Control vs. Incentive—the Optimal Allocation of Ownership

Tianxi Wang[1]

London School of Economics

The paper first differentiates “control” and “incentive”. Then it shows that integration in which the principal gets ownership of the physical assets necessary for the agent to create values enhances control of the principal over the agent’s human capital and thus improve coordination ex post, but that reduces the agent’s ex ante incentive to make human capital investment and ex post incentive to exert effort. Thus optimal ownership structure is determined by the balance of control vs. incentive and integration happens if and only if benefit of coordination outweighs the incentive losses.

1. Introduction

In the period January-November 2005, 24,806 Merger and Acquisition (M&A) deals with a combined value of US$2,059 billion have so far completed around the world[2]. How to understand these huge M&A activities? Do they bear any economical efficiency? If someone opens “The Economist” journals, he finds that almost every essay about M&A features a word “Synergy”; if the two parties involved in a M&A deal have strong synergies, people (investors) would expect the deal worths it while, or otherwise the deal is more probably an instance of empire-building of the management. However, theoretically the story about “synergy” only leads us to Coasian question, why the synergies can only be exploited through ownership change rather than other contractual arrangements? And if M&A can realize the synergies, what is the economical cost of M&A, or in other words, what determine the limit of the economical efficiency of M&A?

Coase (1937) raised Coasian question and the theory of the firm. Since then, there is vast literature attempting to understand the question. However I find something unsatisfactory when contrasting the existing theory with the huge M&A realities. The literature seldom takes into account control side, and overwhelmingly concentrates on incentive side. As a result, most literature does not even mention “synergy”. I think that a realistic theory of the firm should balance between control side and incentive side, as any leadership of organizations would do. The paper presents a preliminary attempt in constructing such a theory of the firm that is based on the balance between control and incentive.

First the paper clarifies the difference of control problem from incentive problem. Both of them mean that a principal (she) wants an agent (him) to choose some uncontractible alternatives desirable for her. Which choice the agent makes depends on the *differences* between the payoffs (benefits minus costs) these alternatives yield to him. If some payoff difference is private

---

[1] I would like to thank Timothy Besley, Leonardo Felli, Hao Li, John Moore, Michele Piccione, and Andrea Prat for their beneficial comments. Correspondence address: Tianxi Wang, STICERD, London School of Economics, Houghton Street, WC2A, 2AE. Email address: t.wang2@lse.ac.uk.

[2] The information comes from http://www.kpmg.ca/en/news/pr20051212.html.

(inalienable) to him, then that is an "*incentive*" problem; if all payoff differences are alienable through some arrangement, then that is a "*control*" problem. The alternatives in the former are generally called "effort" or "human capital investment", while those in the later are called "projects". Consider a simple case with two alternatives, A1 and A2. If the agent does not incur additional *private* cost and benefit between them, then the principal faces a control problem. If the agent bears higher private cost, like disutility, from doing A1 than A2, then that is an incentive problem. Roughly, if all costs could be paid by the principal, then she faces a control problem; if some cost *technologically has to* be afforded by the agent, then that is an incentive problem. Take an example from Milgrom and Roberts (1992). A group of sailors propel a rowboat. To let a sailor move his oars at same rhythm as others is control problem, while to let him exert high effort is an incentive problem. For another example, to let G. W. Bush make the right decision like whether to invade Iraq is control problem, while to let him spend more time in the oval office than in his Texas farm is an incentive problem. A simple way to resolve control problem is to let the principal get all alienable payoffs and then let the agent just indifferent with the alternatives. But that arrangement could not resolve incentive problem. In fact, that would induce too much incentive loss. Thus this simple case hints that there exists some tradeoff between control and incentive.

To be clear of the limitation of the literature in incentive side, let us consider some works in the theory of the firm. According to Gibbons (2004), there are four categories of the theory of the firm. In property rights theory (Grossman & Hart (1986) and Hart & Moore (1990)) (GHM hereinafter), if the investment could be made by any party and the value and cost of trade are alienable, then grand integration can always reach first best. This point holds true for the classic hold up problem (Hart & Moore (1988), Che & Hausch (1999) etc.) Thus what they consider is not a control problem, but an incentive problem. In incentive theory, (Holmstrom & Milgrom (1991, 1994)), if the effort does not induce private cost (disutility), then multitask would not introduce any trouble. In quasi-rent seeking theory (Baker & Hubbard (2000) etc.), if rent-seeking does not need additional private cost (effort), then its existence has no any efficiency effect but the distribution effect. All three kinds of literature show that ownership increases incentive, through getting residual control rights to reduce hold up (GHM, Baker & Hubbard (2000))[3], or through "the value of the assets (Holmstrom & Milgrom (1991), Baker et al (2001)). And the tradeoff in allocating ownership lies in incentive balance, between different works or players.

Relational adaptation theory (Simon (1951) and Williamson (1971, 1975, 1991) etc) put some attention on control problem. But they do not present a formal model on the trade-off between control and incentive, though informally this literature, like Williamson (1975), holds that the trade-off of hierarchy is between better adaptation and worse incentive. And this literature is not directly related to ownership structure.

The paper considers a set-up as follows. Ex ante, the agent makes human capital investment. Then state is realized. After that, the principal and the agent bargain over the project to be done subsequently, which requires the agent to access some asset A. After the project is decided, the agent chooses effort to do it. So incentive has twofold meaning, ex ante incentive to make high human capital investment, and ex post incentive to exert high effort. To capture bargaining loss, it is assumed that ex post agent has private information. The paper then proves that the principal getting ownership of A enhances her control over the agent's human capital and thus improve coordination ex post, but reduces the agent's ex ante incentive to make human capital investment

[3] Aghion & Tirole (1997) considers the incentive effect of contractible control rights.

and ex post incentive to exert effort.

