the contract to observe whether the investment did in fact take place: investment must be a contractible activity. Holmstrom and

Hart (1986) provide an example (along the lines of Grossman and Hart (1986) and Moore and Hart (1985)) that illustrates that underinvestment can result even if bargaining is efficient and investment is observable to the parties, provided investment is not also contractible.

While that example shows that underinvestment can result if investment is noncontractible, Tirole (1986, Sec. IV) shows that if, in addition, bargaining is inefficient, underinvestment is necessarily a characteristic of the optimal contract. In his model the "firm" must undertake a relationship-specific investment (unobservable to the other party, the "sponsor") that determines the firm's costs of producing a good that that the sponsor desires. After the investment has been made, only the sponsor learns the value of the good. The parties then bargain (under incomplete information) about how much the firm should be paid if it produces. Since mutually beneficial opportunities are typically foregone when bargaining occurs under incomplete information, the firm anticipates that it will not reap the full benefits of its investment and so invests too little.

In contrast to Tirole (1986) we focus instead on situations of adverse selection in which one of the parties (the "owner") knows the value of the relationship prior to the time when the relation-specific investment must take place but the other (the "worker") does not. Such an asymmetry of information would arise, for example, whenever the worker finds it more difficult to evaluate the quality of the project. Then projects which the owner would know to be different

would be viewed as identical by workers. An asymmetry of information seems to characterize many of the cases in which investment in relation-specific capital is an issue. For example, General Motors might have had better information than Fisher Body about the payoff to their joint venture; a firm considering making a new capital investment may be better informed of its value than the union or individual worker with which it is bargaining; a municipality considering installing cable TV may know more about the ultimate value to the community than potential providers of the service; and the Department of Defence, which knows how each piece of hardware fits into a weapons system and how weapons systems combine to form a total defence network, has better information about the value to them of each individual project than any of the contractors bidding for the contract.

This asymmetry of information is inconsequential if the realized value of the project is itself contractible. For in that case an efficient long-term contract can simply specify the division of the spoils as a function of the realized value. In practice, however, there are numerous reasons why the outcome may not be contractible. Tirole (1986) contains an extensive discussion of this point which we shall not repeat here. We merely mention three of the more obvious reasons. First, if the owner is simultaneously involved in other projects it may be impossible to separate the costs and payoffs of his various projects. Second, the payoff may in part accrue in nontangible benefits that are difficult for an outsider to

evaluate, such as the effect on the firms reputation or the utilities
of the parties. Finally, an outsider may not know the opportunity
cost of funds or other inputs the parties commit to the project, even
if this is common knowledge to the parties themselves.

With the exception of adverse selection the situation we study
is the canonical one in this literature. The owner requires the
participation of the worker in order to carry out his proposed
venture. The events unfold in three stages. In the first stage, the
owner bargains with the worker over the terms of an ex ante contract.
Once hired, however, that worker acquires training or knowledge that
makes him superior to any replacement and which therefore, ex post,
endows him with some leverage. With the specific worker in place, in
the second stage, the owner must decide whether to undertake a
particular investment he has under consideration. If he does so, the
gains from the investment are realized and, in the third stage, there
is ex post bargaining over those gains.

We restrict attention to the case which we believe to be of
most practical importance: where the informed owner is in the stronger
bargaining position ex ante. We formulate this in two ways. In the
first we assume that the owner can bargain at the first stage with
many workers who are ex ante identical.[3]   Recall from the above
discussion that this assumption is conducive to efficiency in the
complete-information setting. In the second, as in Sobel and
Takahashi (1983) and Fudenberg and Tirole (1983), the owner makes a
take-it-or-leave-it offer to a specific worker before investment takes

place.

Examples where the first formulation is appropriate abound:
When a firm is hiring workers to work in a new factory, ex ante there
are many workers with similar skills who are competing for the job.
Ex post, however, the workers acquire specific human capital which
allows them to acquire some rents which depend on the productivity of
the plant. Similarly, consider the case of an inventor who needs a
partner to supply inputs. Ex ante there may be many potential such
suppliers but only one inventor.

