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ECONOMIC ORGANIZATION OF TRADING RELATIONSHIPS: HIERARCHIES AND ASSET OWNERSHIP

by

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Abstract

I consider a trading relationship nested in an imperfect market for trading partners. Comparing "hierarchical institutions" and "market institutions," I show that both may achieve asymptotic efficiency as trades become frequent and small. Because hierarchical trading institutions require less communication per round, they are more attractive when trades are frequent. If a partially relationship-specific investment needs to be made ex ante, and ex post trading takes place in a hierarchy, the model suggests that the hierarchically superior trader should own the asset.

1. INTRODUCTION

I am concerned with the economic organization of trading relationships understood as the answer to two questions: (1) Should trade take place in a market or a hierarchy? and (2) Who should own relationship-specific assets.

To the extent that literature has distinguished between these two questions, they have been considered independently of each other. The choice between markets and hierarchies has traditionally been seen as a tradeoff between the realization of superior gains from trade in markets and various advantages of hierarchies in the presence of bounded rationality (Simon, 1951; Williamson, 1985). In the first part of this paper, I compare the two institutions in terms of realized gains from trade and communication costs. With small and frequent trades, I show that hierarchies can realize almost all gains from trade, provided the hierarchically superior player will be subjected to sufficiently high switching costs, should his partner quit. Because hierarchies require less communication, they are preferable when trades are small and frequent.

The allocation of ownership rights has recently been analyzed in two papers by Grossman and Hart (1986), and Tirole (1986). Both papers focus on ex ante investment distortions resulting from ex post bargaining over gains from a single round of trade. Minimization of these distortions provides a criterion for choosing between alternative allocations of ownership rights. In my model, the asset can support perpetual trading with a specific partner although the traders may change partners at any time. This latter possibility confers bargaining power to the type of trader who does not make the investment and this will have implications for the efficiency of trade.

Hence, both investment distortions and unrealized gains from trade will matter when comparing alternative ownership patterns. In the latter part of the paper, I explore the fact that asset ownership has implications for switching costs. In particular, I show that it is efficient to have the hierarchically superior trader bear the switching costs from owning specific assets. This means that institutional choice and the allocation of ownership rights are interdependent, rather than separate issues.

I think of a <u>hierarchical trading institution</u> as one in which one trade--the dictator--is given the right to decide which trades do and do not take place. The only recourse given the other player is the possibility of terminating the relationship. Conversely, I think of a <u>market institution</u> as one in which both traders approve all aspects of each trade. These statements are, of course, simultaneously general and fuzzy. To make progress on the analysis, I will define two very specific extensive forms and let them represent hierarchies and markets for the present purposes.

I think of the <u>owner</u> of an asset as the trader who has the right to transfer the asset to another trading relationship. It is instructive to compare this to the "residual rights" concept of ownership suggested by Grossman and Hart (1986). If we think of hierarchical institutions as giving residual rights to the dictator, the definition of Grossman and Hart a priori excludes cases where the hierarchically inferior party "owns" the asset. In contrast, the assertion that such organizations usually are unattractive, will be a result of the present analysis.

While the predictions of the paper are roughly consistent with existing literature, the unit of analysis differs. In particular, I look at trading relationships supported by higher or lower switching costs. The usually analyzed stand-alone trades form a special case. Despite the fact that nearly all actual incidents of hierarchical trading are of a longer lasting nature, existing models of hierarchies do not make use of the power of repetition.[1] Similarly, by definition an asset can be used more than once, and yet standard models of ownership rights focus on single period trading.

The analysis focuses on the following sequence of events. One trader makes a partially relationship-specific investment. The traders then bargain over the price per completed trade. Finally, they engage in repeated trades with time-varying, two-sided private information, governed by a particular trading institution. In Section 2, I abstract from the investment and bargaining stages and consider only the governance of ongoing trade. Armed with the results of that analysis, I then, in Section 3, look at the initial stages to evaluate investment distortions.

2. HIERARCHY VERSUS MARKET

In this section I present a theory of the employment relationship based on the following intuition:

During a typical day an employee will be asked to do several different things, some less enjoyable than others. In principle, the employer and the employee could negotiate over the provision of each service. However, under such an arrangement, they would spend a lot of time negotiating. In practice, therefore, we have the institution called employment relationship under which the employee has agreed to obey dictates. Under this institution, the power of the employee derives from the fact that he can quit and thereby normally subject the employer to some (perhaps small) costs. Because many different tasks have to be accomplished on an average day, the employee will not quit over one unpleasant hour but will keep score over a long period. Only if he is exploited "too much" will he quit. Similarly, the employer will be careful to avoid this by asking only for a "fair" amount of unpleasant work.

The main result is a folk theorem for games with two-sided time-varying private information. This particular version of the folk theorem has not been looked at before, but it has some similarities with that of Abreu, Pearce, and Stachetti (1986). Let me now describe the model.

A. Basic Model

I consider two risk neutral players, A and B, both of whom will trade in perpetuity. We focus on the situation where A and B are trading with each other. If either of them should decide to terminate this trading relationship, they will both enter a new relationship with a partner identical to the one they just left. However, at any point in the game, each trading partner's information only goes back to the start of their relationship. So no player can become a "lemon" in the market.

There are infinitely many periods and infinitely many players of each type, all of whom share the interperiod discount rate R. Each period consists of n ex ante identical trading opportunities, which we will call rounds. The discount rate between rounds, r, is then given by $(1 + r)^n = 1 + R$. This awkward construction is adopted to allow the following: suppose the expected ex ante gains from trade are given within a period, such that $1/n$ of them, in expectation, can be realized in each round. By letting n go to infinity, we can then look at the effects of making trades frequent and small--in effect, approaching continuous time trade. (The more straightforward the construction, setting $n = 1$ and looking at $R \to 0$, suffers from the unfortunate property that the gains from trade go to infinity as we take the limit.[2])

The price per completed trade, γ/n, is exogenous in this section. However, because the players are homogeneous on either side of the market, this price is independent of the identity of the trading partners. We label the rounds by $t = 1,2,\ldots,n,n+1,\ldots$, where round 1 marks the start of the current trading relationship. At the start of each round, player A privately observes a "value," w_t/n, and player B privately observes a "cost," c_t/n. This information remains private forever, while the probability distributions of w_t and c_t are common knowledge. The distributions of w_t and c_t are i.i.d across periods and binomial such that a completed trade gives player A an amount $\bar{\alpha}/n$ with probability p_A and $\underline{\alpha}/n$ with complementary probability. Player B gets $\bar{\beta}/n$ with probability p_B and else $\underline{\beta}/n$. We assume that $\underline{\beta}$ and $\underline{\beta} + \underline{\alpha}$ are negative, while $\bar{\alpha}$, $\underline{\alpha}$, $\bar{\beta}$ and $\underline{\beta} + \bar{\alpha}$, are positive. If no trade occurs, both get 0.

A trading relationship can in principle continue forever, but may be terminated in any round be either player. If this happens, the players return to the market for trading partners and immediately find new partners but incur switching costs (from search, partner specific investments, etc.) Δ_A and Δ_B, respectively, in the process. In the hierarchical institution, it will be convenient to assume that the switching costs of the subordinate player are smaller than the difference between the net present value of his payoffs in the cooperative equilibrium and those when the dictator plays his grim strategy. In this case, this means that either

$$(1) \qquad \Delta_A < (1 - P_B)P_A\bar{\alpha}\{\ell n(1 + R)\}^{-1}$$

for the case when B is the dictator or

$$(2) \qquad \Delta_B < -(1 - P_B)(1 - P_A)\underline{\beta}\{\ell n(1 + R)\}^{-1}$$

Since $\{\ell n(1 + R)\}^{-1}$ is the net present value factor of a continuous stream when the one period discount rate is R, these bounds go to infinity as $R \to 0$. However, since the primary function of R is to scale the gains from trade, any decrease in R should be associated with a decrease in $\bar{\alpha}$ and $\underline{\beta}$. It is therefore somewhat difficult to evaluate these restrictions in the context of the present model. It is easier to think of them based on their role in the results: if the switching costs satisfy these bounds then termination is a credible threat. If not, the subordinate player has no way of credibly threatening the dictator and even a grim strategy equilibrium will be preferred. So for realistic models, where α_t and β_t have more general support, the analog conditions will be weaker. For the market institution no such bounds are required.