Ownership defined as residual control rights rather than value of assets, the idea that getting ownership of physical assets enhances control over human capital is informally presented in Hart & Moore (1990). Here the paper formalizes this idea. Furthermore, the paper shows that the tradeoff in allocating ownership is between coordination benefit and incentive losses rather than lies in incentive balance, and integration happens if and only if the former outweighs the later. Those are two main contributions and points of the paper.

There is some other literature considering control problem. Hart & Holmstrom (2002) shares with the paper here the point that integration brings about too much coordination (control) while non-integration brings about too less. But in my paper the cost side of integration are incentive losses, while in HH (02) the costs are that the integration does not account for "the private benefits of managers and workers". Rajan & Zingales (2002) considers the control problem of keeping the employees to work for the firm rather than to steal the critical resources. But there the tradeoff is between productivity and growth of the firm and the risk of being expropriated.

The rest of the paper is organized as follows. Section 2 is used to articulate the difference between control and incentive. In section 3, the model is set up and then resolved. Section 4 is devoted to comparing integration and non-integration to reach the two main points of the paper. In section 5, some empirical results are presented to support our conclusion. In section 6, we conclude.

2. Control and Incentive

This section is used to show in which sense "control" and "incentive" is differentiated, and that sense is substantial, not a problem of disagreement with the terminologies.

We consider the relationship of two parties to a (potential) trade. One party, called "principal" and referred as "she", wants the other party, called "agent" and referred as "he", to do something uncontractible, maybe conditional on which the trade is realized. In the usage of our common sense language, this general problem facing the principal can be called "incentive" problem in the sense that the principal needs to arrange interest relationship to motivate the agent to do the thing she likes; in the other hand, the problem facing her could also be called "control" problem in the sense that she needs to let the agent do what she likes. Thus for this general problem that the principal tries to let the agent do something, it is a usage of terminology to call it a problem "incentive" or "control".

However, we can distinguish two categories within the general kind of problems, which are then called "incentive" and "control" or "coordination" problem respectively. Roughly speaking, the former is the problem studied by the literature titled as "incentive theory", such as Mirreles (1999) and Holmstrom (1982), while the later is not so extensively studied as the former—that is what the paper contributes. To enlist an example, consider a manager of a firm. He faces two kinds of choices. One is to put more time in work or in entertainment. The other is to choose investment project A or B, with A bringing more long run profits but less short run profit, but B on the contrary. Or consider another example from Milgrom and Roberts (1992). A group of people is paddling a canoe in a contest, prize given to the guys or to their tutor. Each player faces two kinds of choices. One is how much effort he uses to move his paddle, and the other is when to put it into water. Or for the third example, consider a general directing an army in a fight. He faces, again, two kinds of choices. One is to spend more time in studying military affairs or more time in politics. The other is to choose from two projects to deploy his army, with some project yielding better strategic effects but more damage to the army, and the other on the contrary.

There is a real sense of difference between the two kinds of choices. In the first case, an important factor influencing decision is the private (inalienable) payoff of the player involved, which cannot be diverted to others, like the disutility of the player using high effort or the feeling of being satisfied. In the second case, the agent's private cost being irrelevant, all relevant payoffs to different projects are alienable, that is, able to be diverted to others by some institutional arrangement. For the first example, if the manager is the owner of the firm, then both the long run and the short run profit are his; but no matter who is the owner of the firm, the cost of less entertainment and more work has to be borne by him. For the second example, if the prize is given to the group of the players rather than to their tutor, each player will try to move their paddles at same rhythm. But even if then, each has to bear the disutility of exerting high effort, and thus the team production problem, studied by Holmstrom (B. J. E., 1982), happens. For the third example, if the general is the owner of the army in the sense of residual control rights, like the right of appointing or removing the commander of the army, he will give more weight to the damage of the army. But whoever is the owner of the army, the general himself must bear the cost of putting less time in politics. In my idea, to let the player to put in higher effort is an *incentive problem*, while to let him choose the better project is a *control problem*. And "control" problem is often related to coordination of the actions of different players. For the political institutions, check and balance system is mainly relevant to control problem, while the accountability is relevant both to control and incentive.

To make it clearly, let us use some formal language. Denote the things the agent decides by a_i, with $i = 1,...,N$. a_i is not contractible. When choosing any thing, two kinds of benefits occur. One is the alienable benefits and costs, denoted by b_i^a and c_i^a. The other is the inalienable benefits and costs, denoted by b_i^n and c_i^n. Thus the alienable payoff is $p_i^a = b_i^a - c_i^a$, and the inalienable payoff is $p_i^n = b_i^n - c_i^n$. And without loss of generality, suppose $p_1^a > p_2^a > ... > p_N^a$.

Definition 1: the problem facing the principal is a ***pure control*** problem, if $p_i^n = p$ for any i. Otherwise the problem is called an "incentive" problem. And the problem is a ***pure incentive*** problem if $p_1^n < p_2^n < ... < p_N^n$. Other cases are called *mixed problem*.

The classic moral hazard problem is pure incentive problem. Consider the following simple model. If choosing effort level $e \in [0,1]$, the agent's disutility is $e^2/2$ and the profit is e. And the agent is limited liability and thus could not be fined. Here e is the decision variable, $p_i^n = -e^2/2$, and $p_i^a = e$.