Particularly in this case of ex ante large numbers, the
formalism of the three stage model neglects a potentially important
feature of real world contracts. Such a model implicitly assumes that
the owner and the worker are able to form an exclusive relationship in
the sense that the owner can credibly promise that he will not engage
in the project in the future with any other worker. This is important
because in our model it is generally optimal to design a contract that
incorporates both a lump-sum payment to the owner (independent of
whether he invests or not) and a payment that is contingent on his
investing. Where it is impossible to specify an exclusive
relationship, the "noncontractible projects" case, an incentive is
introduced for the owner to abscond with the lump-sum payment and then
solicit an offer anew from another worker. Indeed an unscrupulous
owner may find it profitable to go into the business of collecting
lump-sum payments without ever investing. This would be a
particularly attractive option for an owner with a very unprofitable

investment opportunity.

There are a variety of circumstances in which a project is not contractible. An example is where the owner operates in several similar businesses and where it is difficult to specify the way in which a particular project differs from other projects the owner is involved in. Investment by GM in a particular new engine manufacturing process might be in this category. In other cases, however, the project may be contractible. For example a project to provide a cable television service to a city or the automobile bodies for an automobile producer are easily definable. Similarly in a joint venture one partner may be able to promise that all his efforts in a specific line of business will be conducted via the joint venture.

Our focus is mainly on the contractible projects case, formalized by the three stage model. Our result in this case is unambiguous: the optimal long-term contract leads to overinvestment in relation-specific capital. This results despite the fact that it is possible to structure a contract that leads to efficient investment.

When the contract is structured so that projects are only undertaken when it is efficient to do so, the average project undertaken yields a positive payoff to the relationship. Since bargaining yields some of this surplus to the worker, competition at the first stage forces workers to offer a lump-sum to the owner for the right to participate in the relationship. However, since workers cannot distinguish owners with good projects from those with bad, this lump-sum payment must be paid even to an owner who in fact has a bad

project and who has no intention of investing. Such an outcome is not particularly attractive to an owner who in fact has a good project since he shares some of the potential spoils with his unattractive counterparts. Indeed, such an owner would prefer a lower lump-sum payment and a higher payment made contingent on investment (which he intends to undertake). Since workers are happy to oblige an owner of this kind, they will offer the preferred contract. But then the higher investment-contingent payment induces overinvestment.

Althought the focus of the paper is on the contractible projects case, we briefly examine the noncontractible projects case. We model this by extending the horizon beyond three periods and enabling the owner to offer the project anew to a worker after previously contracting with another. Not suprisingly, multiple equilibria arise in this case. We are able to show, nonetheless, that underinvestment cannot arise in equilibrium and provide sufficient conditions for the outcome to involve strict overinvestment.

The second formulation in which the owner has relatively more bargaining power is where he is able to make a take-it-or-leave-it offer to a specific worker. In the absence of discounting, the models of Sobel and Takahashi (1983) and Fudenberg and Tirole (1983) feature such take-it-or-leave-it offers from the informed to the uninformed. In this case there are again multiple equilibria. Of these, one yields the efficient outcome while the others all involve overinvestment. Moreover, those with overinvestment are all preferred by the owner to the efficient equilibrium.

We are not the first to demonstrate that relation-specific capital can lead to overinvestment. Tirole (1986, Sec. V) shows that this is possible in his model if investment is observable. This occurs because investment alters the parties' relative bargaining strength. The idea that investment alters bargaining strength is also central to the analysis of Grossman and Hart (1986).[4] Crawford's (1982) model has the same ambiguity in that both under- and overinvestment are possible. The ambiguity there arises for a completely different reason: he considers risk-averse workers who wish to intertemporally smooth consumption and may therefore dislike the contract that gives efficient investment.

In a paper addressed to a rather different question De Meza and Webb (1987) also derive an overinvestment result. They consider an investing firm which must borrow to finance its investment. Their setting differs fundamentally from ours in that the investment is not specific, and in that binding contracts can be signed before investment takes place. Indeed the failure in the financial markets that drives their results is the presence of limited liability and the impossibility of observing the true value of the project, even ex post. Despite this large contextual difference, their model is somewhat similar to ours in that there is adverse selection and that the financial institution (which corresponds to the worker in our model) expects to earn more on projects that are in fact good. It is this expectation that leads the financial institution to offer contracts that are sufficiently attractive that even poor quality

projects are undertaken in equilibrium. However, their result in some sense derives from the fact that they do not allow for the possibility of payments which are not contingent on investment actually taking place. As discussed above, we consider such in our analysis and they turn out to play an important role.