Let us now look at the trading institutions and their properties.

B. Hierarchical Trading

I let A be the dictator. The sequence of events in each round is the following: (a) A and B privately observe α_t and β_t, respectively; (b) B makes a not necessarily true statement to A, S_{Bt}, reporting a value of β_t; (c) A dictates whether trade should take place ($a_t = 1$) or not ($a_t = 0$); (d) either player may terminate the relationship (set T_{At} or T_{Bt} equal to one instead of zero); (e) unless the relationship is terminated, payoffs $a_t\alpha_t/n$ and $a_t\beta_t/n$ are realized.

I use the notation $x^t \equiv (x_1, x_2, \ldots, x_t)$. So the information sets imply that a strategy for player A is given by two infinite sequences of functions $a_t(\alpha^t, S_B^t, a^{t-1})$, $T_{At}(\alpha^t, S_B^t, a^t)$, while a strategy for player B is given by the two infinite sequences $S_{Bt}(\beta^t, S_B^{t-1}, a^{t-1})$, $T_{Bt}(\beta^t, S_B^t, a^t)$. I restrict the strategy space (make a stationarity assumption on the strategies) such that, in the event of termination, the players replay the same strategies starting at $t = 1$.

For this game, I can prove the following:

Folk Theorem 1H: As trades become small and frequent ($n \rightarrow \infty$), equilibrium payoffs may be arbitrarily close to the first best.

The formal proof is relegated to the Appendix, but it is useful to review the intuition here. I divide time into a sequence of non-overlapping blocks of time, each consisting of τ rounds of possible trade. Depending on the relationship between τ and n, a block may last a fraction of a period or several periods. In the proof, I look at strategies where the players perform statistical tests on each others' behavior within each block, threatening to terminate the relationship if the partner fails the test. If a block lasts a long time (relative to R), these tests are poor, because the temporal distribution of payoffs within the block is important. However, if trade is frequent, such that a block can last only a short time, the tests perform better. At the limit, the temporal distribution of payoffs within a block becomes irrelevant and only averages matter. So if trades are frequent, knowledge of the distribution of the other players' private information is almost as good as the information itself. It is this mechanism which yields the asymptotic result.

Inspection of the proof reveals the role of switching costs Δ_A and Δ_B: for any equilibrium and any parameter configuration, higher Δ_A's allows B to perform stronger tests and this increases overall efficiency. So we have:

Corollary 1: Increased switching costs will, ceteris paribus, discipline the dictator and allow more efficient equilibria to be sustained. On the other hand, it is necessary that the subordinates' switching costs be low enough to make the threat of termination credible.

Going back to Folk Theorem 1H, let us now consider the implications of making player B the dictator. That is, suppose that a_t is set by player B. In this case the sequence of events is as follows: (a) A and B privately observe α_t and β_t, respectively; (B) A makes a not necessarily true statement to B, S_{At}, reporting a value of α_t; (c) B dictates whether trade should take place or not; (d) either player may terminate the relationship; (e) unless this happens, payoffs $a_t\alpha_t/n$ and $a_t\beta_t/n$ are realized. A strategy for A is now given by the two infinite function sequences $S_{At}(\alpha^t, S_A^{t-1}, a^{t-1})$, $T_{At}(\alpha^t, S_A^t, a^t)$ while B's strategy is of the firm $a_t(\beta_t, S_A^t, a^{t-1})$, $T_{Bt}(\beta^t, S_A^t, a^t)$. Otherwise things are as in the case where A is the dictator. Not surprisingly, we can also here prove that full efficiency can be approached as we go towards continuous time trading (see the Appendix). So the results suggest a limiting form of the Coase conjecture (Coase, 1960), that the allocation of decision rights is irrelevant.

The very special support for α and β obviously limit the direct value of Folk Theorem 1H. In particular, given the impossibility result of Myerson and Satterthwaite (1983), it would be desirable to look at the case where α and β have more general distributions D_α and D_β on [0,1]. As one would expect, this is no problem as long as the switching costs of the subordinate player are lower than the net present value of the difference between his payoffs in the cooperative equilibrium and those when the dictator plays his grim strategy. In the Appendix I prove a version of Folk Theorem 1H for this case.

C. Market Version

It is obvious that many extensive forms can fall under this label. Since I ultimately will argue that this institution requires more communication, my main concern will be to use an extensive form with a minimum amount of communication. Given this, however, I also want a set-up which treats the players symmetrically and allows enough information exchange to prove the analog of Folk Theorem 1H.[3] A further constraint is that I do not want an extensive form which would allow play to proceed as in the hierarchical institution. That is, I want to exclude proposals to use dictatorship. The upshot of these considerations is that I will be looking at a rather special example in this subsection. However, the example will require the minimum amount of communication consistent with my concept of a market institution: both parties may make claims about their private information and an agreement requires the participation of both players. So compared to the hierarchical institution, I have four, instead of two, steps involving communication.

When evaluating this, it is important to keep the following in mind. For the purposes of this paper, the primary goal of this subsection is to show that the market institution can achieve asymptotic efficiency. Given Folk Theorem 1H, it is hardly surprising that such a result can be found. In addition, I would like to suggest that some market institutions, presumably those which are used, can allow more efficient trade for given parameter values than hierarchies.

After this preamble, I will define the following extensive form, still assuming that price is agreed upon ex ante.[4] In each round of possible trade, the sequence of events is as follows: (a) A and B privately observe α_t and β_t, respectively; (b) A makes a not necessarily true statement to B, S_{At}, reporting a value of α_t. Simultaneously, B makes an analog statement, S_{Bt}, to A; (c) A proposes whether they should trade ($a_{At} = 1$) or not ($a_{At} = 0$). Simultaneously, B makes an analog proposal (a_{Bt}); (d) either player may terminate the game (set T_{At} or T_{Bt} equal to one); (e) unless the game is terminated, payoffs $a_{At}a_{Bt}\alpha_t/n$ and $a_{At}a_{Bt}\beta_t/n$ are realized (so there is trade iff both parties propose it).

In this game a strategy for A is given by three infinite sequences of functions $S_{At}(\alpha^t, S_A^{t-1}, S_B^{t-1}, a_A^{t-1}, a_B^{t-1}, T_A^{t-1}, T_B^{t-1})$, $a_{At}(\alpha^t, S_A^t, S_B^t, a_A^{t-1}, a_B^{t-1}, T_A^{t-1}, T_B^{t-1})$ and $T_{At}(\alpha^t, S_A^t, S_B^t, a_A^t, a_B^t, T_A^{t-1}, T_B^{t-1})$. A strategy for B is defined analogously, substituting β^t for α^t. Also here, termination results in replay starting at $t = 1$.

In the Appendix I sketch a proof of the following result:

Folk Theorem 1M: As trades become small and frequent ($n \to \infty$), equilibrium payoffs may be arbitrarily close to the first best.