For this reason, we call the thing in a pure control problem "*project*", and the thing in a pure incentive problem "*effort*". In Grossman-Hart-Moore theory[4] (GHM hereinafter), it is called "human capital investment".

To make clearer the difference between control and incentive, consider a special institution, authority relationship.

Definition 2: the principal has ***authority*** over the agent, if the principal can decide the thing the agent needs to do and the agent would follow her order. A contract conferring the principal this authority over the agent is called *authority contract*.

Thus, here authority means control over human capital, not the decision rights over physical capital as generally occur in the literature.

Proposition 1: in a pure control problem if the principal gets all alienable payoffs, then she can establish authority relationship over the agent, which resolves the control problem.

Proof: if the principal acquires all alienable payoffs, the agent is indifferent with the projects, and thus is willing to follow her order about the project to be done. That resolves the control problem. ▌

Proposition 1 shows that authority relationship can resolve control problem, but surely it cannot resolve incentive problem. The principal cannot order the agent to exert high effort, since it is the agent who bears the fatigue from the high effort.

For the principal to get all alienable payoffs, it generally needs some institutional arrangement, like ownership transfer. For example, in the setup above, suppose $c_i^a = 0$ for $i = 1,2,..., N-1$ and $b_N^a > p_1^a = b_1^a$. And the cost c_N^a is the loss of the value of the asset used in the production, which is not contractible. That is, when the principal is not the owner of the asset and gets the decision rights over the projects, she will abuse her power to choose the project that maltreats the agent's asset. Then the agent will refuse to obey her order and the authority relationship cannot be established. However, if the principal is the owner of the asset, she will take into account the loss of its value, and the agent is indifferent with the projects. The authority relationship can be formed and can reach efficiency.

This is the simplest way in which ownership of assets is conducive to control over human capital. Here ownership makes difference through its value, which is the meaning of ownership in Holmstrom and Milgrom (1991). The paper below will consider subtler and more systematical ways in which residual control rights influence the control and incentive aspects.

3. The Model

Consider the relationship between a medicine company and a biotechnological research team, denoted by M1 and M2 respectively. The company wants a new medicine, which is special to its competitive strategy. To carry out the project for the new medicine, the research team needs some physical asset, denoted by A. But using the asset, the research team could also carries out the other

---

[4] Grossman & Hart (1986), Hart & Moore (1990).

project that leads to a medicine welcomed by the outside competitive market. Call the project coordinated with the company's integrated strategy and special to its need "*coordinated project*", denoted by "**cd**". And call the project that leads to the product independent with any special buyer's need "*independent project*", denoted by "**in**".

3.1 Set-Up

There two risk neutral parties, M1 and M2, and an asset, A. Ex ante, M2 makes some human capital investment. Ex post, using the asset M2 could do one of the two kinds of ***relevant*** projects, "**cd**" or "**in**". Besides the two relevant projects, each party could think out infinitely possible irrelevant (inefficient) projects to abuse the other party.

Timing Tree

There are five dates. At date 0, M1 and M2 decide the belonging of A and probably, some side payment. At date 1, M2 makes the human capital investment. At date 2, the state is realized. Then at date 3, M1 and M2 bargain and contract on the payment and the project which M2 will do in the period. At date 4, the product comes out, and probably M1 and M2 bargain over the trade and price.

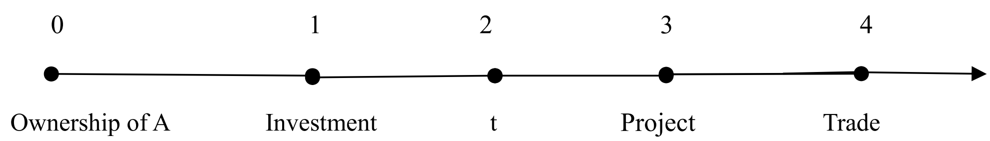


Figure 1: timing tree

Four Regimes of Allocating the Property Rights of Asset A

There are two parts in the property rights, the ownership rights that include residual control rights and the inalienable payoff rights, and the (alienable) payoff rights. Each of these two has its meaning on incentive and control. Here I, following Grossman and Hart (1986), use residual control rights as the characterization of ownership[5].

Thus here the payoff rights of A mean the ownership of the product of the projects. And the ownership of A means the residual control rights over A and the ownership of the A's (reselling) value. There are four kinds of allocation of the property rights of A, as follows.

Regime 1: M2 owns A and the payoff rights of A.

Regime 2: M1 owns A and M2 gets the payoff rights of A.

Regime 3: M2 owns A and M1 gets the payoff rights of A.

Regime 4: M1 owns A and the payoff rights of A.

In regime 1, M2 is an independent contractor. Regime 2 could be considered as a rent contract on asset A, or M2 is such a division of M1 that has its independent account. In Regime 3, M1 makes an exclusive dealing contract with M2 in which M2 can only supply M1. In regime 4,

5 However, in literature, ownership also means the owner of the inalienable payoff rights, which is generally called "the value of the asset", and Holmstrom and Milgrom (1991) developed a theory of ownership based on this meaning.

M2 is a salaried employee of M1 in the ordinary sense. In the paper here, it will be shown that Regime 3 is equivalent 4, and is always worse than Regime 2. Thus the only thing that matter is the allocation of ownership of A. I guess that we need to introduce the value of the assets to justify regime 3 and 4, in a manner of Holmstrom and Milgrom (1991).