The paper is organized as follows. In Section I we analyze the case where there are large numbers of potential workers while in Section II we examine take-it-or-leave-it offers by the owner. We present our conclusions in Section III.

I Ex ante large numbers of workers

(1) Contractible projects

We begin by recalling the timing structure, and by describing the payoffs. The owner has a project which yields G if a worker participates and if an amount K is invested. In the first stage the owner can enter into a contract with a particular worker. In the second stage, investment specific to that owner and that worker takes place if K is expended. If investment doesn't take place the game ends. In the third stage, G is learned by the worker (but is not verifiable by a third party) and the owner and worker bargain over its division.

The outcome of this game depends on what is known and what can be contracted on at each stage. First, we assume throughout that the third stage payoff cannot be contracted on in the first stage so that ex post bargaining (we use the generalized Nash bargaining solution)

is the rule. The inability to commit to third stage payoffs could be due to a variety of factors. One possibility is that the actual activity the worker is to carry out cannot be specified in advance so the worker can threaten to hold out after the investment takes place. Second, we assume that the contract can be made contingent on the owner/worker specific investment taking place. This is possible if it can be verified (by the Courts) that the owner invests K in the specific capital.[5] The third, and central assumption, is that the owner knows G exactly while the worker only knows the distribution F(G) from which G has been drawn. The final assumption is that the owner is in a better bargaining position than the owner.

To capture the competition that emerges between workers when there are many of them, we suppose that they make offers to the owner at the first stage. These offers specify payments the worker is willing to make in exchange for becoming involved with the owner. With contractible projects and investment there are two such payments that can be made. The first is a payment V which accrues only to owners who actually invest. The second is a payment L in exchange for which the owner promises never to undertake the investment with a different worker.[6] Thus in general an offer is a pair {L,V}, where L is an amount paid by the worker to the firm whether or not investment later takes place, and V is a contingent payment that is made only if investment in fact takes place.

We now solve for the equilibrium offers. As is usual for problems of this kind, we solve it by backwards induction. If the

third stage is reached, there is bargaining under full information: capital costs are sunk and the surplus G must be divided. The generalized Nash bargaining solution to this bargaining problem mazimizes $P_O^{1-\alpha}P_W^{\alpha}$ (where P_O and P_W are the payoffs to the owner and worker respectively) subject to the restriction that the sum of the payoffs is restricted to equal G.[7] The third stage payoffs to the owner and worker are therefore $(1-\alpha)G$ and αG respectively.[8]

Now consider the second stage and suppose that the owner has accepted an offer of $\{L,V\}$. Since, L is received by the owner independent of whether investment takes place, the owner finds investment worthwhile if and only if $(1-\alpha)G + V \geq K$. Thus the owner will undertake any investment for which

$$G \geq (K-V)/(1-\alpha) \equiv G^V. \tag{1}$$

Thus an offer of $\{L,V\}$ that is accepted results in a cutoff, G^V, such that only investments that yield a return higher than the cutoff are undertaken. The higher is V, the lower the cutoff. In other words, the higher the payment that is received in the event that investment is undertaken the more projects are undertaken.

Consider the first stage and suppose that an accepted offer involves a contingent payment of V. Then the amount that the worker expects to receive in the continuation game is given by:

$$\int_{G^V}[\alpha G-V]dF(G) = \int_{G^V}\alpha GdF(G) - V[1-F(G^V)] \tag{2}$$

Since competition between workers ensures zero profits for the workers, it must be the case that L is given by the expression in (2).[9] We can thus characterize the contracts by V with L being

determined by (2). Furthermore, we can restrict attention to $V \leq K$ since, from (1), this is an implication of nonnegative G.