The theorem is independent of the magnitude of the switching costs, because grim strategies can be used as threats.[5] This was not possible in the hierarchical institution since one player is powerless within that relationship.

D. Comparison

The folk theorems show that both institutions may approach efficient trade as the frequency of trading goes up. At the same time, the weight of the communication costs will increase in that case. Since, per assumption, the communication costs per round are higher in the market institution, this implies:

Proposition 1: When trading is very frequent, net efficiency, gains from trade minus communication costs, may be larger for the hierarchy.

This is the first main result of this paper. Proposition 1 applies to a very special economic structure patterned after a bargaining problem. It should, however, be quite clear that the technique used in the proof can be adapted to much more general models. Such games may, of course, fit the description of an employment relationship more closely.[6]

Because more information can be revealed in the market institution, it seems natural to conjecture that it can support more efficient trade, especially when n is small and R is large. However, for the extensive forms used here, this is not the case, because price is fixed endogenously such that one-shot games will give trade iff $\beta_t = \bar{\beta}$. I originally fixed price exogenously for two reasons. First, I wanted the hierarchical institution to reflect reality and to allow a fair comparison. This entailed that I use the same assumption for the market. Second, given that my focus is on the limiting results, where efficiency is achieved without worrying (directly) about price, this is, in fact, "cheapest" at the limit. Away from the limit, especially in one shot games, it is not realistic to take price as exogenously given. Big gains from trade can be had by endogenizing it. So the realistic analogs of hierarchies in one shot games is take-it-or-leave-it offers to one party. The analog of markets is some symmetric price bargaining game. Following the results of Myerson and Satterthwaite (1983), it is clear that there are market institutions which have greater expected gains from trade than set-ups with take-it-or-leave-it offers. (The work of Abreu, Pearce and Milgrom, 1987, shows that there are instances where it hurts to allow more information to be known.) Given this reasonable but admittedly quite ragged argument we can suggest that <u>intelligently chosen market institutions have greater net efficiency than hierarchies when trading is infrequent</u>.[7] The overall relationship between net efficiency and frequency of trading is illustrated in Figure 1.

<Insert Figure 1 about here>

E. <u>No Communication</u>

If the players cannot communicate, or find it too costly to do so, the market institution is no longer possible. For the hierarchical institution, matters may change greatly. In this case, the dictator has no way of finding out when his action is more costly to the other player. The most efficient equilibria are the ones where the dictator sets a_t equal to zero or one at all times, or lets a_t reflect only his own private information. To make things interesting, we look at the latter case and assume that $\underline{\alpha} + p_B\underline{\beta} + (1 - p_B)\underline{\beta} < 0$ and $\underline{\beta} + p_A\underline{\alpha} + (1 - p_A)\bar{\alpha} < 0$.

Suppose first that A is the dictator. The highest attainable joint average payoff per round is $\{p_A\bar{\alpha} + p_Ap_B\bar{\beta} + p_A(1 - p_B)\underline{\beta}\}/n$. However, this upper bound is only attainable if A can be restrained from cheating. That is, we need a sufficiently high n and/or Δ_A. Similarly, if B is the dictator, the upper bound on the joint average payoff is $\{p_Bp_A\bar{\alpha} + p_B(1 - p_A)\underline{\alpha} + p_B\bar{\beta}\}/n$ and feasibility requires a sufficiently high n and/or Δ_B.

Summarizing, in the limit, player A is a better dictator if Δ_A is relatively high, Δ_B is low and

$$(3) \qquad p_A(1 - p_B)(\bar{\alpha} + \underline{\beta}) > (1 - p_A)p_B(\underline{\alpha} + \underline{\beta})$$

To interpret this condition, note that $p_A(1 - p_B)(\bar{\alpha} + \underline{\beta})/n$ is the minimum foregone utility if B is the dictator, while at least $(1 - p_A)p_B(\underline{\alpha} + \bar{\beta})/n$ is lost if A is the dictator. Thus, we find that also without communication a player is a better dictator if he is subject to relatively higher switching costs and has more valuable information.[8] (See also Farrell, 1987.)

Since communication costs are the main new component of the present theory, it is useful to think of the model without communication as it applies to the employment relation. We have a tendency to think of communication as "cheap" relative to the efficiency losses, and yet it is very rare that such communication actually is observed. Further, the fact that firms commonly delegate hierarchical authority shows that even simple dictatorship entails a nontrivial administrative burden.

Let me now expand the model by taking into account initial investments and price bargaining.

3. THE ALLOCATION OF OWNERSHIP RIGHTS

I here exploit Corollary 1, that dictator switching costs have a positive function in the hierarchy. Since traders who invest in relationship specific assets take on switching costs, the efficiency of hierarchy can be influenced by allocation of these investment responsibilities. In particular, the dictator can be more effectively disciplined the more he has at stake. This then allows me to predict that the employer, not the employee, should own relationship specific assets.

The issue is analyzed by adding two stages in front of the game from Section 2--first, an investment stage, and then a bargaining stage. Because I can piggyback on the results from before, the argument is simple. Let me describe the model.

A. Extensive Forms

At the start of the trading relationship one player, the owner, invests an amount, e, in a partially relationship specific asset which he will operate himself. As in Grossman and Hart (1986), it is assumed that the investment level is observable, but not verifiable, and thus noncontractible. The effect of the investment is to increase the possible gains from trade. So if A is the owner, the probability of a high value, $P_A(e)$, is increasing in e, and if B is the owner, the probability of a low cost, $P_B(e)$, is increasing in e. I assume that these functions are bounded away from one. For simplicity, we further require that only one player can invest and that total gains from trade are independent of the identity of the owner.[9] The investment decision is made with full knowledge of the rest of the game tree (since all trading relationships are identically organized). After the investment is made, the traders bargain to arrive at a price per completed trade, γ/n. Also the bargaining takes place with full knowledge of the institution governing ex post trades. As in Section 2, we confine attention to cases where $\underline{\beta}$ and $\underline{\beta} + \underline{\alpha}$ are negative and $\bar{\alpha}$, $\underline{\alpha}$, $\bar{\beta}$ and $\underline{\beta} + \bar{\alpha}$ are positive.

If the trading relationship is terminated, a fraction, $\nu \in (0,1)$ of the value of the asset is lost. So if δ is a player's switching cost due to other factors, we can find total switching costs as $\Delta_A = \delta + \nu e$, $\Delta_B = \delta$ if A is the owner and $\Delta_A = \delta$, $\Delta_B = \delta + \nu e$ if B is the owner.[10]

Now for some notation. A variable or function subscript i,j refers to the owner (i = A,B) and the trading institution (j = a if the buyer A is hierarchically superior and j = b if the seller B is hierarchically superior. Use the following shorthand from the maximum total gains from trade, contingent on e,

$$(4) \qquad G(e) \equiv (\bar{\alpha} + \bar{\beta})p_A p_B + (\bar{\alpha} + \underline{\beta})p_A(1 - p_B) + (\underline{\alpha} + \bar{\beta})(1 - p_A)p_B.$$

Further, let $F_{ij}(\Delta_A, \Delta_B, e)$ denote the expected fraction of G(e) which are realized when i is the owner, j is the institution, switching costs are Δ_A, Δ_B, respectively, and investment is e. So F_{ij} is contingent on a particular equilibrium being played in the repeated trading game from Section 2. There are infinitely many equilibria of that game and I have only characterized one. Nevertheless, I submit that the analysis in Section 2 as summarized in Corollary 1, makes it reasonable to assume that:

<u>Assumption</u>: (i) $F_{Aa} > F_{Ba}$, for a given e.

(ii) $dF_{Aa}/de \geq 0 \geq dF_{Ba}/de$, for a given e,

and conversely if b is hierarchically superior.