Control and Incentive

The value of the two projects is as follows. Suppose at date 1, M2 invests I, at investment cost $c_i(I)$. Then if M2 chooses to do project "in" with effort e at date 3, then at date 4, a standard product of value $v_{in}(I,e;s)$ comes out in state s. The disutility of the effort is $c_w(e)$. If M2 chooses to do project "cd" at date 3 with the same effort, then at date 4, a product coordinated with M1's strategy comes out, whose value to M1 is $v_{cd}(I,e)$ and to the outside market is 0. Assume, as usual, that the value functions are increasing and concave and second order differentiable and the cost functions are increasing and convex and second order differentiable. The lowest effort and the outside value of M2's human capital are normalized to 0. The irrelevant projects have value no bigger than their costs to anyone. Some (infinite) projects have extraordinary low cost and low value, by which M2 could abuse M1, and others (infinite) have extraordinary high cost and high value, by which M1 could abuse M2.

Given that there is no additional private cost needed to switch between project "cd" and project "in", it is a ***control problem*** for M1 to let M2 do the project coordinated with her integrated strategy. It is an ***ex ante incentive problem*** for M1 to let M2 make high investment ex ante and it is an ***ex post incentive problem*** for M1 to induce M2 to exert high effort ex post.

Information and Bargaining Power

Ex ante both M1 and M2 are not clear of what the projects, relevant and irrelevant, mean, since it is very hard to foresee what the future research scheme will be about. However ex post both parties know and can let the court know what the projects mean. Thus the projects are ex ante undecribablele, but ex post verifiable.

Assumption 1: the parties cannot commit not to renegotiate ex ante.

As in Hart and Moore (1999), this assumption is critical to avoid the attack of Maskin and Tirole (1999) on incomplete contracting approach. The assumption plus the existence of infinite inefficient projects guarantees that at date 0 the best we can do is to allocate the property rights of A and thus in each regime the parties have to wait ex post to settle down the choice of the projects and the trade by bargaining[6].

---

[6] A simple intuition is as follows. Since there is no name and infinite possibilities, ex ante what the mechanism could do is to allocate the decision rights. If one party has veto power, since the game is zero-sum game, then no party can get the payoff bigger than that in the bargaining without any mechanism. If no one party has veto power, then the first one whose decision has substantial meaning, like limiting the extent of the subsequent choices, will abuse his power by trying to impose the inefficient projects. For example, M2 will try to impose the projects that have low cost but low value. Then they will renegotiate, which returns to the case without the ex ante mechanism, except the possibility that some party reaps more payoff. But that could be offset by the ex ante transfers.

The bargaining powers are assumed as follows. At date 0, M1, as the bigger firm[7] with some market power, has all bargaining power. To make "control" problem harder, we assume that after their relationship is started M2 holds up M1 with his human capital in any regime, because ex ante M1 has made the necessary human capital investment. Thus, following Grossman and Hart (1986), we do not assume the allocation of property rights influences ex post bargaining power[8]. Therefore we assume that the bargaining power is distributed 0.5-0.5 at date 3 and 4[9], which mean that with probability 0.5, one party can make a take-it-or-leave-it offer to the other.

All values and costs are not verifiable at any date. For simplicity let $v_{in} = sv_{cd}(I,e)$. At date 1, both M1 and M2 knows s is a random valuable uniformly distributed on $[0,1]$. At date 3, both parties know I and function v_{cd}, and M2 knows s but M1's knowledge about it does not change. At date 4, both parties know the value of v_{cd} if project "cd" has been done.

Here we digress from the traditional incomplete contracting approach by assuming that v_{in} is private information of M2 even ex post. By this assumption I want to capture the idea that bargaining is costly, and at least one meaning of better control is economization over the bargaining costs, since theoretically it is hard to describe the bargaining costs in a complete information setup. Since $v_{in} \leq v_{cd}$ always holds at date 2, there is benefit of coordination. To measure the significance of this benefit, let $v_{cd} = v(I,e) + k$, where k is a nonnegative constant and $v(I,0) = 0$. Then k has no incentive effect both ex ante and ex post, and the larger k is, the larger the benefit of coordination is.

If there is no incentive effect, doing "cd" at date 3 is always efficient.

Definition 3: it is called "*loss of control*" if at date 3 project "cd" is abandoned.

But after incentive effects are incorporated, more control does not necessary mean more efficiency. For that, we have the following definition.

Definition 4: it is called "*too less coordination*", if at date 3 project "in" is chosen while "cd" can generate more surplus; it is called "*too much coordination*", if at date 3 project "cd" is chosen while "in" can generate more surplus.

We make an additional assumption to guarantee that the principal-agent relationship between M1 and M2 is inevitable.

Assumption 2: M1 is too huge to be acquired by M2 and M1 has no time to operate with A by herself.

Below the paper will analyze the four regimes respectively by backward induction. For

[7] This does not matter.

[8] Though definitely it is easier to find an employee (who does not have the asset) than to find a partner who have the asset, or it is easier to fire a worker than to fire an independent contractor. However, we do not have a good theory about this point.

[9] Provided M2 has positive bargaining power and the distribution of the powers does not change in period 2, the concrete number does not matter.

simplicity, there is no discount for future date payoffs.

3.2 Regime 1: Independent Contractor

In regime 1, M2, as an independent contractor of M1, has both the payoff rights and the ownership of A. Then at date 4, M2 is the owner of the product of the project he did. Suppose M2 makes investment I at date 1. If at date 3, he did project "in" with effort e, then he attains the standard product and sell it to the outside market, getting $sv_{cd}(I,e)$. If he did project "cd" at date 3, he attains the special product coordinated with M1's strategy at date 4. Then he will bargain with M1 over the price of the product. Given the bargaining power distribution is 05-0.5, the price would be $v_{cd}(I,e)/2$.