Of the possible values of V, which one (with its corresponding L from (2)) will be offered in equilibrium? To examine this question consider a proposed $\{L,V\}$ equilibrium contract and an owner for whom $G>K$ under that contract. Since such an owner is the kind with whom the worker wishes to enter into a relationship, it must be the case that there is no other breakeven contract which such an owner would prefer. Since such an owner earns $L+V-K+G(1-\alpha)$, and since K and G are fixed, his preferences are increasing in $L+V$. Thus selecting his most-preferred contract amounts to maximizing $\phi(V) \equiv L(V)+V$ with respect to V, subject to (1) and (2). This gives:

$$d\phi/dV = dL/dV + 1$$
$$= -\alpha G^V f(G^V)dG^V/dV - [1-F(G^V)] + Vf(G^V)dG^V/dV + 1$$
$$= [K-G^V]f(G^V)dG^V/dV + F(G^V). \qquad (3)$$

Extremal solutions, which will be considered below, arise when (3) implies that L is negative. This can happen, for instance, when α is low. Interior solutions are obtained by equating (3) to zero which gives:

$$[K-G^V] = F(G^V)(1-\alpha)/f(G^V). \qquad (4)$$

Since the right-hand-side is positive, we have $K>G^V$: there is overinvestment in equilibrium.

The second-order-condition for a maximum is:
$$d^2\phi/dV^2 = [K-G^V]f'(G^V)[dG^V/dV]^2 + f(G^V)dG^V/dV - f(G^V)[dG^V/dV]^2 < 0, \text{ or}$$
$$[K-G^V]f'(G^V)-(2-\alpha)f(G^V)<0.$$

In order to interpret (3) and the overinvestment result let us consider a proposed $\{L,V\}$ equilibrium contract and suppose that a worker wishes to improve upon it. In particular, the worker wants to design a contract that, compared to the proposed $\{L,V\}$ contract, has the effect of inducing the marginal investment not to be undertaken while not affecting the inframarginal investments. In order to reduce the amount of investment that is undertaken in equilibrium, the new contract will have to have a slightly lower V than before. In order, at the same time, to be as attractive to an owner whose investment is inframarginal, that owner must be kept as well off as before. To do this, the decrease in V must be matched by an exactly equal increase in L.

So consider the effect of increasing L by \$1 while reducing V by \$1. There are two effects: First, when V is decreased by \$1, $|f(G^V)dG^V/dV|$ fewer projects are undertaken. The marginal such project loses $[K-G^V]$. Note however that, by definition, the owner breaks even on the marginal project. This means that the efficiency gains that result from the abandonment of marginal projects all accrue to the worker. These gains from the decrease in V are given by the first term in (3). The second effect is distributive. Any owner who would not have undertaken the project in any case receives \$1 more. The probability that the owner is of this type is $F(G^V)$. There is thus an increase in the payment to a noninvesting owner of $\$F(G^V)$. If $[K-G^V]f(G^V)dG^V/dV$ exceeds $F(G^V)$ then the worker gains from the change since he can induce every investor to accept his new contract.

With this intuition in mind it is easy to see directly from (3) why the equilibrium contract cannot involve only efficient investment. In the efficient case $K=G^V$ so that the first term in (3) vanishes and we are left with $F(G^V)$. At the point $K=G$, reducing V by \$1 while increasing L by \$1 has a second-order effect on the efficiency of investment that is undertaken. However it has a first-order effect on the lump-sum payments that are made to the type of owner who does not invest. In other words, resources are squandered on the kind of owner whom the worker does not wish to attract in the first place. Although increasing V induces some inefficient investment, this has the effect of enabling the worker continue to attract owners with good investments while offering them a lower lump-sum payment. The reduction in the lump-sum payment is desirable because it applies not only to owners with good investments, but to those with bad investments as well.

We now show that the above equilibrium is robust to renegotiation between the initial signing and the undertaking of the investment. At this point the owner has already received L so that when the payoff is between G^V and K both parties to the relationship could be made better off by agreeing not to go ahead with the investment. The gain from cancelling the contract is K-G. If this gain is split in the usual way, the owner must net $(1-\alpha)(K-G)$ and the worker $\alpha(K-G)$. To implement the outcome of this renegotiation, therefore, the worker must offer the owner $(1-\alpha)(K-G)$ not to invest.