That is, (i) a greater fraction of gross gains will be realized if the hierarchically superior party owns the asset and (ii) increasing investments help when the superior party owns the asset and they hurt when he does not.

I still need to specify the nature of the bargaining process leading to γ/n. To keep the exposition simple, I follow Grossman and Hart (1986) and postulate a particular equilibrium function. Specifically, I assume that a player's share of FG will be equal to his opponent's share of total switching costs. Denote by S_{ij} the share of FG going to A when i is the owner and j is hierarchically superior. I then assume

$$(5) \qquad S_{Aj} = \delta(2\delta + \nu e)^{-1} = 1 - S_{Bj}.$$

I finally use K^A_{ij}, K^B_{ij} to denote communication costs incurred by A and

B, respectively. I assume that these are independent of e and that their sum is independent of the identity of the owner.

B. Analysis

Based on the above, the first best level of investment is

(6) $$e^*_{ij} \equiv \arg\max F_{ij}G - e - K^A_{ij} - K^B_{ij}$$

and equilibrium investments are

(7) $$\tilde{e}_{ij} \equiv \arg\max \delta(2\delta + \nu e)^{-1} F_{ij}G - e - K^i_{ij}.$$

Assuming that differentiability and concavity hold for both (6) and (7), I can show the following:

Proposition 2: In hierarchies, it is more efficient if the hierarchically superior trader owns relationship-specific assets.

The proof, which is contained in the Appendix, reveals that employer ownership is favored with respect to both realized gains from trade and investment distortions. The first part of the argument is obviously just Assumption (i). The investment advantage follows from Assumption (ii). Greater switching costs for the dictator play a positive role, while greater switching costs for the subordinate may impede efficient trading. This is illustrated in Figure 2.

<Insert Figure 2 about here>

While the proposition is true within the assumptions of the model, there are obviously more special cases in which the conclusion would reverse. In particular, if the degree of asset specificity ν differ between the traders, there may be some reason for having the player with the best outside options win the asset. However, the forces generating the above result would still be at work.

4. CONCLUSION

In this paper I have suggested a new theory of economic organization. The prediction of the theory are very similar to those of transaction cost economics. Concerning hierarchies, both theories agree that market frictions and frequent trading leads to hierarchies. However, the results depend on very different premises. In Williamson (1979), hierarchies are expensive to create and high frequency helps spread the costs over many trades. In contrast, I look at hierarchies as relatively cheaper to administer, with high frequency giving them approximate efficiency. Concerning asset ownership, the present paper only contains a very partial theory. However, the fact that asset specificity can play a positive role in hierarchies could probably be used to develop a more complete theory of the choice between markets and hierarchies with different allocations of ownership rights. In particular, one could conjecture that more asset specificity, ceteris paribus, favor hierarchies over markets. This conjecture, illustrated in Figure 3, is also consistent with transaction cost economics, although once again for different reasons. Williamson (1984) is more concerned with incentive intensity and bargaining costs, while my argument rests on investment distortions and the efficiency of hierarchies.

<Insert Figure 3 about here>

The two theories are, however, not inconsistent, and many of the existing empirical tests of transaction cost economics can be used to support the present theory as well (e.g., Andersen and Schmittlein, 1984; Monteverde and Teece, 1982; or Masten, 1984). In fact, because the predictions of the two theories are so similar, it may not be easy to devise a discriminating test.

There is another, more troubling, problem in relating the present theory to transaction cost economics. Coase's (1937) original insight was that "a firm [has a] role to play in the economic system if . . . transactions [can] be organized within the firm at less cost than if the same transactions were carried out through the market." This statement, and the implications that markets and firms are alternatives, have often been looked at as a tautology. And, I indeed adopted that terminology in Section 2. However, <u>in the present model, markets</u> in the usual sense of the word, <u>are not direct alternatives to hierarchy</u>. With positive switching costs, the model in Section 2 compares two equilibria--one where one player chooses to accept dictates, and one in which the players bargain. If the relationship is dissolved, the players can go to the market for alternative trading partners. Without switching costs, the bargaining equilibrium has both players looking at several other partners. so the choice between the two equilibria can be seen as a market/hierarchy choice in that case. But in the interesting case, when switching costs are positive, hierarchies and markets are not really direct alternatives. The primary reason for this difference is that Williamson thinks of governance structures as covering both the negotiation and the execution of transactions (1979, p. 239). In contrast, I have focused on execution alone (adoption of trading relationships).

A further distinguishing characteristic of my theory is related to the point raised in the first paragraph of this paper. Much existing theory has not differentiated between the nature of a trading relationship (hierarchy) and the allocation of ownership rights (integration). The perspective in this paper holds that these are different questions. That is, instead of looking at a make-or-buy decision, we ought to look at two matters: how the trading relationship is organized, and who owns the relevant assets.

My focus on trading relationships can be seen as a generalization of standard theory aimed at exploring the impact of market frictions. As always, the proof is in the taste of the pudding, but I hope to have demonstrated that this allows intuitively satisfactory explanations of important phenomena. The model in this paper is very narrow. It is obviously difficult to speculate on the extent to which the framework can be used more generally. However, compared to other theories of economic organization, the present theory is relatively easy to formalize.

Appendix

Let $\hat{\sigma}$ be a pair of subgame perfect equilibrium supergame strategies, and let $\hat{u}_A$ and $\hat{u}_B$ be the expected discounted average period payoffs in this equilibrium. The cooperative solution, which entails setting $a_t = 0$ iff $(\alpha_t, \beta_t) = (\underline{\alpha}, \underline{\beta})$, gives the expected per period payoffs

$$u_A^* \equiv \Sigma_{t=1}^{n} \; [1/(1 + r)]^{t-1} [p_A\bar{\alpha} + (1 - p_A)p_B\underline{\alpha}]/n$$

$$u_B^* \equiv \Sigma_{t=1}^{n} \; [1/(1 + r)]^{t-1} [(1 - p_B)p_A\underline{\beta} + p_B\bar{\beta}]/n.$$

So we can state the Folk Theorem as:

Folk Theorem 1H: $\forall\ \varepsilon > 0\ \exists\ \bar{n} > 0\ \forall\ n > \bar{n}\ \exists\ \hat{\sigma}$: $\hat{u}_A + \varepsilon > u_A^*$ and $\hat{u}_B + \varepsilon > u_B^*$.

Proof: I will proceed by construction. Divide time into a sequence of non-overlapping blocks of time each consisting of τ rounds of possible trade (τ may not exceed n). We will consider strategies where termination results as soon as B has send the message $\underline{\beta}$ more than $(1 - p_B)\tau$ times in a block or A has responded to this message with $a = 1$ more than $p_A(1 - p_B)\tau$ times.[11] The result will be established in two steps. First, I show that the discounted average period payoffs, given this block structure, have the desired limiting properties. Second, I find conditions under which the block structure is compatible with subgame perfection.

Given the block structure, the players face conceptually simple Markov decision problems: each player wants to take/claim his benefits early and when they are worth the most. While it is computationally difficult to solve these problems, their solution clearly exists.

Let us first take a look at player A. From the perspective of A, the worst thing B can do is to claim his $\underline{\beta}$'s on the first $(1 - p_B)\tau$ rounds of each block. In this case, we will say that B plays his "greedy" strategy. Suppose now that A responds with the following, not necessarily optimal, "friendly" strategy: take $a_t = 0$ iff $S_{Bt} = \underline{\beta}$ and $a_t = \underline{\alpha}$ until the last few rounds which a series of $a_t = 0$ or $a_t = 1$ will be taken to use exactly (up to an integer) $p_A(1 - p_B)\tau$ instances of $a_t = 1$ after $S_{Bt} = \underline{\beta}$. The expected discounted average per period payoff to A, resulting from this scenario, is a lower bound to that obtained in a perfect equilibrium within the block structure. Call this $\underline{u}_A$. I can then prove the following lemma.