At date 3, M1 and M2 bargain over the project to be done. When s is bigger than 0.5, M1 needs to buy M2 back to project "cd". But the trouble is that M1 does not know precisely how profitable of M2's outside opportunity, the independent project. That gives M2 the incentive to pretend that it were highly profitable. Surely, M1 foresees this, and thus may not satisfy M2's claim fully. But then loss of control happens.

The bargaining process is as follows. At stage 1, M2 decides to do project "in" directly or bargain with M1 over project "cd". If he chooses the former, then game goes to date 4. Otherwise, at stage 2, they bargain over the price M1 needs to pay M2 for him to do project "cd". With probability 0.5, M2 offers M1 a take-it-or-leave-it (tioli) price; if she accepts, project "cd" is chosen at stage 3; if she refuses, M2 comes back to project "in". And then game goes to date 4. With probability 0.5, M1 makes a take-it-or-leave-it offer to M2 about the price; if M2 accepts, project "cd" is chosen at stage 3; if he refuses, he comes back to project "in". Thus game tree is following:

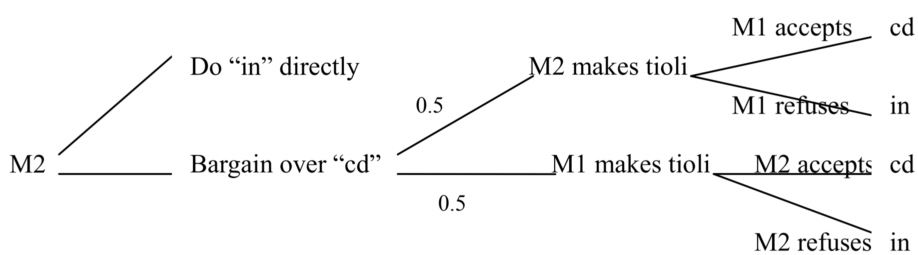


Figure 2: game tree of date 3 in Regime 1

Denote by $V(I,s)$ the value of the following maximization problem of M2:

$V(I,s) = \max_e sv_{cd}(I,e) - c_w(e)$. And denote the maximizor by $e(I,s)$, and especially, let $v'_{cd} = v_{cd}(I,e(I,0.5))$. In the following discussion for simplicity we neglect argument I if that does not cause confusion. Then if M2 does project "cd" at date 3, M1 will get v'_{cd} at date 4. And if M2 goes his way to do “in” directly, he gets $V(s)$.

Lemma 1: at stage 1 M2 always chooses to bargain over cd2 with M1.

Proof: If M2 gets the chance to make a take-it-or-leave-it offer to M1, he could offer price $0.5v'_{cd}$, then he gets $V(0.5)+0.5v'_{cd}$; or he could offer a higher price, then M1 will refuse, and then M2 gets $V(s)$. Then M2’s payoff is $\max(V(0.5)+0.5v'_{cd}, V(s))$. Now suppose M1 gets the chance to make a take-it-or-leave-it offer to M2. Denote the price she offers by P. If M2 accepts it, he gets $V(0.5)+P$; if he refuses it, he gets $V(s)$. Thus at this time M2’s payoff is $\max(V(0.5)+P, V(s))$. Then if M2 chooses to bargain with M1, his payoff is

$\frac{1}{2}\max(V(0.5)+0.5v'_{cd}, V(s)) + \frac{1}{2}\max(V(0.5)+P, V(s))$, which is no less than $V(s)$. $\blacksquare$

Lemma 2: when M1 makes the offer, he always sets the price equal to 0 and M2 accept M1’s offer if and only if $s \le 0.5$.

Proof: see appendix. $\blacksquare$

Denote by $\tilde{s}$ the solution of equation $V(s)=V(0.5)+0.5v'_{cd}$.

Lemma 3: $0.5 < \tilde{s} \le 1$.

Proof: obviously $\tilde{s} > 0.5$ given that $V(s)$ is a strictly increasing function. For the second part, notice that $e(1)$ is the solution of the M2’s maximum problem when $s=1$. Thus

$v_{cd}(e(1)) - c_w(e(1)) \ge v_{cd}(e(0.5)) - c_w(e(0.5)) = V(0.5) + 0.5v_{cd}(e(0.5))$. The left-hand of the inequality above equals to $V(1)$. Thus $V(1)-V(0.5) \ge 0.5v'_{cd}$. That means $\tilde{s} \le 1$. $\blacksquare$

Proposition 2: when $s > \tilde{s}$, project “in” is definitely chosen; When $0.5 < s \le \tilde{s}$, project “in” is chosen with probability 0.5; when $s \le 0.5$, project “cd” is chosen.

Proof: in the proof of lemma1, we know that if M2 gets the chance to make a take-it-or-leave-it offer , his payoff is $\max(V(0.5)+0.5v'_{cd}, V(s))$; and if M1 gets the chance to make an offer, M2’s payoff is $\max(V(0.5), V(s))$.

When $\tilde{s} < s$, in either case $V(s)$ is the larger one, therefore M2 will make M1 refuse his offer or M2 will refuse M1’s offer. Then “in” is implemented always.

When $0.5 < s \le \tilde{s}$, $V(0.5) < V(s)) \le V(0.5)+0.5v'_{cd}$. M2 will make M1 accept his offer and then implement project “cd”, when he gets the chance to make it. But when M1 gets the chance to make the offer, M2 will refuse it and then does project “in”.

When $s \le 0.5$, $V(s)$ is always the smaller one. Thus in either case, the offer is accepted, and then project “cd” is implemented. $\blacksquare$

By definition 3, we have the following corollary.