This would require the worker to know G, however. If, as we

have assumed, G is unobservable, the worker must offer an amount to the owner not to invest that is independent of G. Suppose the worker offers M. Then investors would receive as much as they received before. All noninvestors would now receive an additional M. This would have exactly the same effect on investment decisions and on the payoffs of the worker as increasing L in the original contract while leaving L+V unchanged. Since the initial optimal contract ensured that the worker could not improve his lot in this way, renegotiation has no effect on the outcome. This occurs essentially because all owners accept the contract so that its acceptance yields no information that can improve the allocation.

This argument demonstrates that our original equilibrium is robust to renegotiation. It also implies that this is the only equilibrium even when renegotiation is allowed. This results from the fact that were there any other equilibrium with renegotiation, the worker coul offer our equilibrium contract instead, knowing that it would be accepted by an investing owner and that it would be robust to renegotiation.

We now consider the effect of an increase in α, the share of the ex post benefits that accrues to the workers, on the efficiency of investment. Intuition would suggest that such an increase makes overinvestment more severe since efficiency obtains when α is zero. Indeed, when the second order conditions obtain, there is a monotone relation between α and equilibrium G^V (assuming it is interior) which can be obtained by differentiating (4):

$$dG^V/d\alpha = [K-G^V]f(G^V)/\{(1-\alpha)^3 d^2\phi/dV^2\}.$$

Up to now we have considered interior solutions. Yet, it is possible that $d\phi/dV$ is positive even for L equal to zero. In this case, the equilibrium contract is of the form $\{0,V^*\}$ with associated cutoff G^*; it has L equal to zero because more attractive contracts with negative L's will not be accepted by noninvestors. Combining (1) and (2), G^* is given by:

$$\int_{G^*} \alpha[G-G^*]dF(G) - [1-F(G^*)][K-G^*] = 0 \qquad (5)$$

Since the first term in (5) is positive, the cutoff value G^* must be smaller than K so there is overinvestment. Differentiating (5), it is also apparent that G^* falls when α rises so that the extent of overinvestment diminishes.

It might be asked under what circumstances extremal solutions are likely to emerge. In other words when does (3) imply that L is negative so that noninvestors are unwilling to participate. This occurs if there are a great many projects with G less than K, so that $F(G^*)$ is high, and any lump sum transfer is very costly to the worker. Indeed, in this case (3) is likely to be positive even for G^V equal to G^*. Suppose that, contrary to our assumption, ownership of projects is itself endogenous and that essentially any individual can, without effort, become an owner of a worthless project which is indistinguishable from worthwhile projects. Then, as long as L is positive all individuals will choose to become owners of such projects so that $F(0)$ is arbitrarily close to one and $f(x)$ for x positive is arbitrarily small. Then (3) is positive for all positive G^V and the

$\{0, V^*\}$ is the unique equilibrium. If, instead, G is uniformly distributed, it is straightforward to show that the interior solution applies when more than half the projects are worthwhile while the boundary solution applies otherwise.

The extremal solution also tends to arise when α is low. This occurs for two reasons. First, a low α means that dG^V/dV, which equals $-1/(1-\alpha)$ is small in absolute value so the negative term of (3) is relatively small. Second, a low α means that, when L is zero so that (5) holds, $K-G^V$ is small. This also tends to reduce the importance of the negative term in (3). Indeed, for α equal zero, a zero L implies that K equals G^V so that (3) is unambiguously positive.

(ii) Noncontractible Projects

If the project is not contractible it is important to consider a setting in which the incentive for the owner to abscond with a lump-sum payment and solicit an offer anew from another worker plays a role. The simplest modification that achieves this is to assume that if at the second stage the owner decides not to invest, the game begins again with workers making new offers to the owner. This gives rise to an infinite horizon game with no discounting but with complete recall. As above, contracts can, in general, include a lump-sum payment and an investment-contingent component. Here, however, the lump-sum component does not automatically create an exclusive relationship.[10]

Our interest is not in fully characterizing the possible equilibria that can arise. Rather, our concern is with the

conclusions that can be drawn about the amount of investment that can occur in equilibria. The first point to note is that there cannot be underinvestment in equilibrium in the sense that an owner whose G exceeds K must eventually invest.[11]. The reason is the following. Suppose, to the contrary that, the best project actually undertaken has a payoff G'' which is above K. Define, for any equilibrium, $Z(t)$ to be the net payoff of the projects which will be undertaken after the t'th round of the game but which have not yet been undertaken by the t'th round. Then, $Z(t)$ is obviously nonincreasing in t[12]. Therefore, for each ε, there is a T such that $Z(T)$ is smaller than ε. This means that at T the owners of all projects can collectively expect a payoff no higher than ε. Therefore, at T, there exists owners whose project yields less than G'' who would prefer to accept the offer $\{0, \alpha K\}$ to continuing with the original equilibrium. Yet, such an offer, if accepted yields profits to the worker. Thus there cannot be an equilibrium with G'' greater than K.