Lemma 1: $\lim_{\tau\to\infty} \lim_{n\to\infty} \underline{u}_A = \lim_{n\to\infty} u^*_A$.

Proof: We look at the average discounted per period payoff to player A if he plays friendly and B pays his greedy strategy. If $\underline{u}_A$ denotes A's average discounted per period payoff within a block, we can write $\underline{u}_A$ as:

$$(A.1) \qquad \underline{u}_A = (n/\tau) \sum_{s=0}^{(1-p_A)1-p_B)\tau} [p_A^{p_A(1-p_B)\tau} (1 - p_A)^s \binom{p_A(1 - P_B)\tau + s}{s}$$

$$\times \sum_{t=1}^{p_A(1-p_B)\tau+\beta} (1 + r)^{1-t}\, \underline{\alpha} \frac{P_A(1 - p_B)\tau}{p_A(1 - p_B)\tau + s}]/n$$

$$+ \ (n/r) \sum_{s=0}^{p_A(1-p_B)\tau} [p_A^s(1 - p_A)^{(1-p_A)(1-p_B)\tau} \binom{(1 - p_A)(1 - p_B)\tau + s}{s}$$

$$\times \ \Big(\sum_{t=1}^{(1-p_A)(1-p_B)\tau+s} (1 + r)^{1-t} \bar{\alpha} \frac{s}{(1 - p_A)(1 - p_B)\tau + s}$$

$$+ \sum_{t=(1-p_A)(1-p_B)\tau+s+1}^{(1-p_B)\tau} (1 + r)^{1-t}\bar{\alpha}\Big)]/n$$

$$+ \ (n/\tau) \sum_{t=(1-p_B)\tau+1}^{\tau} (1 + r)^{1-t} \ [p_A\bar{\alpha} + (1 - p_A)\underline{\alpha}]/n$$

To interpret this, it helpful to look at Figure 4. The first term accounts for the realization where the cumulative number of times in which $a_t = 1$ hits the horizontal line; the second term accounts for the realizations where this total hits the sloping line; and the third term gives the expected net present value for the rest of the block.

Insert Figure 4 about here

Now fix a τ. As $n \to \infty$, $r \to 0$, and the different temporal positions of the three terms becomes immaterial, so (A.1) degenerates to:

$$\text{(A.2)} \qquad \lim_{n\to\infty} \underline{u}_A = \{ \sum_{s=0}^{(1-p_A)(1-p_B)\tau} p_A^{p_A(1-p_B)\tau} (1 - p_A)^s \binom{p_A(1 - p_B)\tau + s}{s} \bar{\alpha} p_A(1 - p_A)\tau$$

$$+ \sum_{s=0}^{p_A(1-p_B)\tau} p_A^s(1 - p_A)^{(1-p_A)(1-p_B)\tau} \binom{(1 - p_A)(1 - p_B)\tau + s}{s}$$

$$\times (\bar{\alpha}s + \bar{\alpha}[(1 - p_B)\tau - s - (1 - p_A)(1 - p_B)\tau]) + \tau p_B[p_A\bar{\alpha} + (1 - p_A)\underline{\alpha}]\}$$

$$\times \lim_{n\to\infty} \sum_{t=1}^{\tau} (1 + R)^{(1-t)/n}$$

If we let $\tau \to \infty$ the value of the first two terms converge to that realized when the process moves along a "straight" line from $(0,0)$ to $((1 - p_B)\tau,\ p_A(1 - p_B)\tau)$. So as $t \to \infty$, (A.2) degenerates to

$$\text{(A.3)} \qquad \lim_{\tau\to\infty} \lim_{n\to\infty} \underline{u}_A = \{(1 - p_B)p_A\bar{\alpha} + p_B[p_A\bar{\alpha} + (1 - p_A)\underline{\alpha}]\}[\ln(1 + R)]^{-1}$$
$$= [p_A\bar{\alpha} + p_B(1 - p_A)\underline{\alpha}[\ln(1 + R)]^{-1} = \lim_{n\to\infty} u_A^*.$$

So the average discounted per period payoff goes to $\lim_{n\to\infty} u_A^*$ as first $n \to \infty$ and then $\tau \to \infty$. Q.E.D.

To prove the analog result for B, I assume that A plays greedily and B plays friendly. that is, we assume that A takes $a_t = 1$ after the first $p_A(1 - p_B)\tau$ instances of $s_{Bt} = \underline{\beta}$. Similarly, I assume that B sends truthful messages until the last few rounds when he claims $\underline{\beta}$ or $\bar{\beta}$ constantly such that he just fills his quota of $(1 - p_B)\tau$ $\underline{\beta}$'s. Again here, B's expected discounted average per period payoff is a lower bound to what he will get in a perfect equilibrium under the block structure. By another trivial but tedious calculation we can see that lim $\tau \to \infty$ lim $n \to \infty$ of this lower bound equals lim $n \to \infty$ of u_B^*.

It remains to be shown that the block structure can be a subgame perfect equilibrium. Let me first establish that it can be an equilibrium. Note that individual rationality is guaranteed by assumption. So it is sufficient to demonstrate that the players in no circumstances will go beyond their quotas. Consider A. His incentives to go beyond his quota are largest if he has used his $p_A(1 - p_B)\tau$ instances of "$a_t = 1$ after $S_{Bt} = \underline{\beta}$" in the initial $p_A(1 - p_B)\tau$ rounds of a block. At that point his expected net present value from cheating is given by:

$$\sum_{t=1}^{[1-p_A(1-p_B)]\tau} (1 + r)^{1-t}[p_A\bar{\alpha}/n + (1 - p_A)\underline{\alpha}/n]$$

$$+ (V_A - \Delta_A)[1/(1 + r)]^{[1-p_A(1-p_B)]\tau}$$

where V_A is A's expected net present value from the equilibrium, evaluated at the start of a block. Conversely, his expected net present value from staying within his quota is bounded from below by

$$\sum_{t=(1-p_A)(1-p_B)\tau+1}^{[1-p_A(1-p_B)]\tau} (1 + r)^{1-t}[p_A\bar{\alpha}/n + (1 - p_A)\underline{\alpha}/n]$$

$$+ V_A[1/(1 + r)]^{[1-p_A(1-p_B)]\tau}$$

From this, a sufficient condition for A not violating his quota is:

$$(A.4)\qquad \sum_{t=1}^{(1-p_A)(1-p_B)\tau} (1+r)^{1-t}[p_A\bar{\alpha}/n + (1-p_A)\underline{\alpha}/n]$$

$$< \Delta_A[1/(1+r)]^{[1-p_A(1-p_B)]\tau}$$

To derive an analog condition for B, I focus on the situation where he has used his $(1 - p_B)\tau$ messages claiming $\underline{\beta}$ in the first $(1 - p_B)\tau$ rounds of a block. From that point his expected net present value from cheating is bounded from above by

$$\sum_{t=1}^{p_B\tau} (1+r)^{1-t} p_A[p_B\bar{\beta}/n + (1-p_B)\underline{\beta}/n] + (V_B - \Delta_B)[1/(1+r)]^{p_B\tau}$$

Conversely, his expected net present value from staying within his quota is

$$\sum_{t=1}^{p_B\tau} (1+r)^{1-t} p_B[p_B\bar{\beta}/n + (1-p_B)\underline{\beta}/n] + V_B[1/(1+r)]^{p_B\tau}$$

where V_B is B's expected net present value from the equilibrium, evaluated at the start of a block. So a sufficient condition for B to stay within his quota is:

$$(A.5)\quad \sum_{t=1}^{p_B\tau} (1+r)^{1-t}(1-p_A)[p_B\bar{\beta} + (1-p_B)\underline{\beta}] < n\Delta_B[1/(1+r)]^{p_B\tau}$$

For a given n, (A.4) and (A.5) given an upper bound on τ, call $\bar{\tau}(n)$. If τ is greater than this, the temptation to cheat will become overwhelming. I can show:

Lemma 2: $\bar{\tau}(n) \to \infty$ as $n \to \infty$.