Corollary 1: In regime 1, with probability $0.75 - 0.5\tilde{s}$, there is loss of control.

Proof: by proposition 2, the probability of doing “in” at date 3 is $1 - \tilde{s} + \dfrac{\tilde{s} - 0.5}{2} =$ $0.75 - 0.5\tilde{s}$. $\blacksquare$

At date 3, if M2 does project “cd”, the social surplus is $V(0.5) + 0.5v'_{cd}$. If he does project “in”, the surplus is $V(s)$. Thus when $s > \tilde{s}$, “in” is more efficient and when $s \le \tilde{s}$, “cd” is. Then proposition 2 tells us that:

Corollary 2: In regime 1, with probability $\dfrac{1}{2}(\tilde{s} - 0.5)$ there is too less coordination.

Remark: there is another perfect Bayesian equilibrium in which at stage 1 only M2 of type $s \le \tilde{s}$ comes to bargain with M1. But, in this equilibrium proposition 2 and the corollaries still hold true.

Then we turn to date 1 to investigate the ex ante incentive problem.

At date 3, with probability $\dfrac{\tilde{s}(I) + 0.5}{2}$, project “cd” is chosen and the surplus is $V(I,0.5) + \dfrac{v_{cd}(I, e(I,0.5))}{2}$; with probability $1 - \tilde{s}(I)$, M2 chooses project “in” and the surplus is $E(V(I,s) \mid s > \tilde{s}(I))$; and with probability $\dfrac{1}{2}(\tilde{s}(I) - 0.5)$, project “in” is done in period 2, and the surplus is $E(V(I,s) \mid 0.5 < s \le \tilde{s})$. The total expected surplus at date 1 is

$$W^1(I) = \frac{\tilde{s}(I) + 0.5}{2}\left(V(I,0.5) + \frac{v_{cd}(I, e(I,0.5))}{2}\right) + \frac{1}{2}(\tilde{s}(I) - 0.5)\ E(V(I,s) \mid 0.5 < s \le \tilde{s})$$
$$+ (1 - \tilde{s}(I))\ E(V(I,s) \mid s > \tilde{s}(I))$$

. And M2’s expected value at date 1 is

$$U^1(I) = \frac{\tilde{s}(I) + 0.5}{2}\ V(I,0.5) + \frac{1}{2}(\tilde{s}(I) - 0.5)\ E(V(I,s) \mid 0.5 < s \le \tilde{s}) + (1 - \tilde{s}(I))$$
$$E(V(I,s) \mid s > \tilde{s}(I)).$$

Then M2’s ex ante problem is $\max_I U_2(I) - c_i(I)$. Denote the optimal invest level by $\hat{I}^1$, then the ex ante social surplus is $W^1(\hat{I}^1)$.

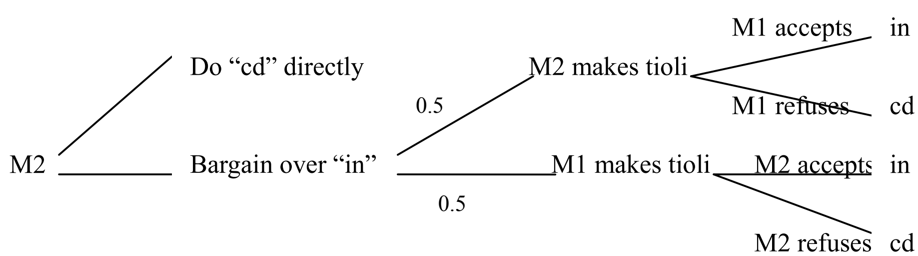
3.3 Regime 2: Division with Its Independent Account

In regime 2, M1 owns A, but M2 has the payoff rights. At the beginning of each period, M1 decide whether to let M2 use A, based on the project and the payment. If M2 is permitted to use A, he owns the products yielded with A. It looks like a contract by which M2 rent M1's asset. But it is more interesting to interpret it as an inside arrangement within a firm. Following GHM, the ownership structure defines the boundary of the firm. Thus A could be a division of an M-type firm, and M2 is the manager of the division. The fact that M2 has the payoff rights means that the division has the independent account of its own; otherwise, M2 shall not care about the ownership rights of the products. The arrangement of this kind is very pervasive after the occurrence of M-type firms. The argument in this section will justify this point.

Again we use backward induction. At date 4, everything is same as in regime 1 since at present only the payoff rights of A matters. Thus, if M2 did project "in" at date 3 with effort e, he gets revenue v_{in}. If he did projects "cd", he attains the special product coordinated with M1's strategy. Then he will be paid with the price $v_{cd}/2$.

At date 3, the difference with Regime 1 presents itself. In regime 1, M2 is the owner of A, therefore he can go away with A to do project "in". Then M1 has to buy him back to project "cd". In regime 2 if M2 wants to use A for project "in", he has to get M1's agreement and thus to buy her to the project. Thus, the change of ownership of A alters the default project. In regime 1, it is "in", while in regime 2, it is "cd". It will be shown that this difference gives M1 more control over M2.

Bargaining process of date 3 is as follows. At stage 1, M2 could show M1 his intention to choose project "cd", or to bargain over the price M2 needs to pay M1 for him to do project "in"[10]. If M2 chooses project "cd", at stage 2 M1 will let him use A and game goes to date 4[11]; otherwise, at stage 2, they bargain over the price, as follows. With probability 0.5, one party can make a take-it-or-leave-it offer to the other party. If the other party accepts, then the payment is paid at date 3 and M2 does project "in" subsequently; if the other party refuses the offer, nothing is paid at date 3 and M2 goes back to project "cd". Game tree is as follows.