Our remaining findings rely on the observation that no contract which nets an owner who actually invests less than V^* will actually be accepted in equilibrium. To see this, suppose that such an offer is accepted. Since the owner could instead have accepted the offer $\{0, V^*\}$ which workers are always willing to make, it must be the case that the owner intends to earn more than $\{0, V^*\}$ by absconding with the lump-sum component of the offer. Thus workers would not make this offer.

This observation has two consequences. First it implies that

when $\{0, V^*\}$ is the solution in the contractible projects equilibrium (the extremal case) it is also the unique equilibrium when projects are noncontractible. The reason is that, in this case, there is no contract which nets more to an investing owner while letting workers break even.

The second implication is that, even when the solution in the contractible projects equilibrium is interior, there is a range of parameter values for which all the equilibria without contractible investment feature overinvestment. Interiority of the solution in the previous section implies that there is some $\{L, V\}$ combination with positive L and V larger than αK (since overinvestment is assured) which is preferred to $\{0, V^*\}$ by investing owners. This does not guarantee that the contract $\{L', \alpha K\}$ where L' is given by (2) with V equal to αK is preferred to $\{0, V^*\}$; indeed it often is not. When it isn't, all equilibria with noncontractible projects involve overinvestment. This occurs because, to obtain efficient investment, owners would have to accept contracts whose V equals αK. Yet, when $L' + \alpha K$ is lower than V^*, there is no offer whose V equals αK and which lets workers break even that will be accepted in equilibrium.

Thus for a wide range of parameter values there is strict overinvestment. The range we have not considered is where there is an interior solution in the three stage model and the investing owner prefers the $\{L', \alpha K\}$ contract to the $\{0, V^*\}$ contract. It is easy to show that in this range the efficient equilibrium is sustainable.[13]

To gain some understanding of the relative importance of these

ranges we consider the case in which G is uniformly distributed. As mentioned above $\{0, V^*\}$ is then the most attractive contract if less than half the projects are worth undertaking. Even when more than half are worth undertaking, so that we are not in the extremal case, $\{0, V^*\}$ is preferred to $\{L', \alpha K\}$ if and only if less than two thirds of the projects are worth undertaking.

III Take-it-or-leave-it offers by the owner

A different method for eliminating the bargaining power of the workers is to put the informed owner in the position of making a take-it-or-leave-it offer to the uninformed worker at the first stage. In particular, the owner offers to invest if the worker makes a transfer of B to him. This method is attractive when the workers are in some sense already employed by the firm and the owner is unable in any event to carry out the project with some new worker. There thus cannot be a lump sum payment such as L. Any request for such a lump sum payment by the firm will simply be turned down. The offer the firm makes is thus a request for a transfer B which is payable only if investment takes place. If the offer is accepted, investment takes place, if it is rejected it doesn't.

The level of transfer, B, that the owner is willing to accept from the worker may signal something to the worker about the true value of G. We analyze the pure strategy equilibria of this signalling game. Although there are multiple equilibria, several properties that any equilibrium must satisfy can be readily

established.

First, if $B > \alpha K$ the offer will be accepted by the worker. If an owner offers αK, G must equal at least K, for otherwise he would lose by making the offer. On the other hand by accepting an offer of B the worker expects to earn $\alpha E(G|B) - B$, where $E(G|B)$ is the expectation of G given an offer of B. Thus, if B equals αK, $E(G|B)$ is at least K and the worker has nothing to lose by accepting the offer.

The consequence of this result is that the owner will never ask less than αK since he can be sure to gain more by asking αK. A second consequence is that there cannot be underinvestment in equilibrium. By asking αK, an owner can earn $(1-\alpha)G + \alpha K$. Therefore he will always undertake an investment for which $G > K$.