Proof: We here look at the maximum block length $\bar{\tau}(n)$, under which player A will refrain from violating his quota. If we hold r and V_A constant, $\bar{\tau}(n)$ is given by

$$(A.6) \qquad \bar{\tau}(n) = \max\{\tau(n) | \sum_{t=1}^{(1-p_A)(1-p_B)\tau(n)} (1 + r)^{1-t}[p_A\bar{\alpha} + (1 - p_A)\underline{\alpha}]/n$$

$$< \Delta_A[1/(1 + r)]^{[1-p_A(1-p_B)]\tau(n)}\}$$

from equation (A.4).

We can rewrite (A.6) as

$$(A.7) \qquad \bar{\tau}(n) = \max\{\tau(n) | \sum_{t=1-[1-p_A(1-p_B)]\tau(n)}^{-p_B\tau(n)} (1 + r)^{1-t}$$

$$< n\Delta_A[p_A\bar{\alpha} + (1 - p_A)\underline{\alpha}]^{-1}\}$$

If we let $r \to 0$, the left side of this inequality goes to $(1 - p_B)(1 - p_A)\tau(n) - 1$ while the right side goes to positive infinity. So the maximum block length under which A will obtain from violating his quota goes to infinity as n goes to infinity.

The arguments for player B, using equation (A.5), can be made by analogous methods. Q.E.D.

So the limiting arguments from the first part of the proof remain valid under (A.4) and (A.5).

To show subgame perfection I need to make sure that termination is a rational response to violation of a quota. Suppose that A sets a = 1 at all times after any violation until the game is terminated. In this case B will terminate the game if

$$\text{(A.8)} \qquad [p_B\bar{\beta}/n + (1 - p_B)\underline{\beta}/n]/r < -\Delta_B + \underline{u}_B/R$$

By Lemma 1, $\underline{u}_B \to u_B^*$ as $n \to \infty$, such that (A.8) at the limit reduces to

$$\Delta_B < -\lim_{n\to\infty} \Sigma_{s=1}^{\infty} (1 + r)^{1-s}(1 - p_B)(1 - p_A)\underline{\beta}/n$$

$$= - (1 - p_B)(1 - p_A)\underline{\beta}\{\ln(1 + R)\}^{-1}$$

which holds by assumption.[12] Q.E.D.

Proof of Analog to Folk Theorem 1H when B is the Dictator (Sketch)

The proof is by construction and again uses quota systems. In this case, B only allows A to claim $\bar{\alpha}$ at total of $p_A\tau$ times in a block while A only allows B to respond to $\underline{\alpha}$ with a = 0 a fraction, $1 - p_B$, of the time within a block. Given this, the limiting arguments work as before.

The only new element comes in when we need to show that termination by A is a subgame perfect response if the quotas are violated. To this end, suppose that B will follow any quota violation by setting $a_t = 1$ iff $\beta_t = \underline{\beta}$ for all times until termination. In this case A will terminate if

$$\text{(A.9)} \qquad p_B[p_A\bar{\alpha} + (1 - p_A)\underline{\alpha}/(nr) < -\Delta_A + \underline{u}_A/R$$

where $\underline{u}_A$ is defined analogously to $\underline{u}_B$. As $n \to \infty$, this reduces to the assumed constraint on Δ_A:

$$\Delta_A < (1 - p_B)p_A\bar{\alpha}\{\ell n(1 + R)\}^{-1} \qquad \text{Q.E.D.}$$

<u>Proof of Folk Theorem 1H for General Distributions</u>: Suppose first that the D's have no mass points. Consider the same strategies as in the proof of Folk Theorem 1H with the following difference. Fix an integer $m \geq 2$. If in any block player A announces "too many" values in any interval $[0, 1/m)$, $[1/m, 2/m), \ldots, [(m - 1/m, 1]$, player B will terminate the game. Similarly, if player B makes "too many" dictates which place his value in any interval $[1/m, 1]$, $[2/m, 1), \ldots, [(m - 1)/m, 1]$, player A will terminate the game. In such a setting, "truth telling" consists in announcing the actual intervals in which α and β are realized. Clearly for fixed m we can proceed as in Folk Theorem 1H to show that the players almost surely will tell the truth as $\tau \to \infty$ after $n \to \infty$. The average efficiency loss from this is

$$\Sigma_{i=0}^{m-1} \{D_\alpha[(i + 1)/m] - D_\alpha(i/m)]\}\{D_\beta[(1 + 1)/m] - D_\beta(i/m)](1/2)$$

If we let m go to infinity, this goes to zero for differentiable D_α, D_β.

If one or both D's have mass points, the proof is modified by letting each mass point be its own "interval." Q.E.D.

Proof of Folk Theorem 1M: I use the same strategies as in the proof of Folk Theorem 1H with the following change. If in any block either player announces "too many" high or low values, his opponent will terminate the game. Further, if a player refuses to trade when the announced values indicate that it is efficient, his opponent will terminate the game.

In the proof of Folk Theorem 1H I showed that A would converge to true reporting as $\tau \to \infty$ after $n \to \infty$. This argument now applies to both players. Similarly, the argument from Folk Theorem 1H that B will converge to "fair" dictates now applies to both players.

To show that termination is subgame perfect for B I assume that A responds to quota violation by always claiming $\bar{\alpha}$. To get the converse I assume that B responds to violation only be wanting to trade when $\beta_t = \bar{\beta}$.

If Δ_A and Δ_B are sufficiently large, the players may prefer staying in such a grim strategy equilibrium over switching. In this case, it is the threat of that punishment which sustains the asymptotically efficient equilibrium. Q.E.D.

For a given function x, let $\tilde{x}_{ij}$ refer to its equilibrium value when ij is the economic organization. So we can state Proposition 2 as:

Proposition 2:

$$\tilde{F}_{Aa} - \tilde{G}_{Aa} - \tilde{e}_{Aa} - K^A_{Aa} - K^B_{Aa} > \tilde{F}_{Ba}\tilde{G}_{Ba} - \tilde{e}_{Ba} - K^A_{Ba} - K^B_{Ba};$$

$$\tilde{F}_{Bb} - \tilde{G}_{Bb} - \tilde{e}_{Bb} - K^A_{Bb} - K^B_{Bb} > \tilde{F}_{Ab}\tilde{G}_{Ab} - \tilde{e}_{Ab} - K^A_{Ab} - K^B_{Ab}.$$

Proof: I will establish the first inequality. The second follows by relabeling. The proof will consist of three steps. First, note that the K's are identical on both sides of the inequality and that Assumption (i) guarantees $F_{Aa}(e) > F_{Ba}(e)$.