[10] They only bargain over project "in", since if M2 says that he intends to do project "cd", M1 will not ask for bargaining over the payment. Everything, the stake and the bargaining power, is same as at date 3. See also note 9.

[11] M1's expected payoff from bargaining with M2 is 0, since with probability 0.5, she can ask for a take-it-or-leave-it payment $v_{cd}/2$ from M2, but with probability 0.5, she can be asked for to pay this amount to M2.

Figure 3: game tree of date 3 in Regime 2

Remember in the last subsection, $V(I,s)=\max_e sv_{cd}(I,e)-c_w(e)$. And the unique maximizors is $e(I,s)$, and $v'_{cd}=v_{cd}(I,e(I,0.5))$. And again, before we discuss the problem at date 1, we neglect argument I. Then if M2 does project "cd", M2 will get $V(0.5)$ at date 4.

As in subsection 3.2, there are two equilibriums, in one of which there is information revelation from M2' action at stage 1 and in the other there is not. We begin from the easier one. The analysis is parallel to that in subsection 3.2.

Lemma 4: M2 always chooses to bargain over "in" with M1 at stage 1.

Proof: see also the proof of lemma 1. If M2 does project "cd" directly, his payoff is $V(0.5)$. Suppose M2 raises bargaining at stage 1. When M2 gets the chance to make a tioli, he has to pay at least $0.5v'_{cd}$ to get M1's agreement with project "in". Or he offers a lower price to induce M1's refusal and then implements "cd". So his payoff is $\max(V(0.5),V(s)-0.5v'_{cd})$. When M1 gets the chance to make tiolio, suppose his price is P. M2's payoff is $\max(V(0.5),V(s)-P)$. None of the two payoffs is less than $V(0.5)$. ▌

Then we come to decide M1's offer P.

Lemma 5: If $\frac{dv_{cd}(e)}{de}>0$ everywhere, then $P>0.5v'_{cd}$. And there exist some $\tilde{s}<1$ such that M2 accepts this offer if and only if $s\le\tilde{s}$.

Proof: By lemma 4, M1 can get nothing information from M2's choice at stage 1. M2 accepts her off if and only if $V(s)-P\ge V(0.5)$. If M2 accepts it, M1 gets P, while if he refuse, M1 gets $0.5v'_{cd}$. Thus M1's problem is

$$\max_P \Pr ob(V(s)-P\ge V(0.5))P+\Pr ob(V(s)-P<V(0.5))0.5v'_{cd}.$$

First for any price inducing positive probability of M2's acceptance, the value lies between P and $0.5v'_{cd}$, then $P<0.5v'_{cd}$ is never optimal. Then, notice that if $\frac{dv_{cd}(e)}{de}>0$, M2's problem has unique solution for any s, and thus $V(1)>V(0.5)+0.5v'_{cd}$ due to incentive reason. Thus for P is little bigger than $0.5v'_{cd}$, $\Pr ob(V(s)-P\ge V(0.5))>0$. So if the price is little bigger than $0.5v'_{cd}$ the value is strictly bigger than $0.5v'_{cd}$. Thus the optimal $\hat{P}>0.5v'_{cd}$.

On the other hand, M1 never let the price is so high that $\Pr ob(V(s) - P \geq V(0.5)) = 0$, since that will let her gain payoff $0.5v'_{cd}$, and strictly worse-off than offering a price little bigger than $0.5v'_{cd}$. Thus $\hat{P} < V(1) - V(0.5)$. Let $\hat{s}$ be the solution of $V(s) - \hat{P} = V(0.5)$. Then $\hat{s} < 1$ and M2 accepts M1's offer if and only if $s \leq \hat{s}$. ■

Remember, $\tilde{s}$ is the solution of $V(s) - 0.5v'_{cd} = V(0.5)$. Then by lemma 5, $0.5 < \tilde{s} < \hat{s} < 1$.

Proposition 3: when $s > \hat{s}$, project "in" is definitely chosen; When $\tilde{s} < s \leq \hat{s}$, project "cd" is chosen with probability 0.5; when $s \leq \tilde{s}$, project "cd" is chosen.

Proof: by lemma 4 and 5. The process is similar to the proof of proposition 2 and is omitted here. ■

Similarly, we have

Corollary 3: In Regime 2, with probability $1 - \hat{s} + \frac{1}{2}(\hat{s} - \tilde{s})$, there is loss of control.

Same as in subsection 3.2, when $s > \tilde{s}$, "in" is more efficient and when $s \leq \tilde{s}$, "cd2" is. Here for any $s \leq \tilde{s}$, cd2 is always chosen. But for any $\tilde{s} < s \leq \hat{s}$, there is probability 0.5 with which "cd" is chosen while "in" is efficient. Thus

Corollary 4: In Regime 2, with probability $\frac{1}{2}(\hat{s} - \tilde{s})$ there is too much coordination.

Then here we recover an insight from Hart and Holmstrom (2002) that integration brings about too much coordination while non-integration brings about too less coordination. But here the cost for integration is the incentive loss.

Remark: there is another perfect Bayesian equilibrium in which only M2 of type $s > \hat{s}$ comes to bargain with M1 at stage 1. But proposition 4 and the corollaries hold true still in that equilibrium.

Then we turn to date 1 to examine the ex ante incentive issue.