There exist other signalling equilibria. Indeed, for all G' between G^{*} and K, there is a signalling equilibrium in which all investments whose G exceeds G' are carried out. The equilibrium for a given G' in this range is supported by offers equal to $K - (1-\alpha)G'$. These offers as well as smaller offers are accepted, larger offers are rejected.

To see that these are indeed equilibria, consider first the owner who makes an equilibrium offer. He earns $(1-\alpha)G - K + K - (1-\alpha)G'$, which is positive if and only if $G \geq G'$. So, owners whose G exceeds G' benefit by making these offers and gain nothing by making smaller offers. On the other hand owners with $G<G'$ will make larger offers which will be rejected. Therefore a worker who accepts the offer of $K-(1-\alpha)G'$ earns $\alpha E(G|G>G') - K + (1-\alpha)G'$. This gain is,

given (5), nonnegative as long as $G' \geq G^*$.

It is worth noting that, not only do overinvestment equilibria exist, they are extremely desirable from the point of view of the owners whose bargaining power is assumed to be strong. Specifically, owners prefer equilibria with higher transfers so their most preferred equilibrium is the one where all projects whose G exceeds G^* are undertaken.

We now briefly consider what would happen if, instead of giving the owner the right to make take-it-or-leave-it offers in the first stage, we endowed both players with a bargaining strength that more closely resembles that in the third stage of our game. It is difficult to know what outcome to predict from such bargaining since there is a dearth of extensive form models analyzing this case. One possiblity which is suggestive is to imagine that, even in the first stage, the two parties are trying to divide the benefits of the relationship with a fraction α going to the worker. This can be achieved by letting V equal αK. The owner then invests if $(1-\alpha)(G-K)$ is positive so that efficiency prevails.[14] This points to the importance of the change in bargaining strength between stage one and stage three for our overinvestment results.

IV Conclusions

Our main conclusion is that adverse selection creates a tendency towards overinvestment. Moreover in the important case where investment is contractible and there are _ex ante_ large numbers

overinvestment characterizes the unique equilibrium contractual relationship.

That optimal contract has the feature that it requires a lump-sum payment for the exclusive right to the particular project. If our model is correct we ought to observe such payments. In many of the situations which we would argue are characterized by our assumptions, such as cable television franchises and military procurement, it is not uncommon to see substantial lobbying efforts for the right to supply the good in question. Provided the granter of that right - the Municipality or the Defence Department in these examples - is a beneficiary of these efforts, then the initial lobbying can be interpreted as the lump-sum (noncontingent) payment in our model. Besides the wining-and-dining that is usually part and parcel of the rent-dissipation process, such benefits might also include uncompensated design work, feasibility analysis, and consumer surveys performed by the lobbying firm.

In order to highlight the effect of adverse selection on overinvestment, we have made some strong assumptions. For example, our discussion in Section II suggests that the asymmetry in initial bargaining power may be necessary for the result. Similarly, if, as in Grossman and Hart (1986) or Tirole (1986), investment itself is not contractible a countervailing tendency towards underinvestment arises. Finally, our assumption of efficient bargaining is clearly important. Suppose, for purposes of illustration, that bargaining dissipates some fraction, say τ, of the gains from a project. Then we should replace

G by τG in our analysis. In the contractible projects case, for example, it is then immediate from equations (1) and (4) that there could be underinvestment in equilibrium. This is fairly obvious since as τ approaches unity there will be no investment at all! Thus while the presence of bargaining leads to overinvestment, costs of bargaining move the outcome in the opposite direction.

We close with a comment on the implications of our analysis for the traditional anlysis of vertical integration. That analysis asserts that if the costs of organizing economic activity are different within the firm than in markets then situations in which arms-length contracting is inefficient may give rise to vertical integration.[15] This raises the question of the incentives for vertical integration in our model. One common way of thinking about this is issue is to suppose that the firm faces a trade-off in its vertical integration decision. On the one hand, vertical integration may remove the bargaining in the third stage (and replace it with an authority relationship), but, on the other hand, there may be some inefficiency involved in carrying out the transaction "in house".