Second, the first order condition from (6) defines e^*_{Aj} by $d(F^*_{ia}G^*)/de = 1$, while (7) gives $\tilde{e}_{ia}$ by

$$\text{(A.10)} \qquad d(F_{ia}G)/de = [1 - \tilde{F}_{ia}\tilde{G}_{ia}d\tilde{S}_{ia}/de]S^{-1}_{Aa}$$

Since $dS_{Aa}/de < 0$ and $S \in (0,1)$, the concavity of (6) tells us that $e^*_{ia} < \max\{\tilde{e}_{Aa}, \tilde{e}_{Ba}\}$. So there is underinvestment whether A or B is the owner.

Third, I show that the underinvestment is larger when B is the owner. Formally:

Lemma 3: $\tilde{e}_{Aa} > \tilde{e}_{Ba}$.

Proof: We can rewrite (7) as

$$\tilde{e}_{ij} \equiv \arg\max H_{ij}(e) - e.$$

Assumptions (i) and (ii) tell us that $H_{Aa} > H_{Ba}$ and that $dH_{Aa}/de > dH_{Ba}/de$. So $\tilde{e}_{Aa} > \tilde{e}_{Ba}$. Q.E.D.

Given these facts, the result follows. Q.E.D.

References

Abreu, Dilip, David Pearce and Ennio Stachetti, "Towards a Theory of Discounted Repeated Games with Imperfect Monitoring," mimeo, Harvard University, 1986.

Abreu, Dilip, Paul Milgrom and David Pearce, "Information and Timing in Repeated Partnerships," mimeo, Yale University, 1987.

Anderson, Erin and David Schmittlein, "Integration of the Sales Force: An Empirical Examination," Rand Journal of Economics, 15, 385-95, 1984.

Coase, Ronald H., "The Nature of the Firm," Economica N.S., 4, 386-405, 1937.

Coase, Ronald H., "The Problem of Social Cost," Journal of Law and Economics, 3, 1-44, 1960.

Farrell, Joseph, "Rights and Efficiency," mimeo, GTE Labs, 1986.

Farrell, Joseph, "Rigidity vs. License," American Economic Review, 77, 195-97, 1987.

Farrell, Joseph and Eric Maskin, "Renegotiation in Repeated Games," mimeo, Harvard University, 1987.

Gilson, Ronald J. and Robert H. Mnookin, "Sharing Among the Human Capitalists," Stanford Law Review, 37, 313-92, 1985.

Grossman, Sanford and Oliver D. Hart, "The Costs and Benefits of Ownership," Journal of Political Economy, 94, 691-719, 1986.

Holmstrom, Bengt and Paul Milgrom, "Aggregation and Linearity in the Provision of Intertemporal Incentives," Econometrica, 55, 303-28, 1987.

Kreps, David M., "Corporate Culture and Economic Theory," mimeo, Stanford University, 1984.

Masten, Scott, "The Organization of Production: Evidence from the Aerospace Industry," Journal of Law and Economics, 27, 403-18, 1984.

Monteverde, Kirk and David Teece, "Supplier Switching Costs and Vertical Integration in the Automobile Industry," Bell Journal of Economics, 13, 206-13, 1982.

Myerson, Roger B. and Mark A. Satterthwaite, "Efficient Mechanisms for Bilateral Trading," Journal of Economic Theory, 29, 265-81, 1983.

Radner, Roy, "Repeated Principal-Agent Games with Discounting," Econometrica, 53, 1173-98, 1985.

Simon, Robert A., "A Formal Theory of the Employment Relationship," Econometrica, 19, 293-305, 1951.

Tirole, Jean, "Procurement and Renegotiation," Journal of Political Economy, 94, 235-259, 1986.

Williamson, Oliver E., "The Incentive Limits of Firms: A Comparative Institutional Assessment of Bureaucracy," Weltwirtschaftliches Archiv, 120, 736-62, 1984.

Williamson, Oliver E., "Transaction-cost Economics: The Governance of Contractual Relations," Journal of Law and Economics, 22, 223-61, 1979.

Williamson, Oliver E., The Economic Intuitions of Capitalism, New York, N.Y.: Free Press, 1985.

Notes

1. The idea that repetition can discipline the dictator in a hierarchy has only recently been introduced by Kreps (1984), and Gilson and Mnookin (1985). The present model is, in many ways, an elaboration and reformulation of Kreps' ideas.

2. As long as it is possible to switch partners, asymptotic efficiency cannot be achieved in this case. In the unrealistic case where no switching is allowed, grim strategies can serve as threats to give us folk theorems.

3. Yet another way to achieve generality would involve use of the revelation principle. However, this obscures the details of communication which are the focus here.

4. It is tempting to define a market institution by endogenous prices. However, this stacks the deck in my favor.

5. Of course, many of the punishments used here and elsewhere are not renegotiation-proof, but this detail can be taken care of using the techniques of Farrell and Maskin, 1987.

6. To interpret these more general versions of Proposition 1, note that the semantic meaning of different levels of a_t is immaterial. We do not need ex ante knowledge of them, nor do they have to be time invariant. All we need is a constant distribution over their payoff implications.

7. Of course, in some cases institutions with arbitrators or time-varying price menus may do even better (Farrell, 1986).

8. In principle we could find a single inequality condition for the choice of dictator by comparing payoffs from the optimal equilibria for given parameter values. However, such an exercise is very difficult to carry out, and it is not clear that the insights would extend beyond the specifics of the model.

9. I am here assuming that the investment decisions are made in the context of this game only. If players are involved in several trading relationships, investment distortions may disappear entirely due to reputation/supergame effects.

10. Since any new relationship will be identical to the existing relationship, the owner will be the same and he will want the asset to be of the same size.

11. There is no reason to believe that this equilibrium is second best. One would expect that constructions similar to those of Holmstrom and Milgrom (1987) and Radner (1985) dominate it.

12. This statement depends on Δ being independent of n.

Figure 1

Net Efficiency of Markets and Hierarchies

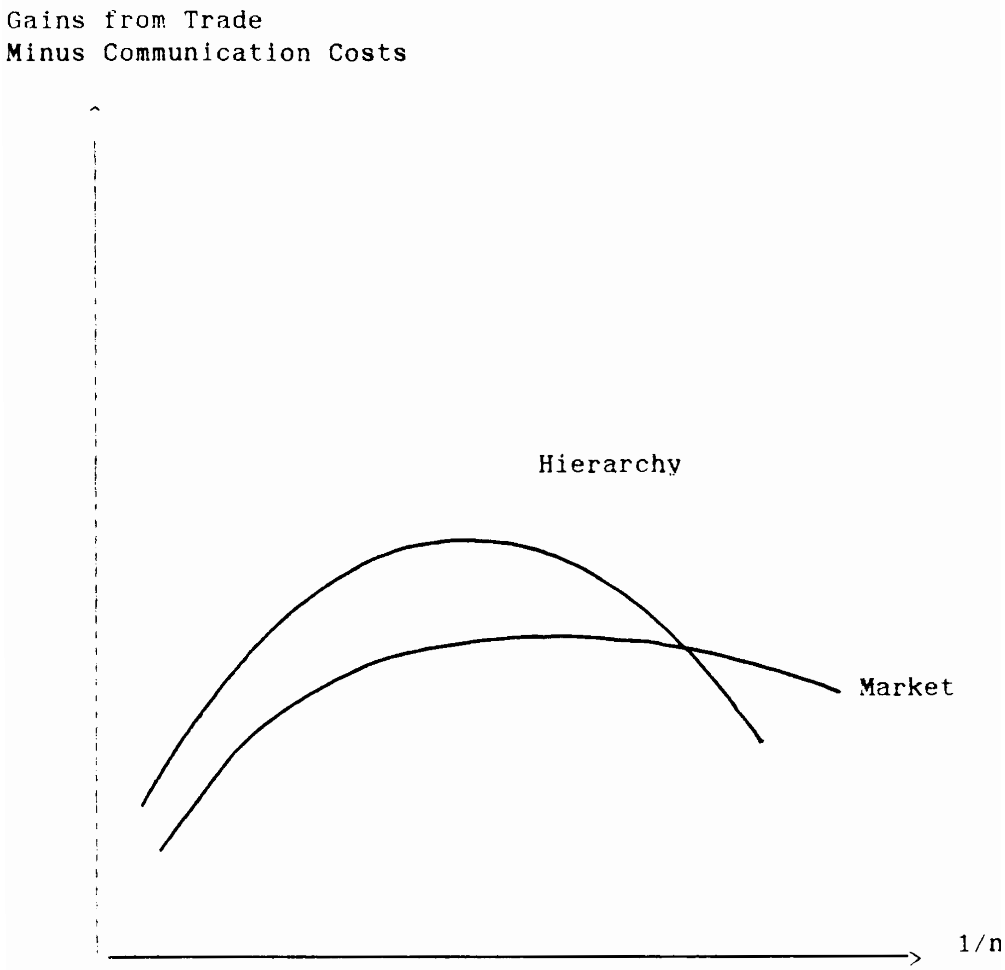

Figure 2

Allocation of Ownership Rights and Overall Efficiency

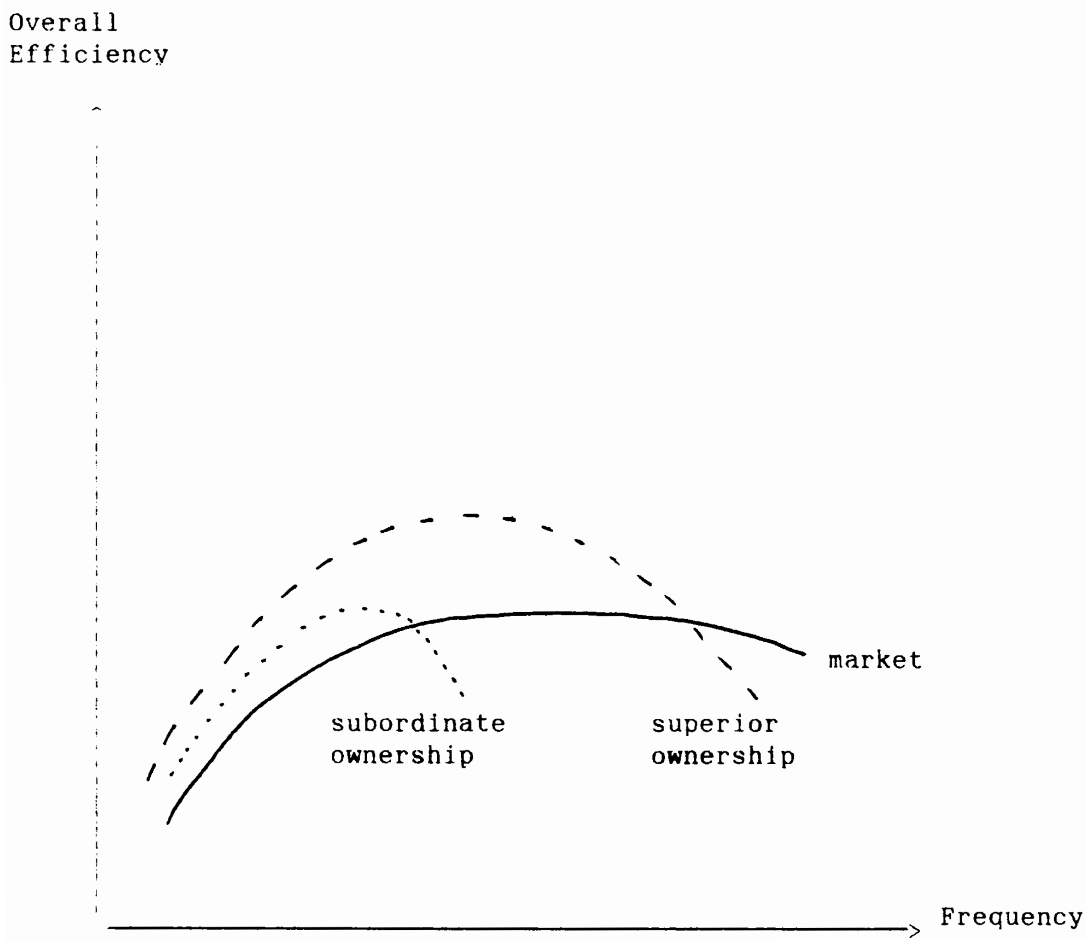

Figure 3

Conjectured Relationship Between Specificity and Overall Efficiency

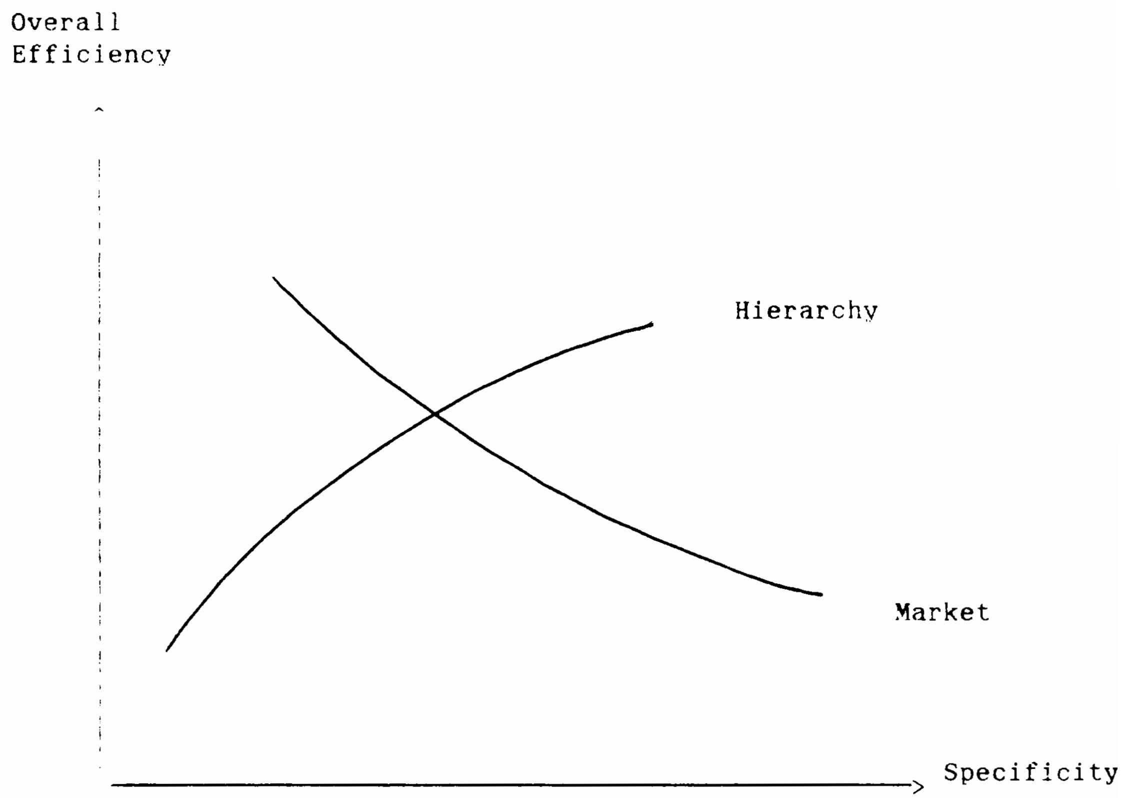

Figure 4

Possible Realizations of A's Friendly Strategy