If that was the case, then owners for whom the third-stage bargaining is particularly costly would have a strong preference for vertical integration. These are the owner's for whom G is high. An equilibrium of a model with endogenous vertical integration and contractible projects might therefore have two cutoffs instead of just one: Owners with projects that exceed the higher cutoff would do the project "in house". Those with projects below this cutoff would offer

their projects in the market as in our model. The second cutoff would divide these projects into those that are undertaken in equilibrium and those that are not. Since the owners with the best projects would self-select out of the market, the adverse selection problem that remains is reduced and the overinvestment that results is less severe. On the other hand, some inefficient vertical integration then coexists with the market's overinvestment.

FOOTNOTES

1   Williamson (1983) shows that efficiency obtains with binding contracts if (and only if) transfers that are valued equally by both parties can be made.

2   This argument is contained, for example, in Hart and Holmstrom (1986), Grossman and Hart (1986), and Milgrom and Roberts (1987).

3   This is what Williamson (1975) refers to as ex ante large numbers.

4   Tirole (1987) provides an example that illustrates how overinvestment can arise in their model.

5   This is a stronger requirement than requiring that investment spending be verifiable since it must also be verifiable that the investment which took place is specific to this owner and this worker. The investment must not be such that the owner can benefit by excluding the worker.

6   If this amount L is positive at the equilibrium contract offered it will be accepted by all owners regardless of their G. By contrast, noninvestors would never take a contract whose L is negative. This means that contracts with negative L's would only have payments to investors and can be lumped together with contracts whose L is zero. With this proviso, we can view L as being paid to all owners.

7   See Roth (1982), Grout (1984).

8   It is immediate from this that, if investment is noncontractible, there is underinvestment.   In this case it is not possible to make first stage transfers which are contingent on whether investment actually takes place.   So, the owner will only invest if $(1-\alpha)G > K$. Yet, investment is socially worthwhile as long as $G \geq K$.   Thus, investments for which the payoff is between K and $K/(1-\alpha)$ will not be undertaken even though they are socially worthwhile.

9   If workers knew G, the expression in (2) would be $\alpha G-V$ for projects in which investment takes place.   Competition between workers then forces V to equal αG.   The owner then gets $(1-\alpha)G-K+\alpha G$ if he invests.   Therefore he invests if G exceeds K and efficiency results.

10   It might be asked why workers ever offer a lump sum component or, put differently, why owners do not simply take the lump sum transfer L and then pursue a relationship with another worker.   The reason for this is that workers are free to draw the inference that an owner who has once accepted a lump sum payment and then not invested is in fact associated with a bad project.   So, while the payment of L doesn't necessarily exclude other workers in the future, it may make workers in the future more reluctant to deal with this particular owner.

11   This rules out the only conceivable form of underinvestment when there is no discounting.   If the payoffs from agreements in later rounds are discounted relative to the payoffs from the first round one could say that there is underinvestment if an owner whose G exceeds K does not invest at the first available opportunity.   It is possible to

construct examples of such delay when the future is discounted as long as $L''+\alpha K$ is bigger than V^*.

12   In any given round either some investments take place or none do. In the latter case Z is unaffected while in the former Z falls since all the projects undertaken have payoffs in excess of K.

13   This can be done as follows. Workers make offers of $\{L',\alpha K\}$ to any owner who has not yet accepted an offer. Owners who accept one of these offers and do not invest are not extended further offers. They are viewed as having a level of G below K. Once again, owners have no incentive not to accept the offers and those whose G exceeds K will, in fact, invest. For a deviating worker to attract an owner he would have to offer a positive lump sum components because V^* is smaller than $L'+\alpha K$. If a worker deviated in this fashion, the owner would accept the offer but would not invest regardless of his G. He would then request new offers. Workers would be willing to extend the offer $\{L',\alpha K\}$ to an owner who has spurned a deviating worker because all owners spurn deviators. Thus the owner is strictly better off by not investing with deviating workers.

14   In the case in which α is one half while the G's can take only a discrete number of values, this solution is identical to the one obtained by applying the axiomatic approach of Harsanyi and Selten (1972) and Myerson (1984).

15   Although this is commonly asserted to be the case in the literature, it is questioned by Grossman and Hart (1986).

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