At date 3, with probability $\frac{\tilde{s}(I) + \hat{s}(I)}{2}$, project "cd" is chosen and the surplus is $V(I, 0.5) + \frac{v_{cd}(I, e(I, 0.5))}{2}$; with probability $1 - \hat{s}(I)$, M2 chooses project "in" and the surplus is $E(V(I,s) \mid s > \hat{s}(I))$; and with probability $\frac{1}{2}(\hat{s}(I) - \tilde{s}(I))$, project "in" is done in period 2, and the surplus is $E(V(I,s) \mid \tilde{s}(I) < s \leq \hat{s}(I))$. The total expected surplus at date 1 is

$$W^2(I) = \frac{\tilde{s}(I) + \hat{s}(I)}{2} \quad (V(I, 0.5) + \frac{v_{cd}(I, e(I, 0.5))}{2}) \quad + \quad E(V(I,s) \mid \tilde{s}(I) < s \leq \hat{s}(I))$$

$\frac{1}{2}(\hat{s}(I)-\tilde{s}(I))+(1-\hat{s}(I))\ E(V(I,s)\mid s>\hat{s}(I))$. And M2's expected value at date 1 is :

$$U^2(I)=(1-\hat{s}(I))\ E(V(I,s)\mid s>\hat{s}(I))+\frac{1}{2}(\hat{s}(I)-\tilde{s}(I))\ E(V(I,s)\mid \tilde{s}(I)<s\le\hat{s}(I))$$

$$+\ \frac{\tilde{s}(I)+\hat{s}(I)}{2}V(I,0.5).$$

Then M2's ex ante problem is $\max_I U_2(I)-c_i(I)$. Denote the optimal invest level by $\hat{I}^2$, then the ex ante social surplus is $W^2(\hat{I}^2)$.

3.4 Regime 3 and 4

First we notice that in the set-up here, regime 3 is equivalent to regime 4 and ownership has no meaning if payoff rights are diverted off. The reason is as follows. Here the inalienable payoff rights, generally called "the value of assets", are not introduced, and thus ownership only means residual control rights, which mean hold-up through physical assets. But here even without the ownership of A, M2 is already able to hold up M1 through his human assets. Thus ownership of A has no meaning to M2 if he has no payoff rights. In the set-up, it is necessary to introduce the other meaning of ownership, the inalienable payoff rights, to differentiate regime 3 and 4.

At date 4, since M2 has no payoff rights, there is no bargaining between M1 and M2. Thus M2 gets 0 at date 4, no matter which effort he used to do the project. Then M2 will choose the lowest possible effort to doing the project, which is 0.

At date 3, M1 and M2 does not bargain over the project to be done. Since M2 has no payoff rights, he is indifferent with the project he is required to do. Given there is benefit of coordination, M1 will require M2 to do project "cd" at date 3 and M2 will agree.

Proposition 4: in Regime 3 (4), there is no loss of control. But there is a lot of incentive loss since M2 will exert the lowest effort. In ex post efficiency, Regime 3 is strictly worse than Regime 1 or 2.

Proof: the first two parts are straightforward from the discussion above. The assertion on the ex post efficiency comes directly from the following lemma. ▌

Here again, unless necessary, we neglect argument I in all function.

Lemma 6: Suppose $v'_{cd}(e)>0$. $v_{cd}(e(0))-c_w(e(0))<v_{cd}(e(s))-c_w(e(s))$ for every $s>0$.

Proof: when $v'_{cd}(e)>0$, $e(s)$ is determined by the following first order condition of M2's maximum problem. $sv'_{cd}(e)=c'_w(s)$.

So $v_{cd}(e(s))-v_{cd}(e(0))=\int_0^s v'_{cd}(e(t))e'(t)dt=\int_0^s \frac{c'_w(e(t))}{t}e'(t)dt$

$$< \int_0^s c_w'(e(t))e'(t)dt = c_w(e(s)) - c_w(e(0)) . \blacksquare$$

But we still need to examine whether Regime 3 (4) could outweigh in ex ante efficiency. At date 3, when M1 and M2 bargain over M2's wage, M2 will take advantage of holding M1 up through his human capital. When he has the chance to make a take-it-or-leave-it offer, he will ask for $0.5v_{cd}(I,0)$. But when M1 gets the chance to make an offer, she could only to offer $c_w(0)$, given the outside value of M1's human capital is 0. So ex ante, M1's payoff is $0.5 \cdot 0.5v_{cd}(I,0)$, equal to $0.25v_{cd}(I,0) = 0.25v(I,0) + 0.25k = 0.25k$, given that $v(I,0) = 0$. Thus, ex ante, M2 has no incentive to make any human capital investment. Therefore Regime 3 is strictly worse than Regime 1 or 2 in ex ante efficiency. So

Corollary 5: Regime 3 is strictly worst than Regime 1 or 2. Thus payoff rights of A should be allocated to M2.

That is because Regime 3 (4) induces too much incentive loss.

By corollary 5, we only need to compare regime 1 and 2. Following GHM, we call Regime 2 "integration" and Regime 1 "non-integration". I will show that the comparison between integration and non-integration is based on the tradeoff between incentive and control.

4 Comparisons of Integration with Non-integration

In this section, we present some comparison static outcomes. There are too possible tradeoffs between control and incentive. One is between ex post control and ex post incentive. The other is between ex post control and ex ante incentive. The interaction of ex ante incentive and ex post incentive is very complex. To show each tradeoff clearer, we make some necessary to exclude this interaction. When discussing the first tradeoff, we assume the ex ante incentive does not matter, and when discussing the second tradeoff, we assume the ex post incentive does not matter.

4.1 Ex Post Control vs. Ex Post Incentive

The first trade-off is between ex post control and ex post incentive. To exclude the influence of ex ante incentive problem, in this subsection, we assume that $c_i'' = \infty$. Thus ex ante M2 only makes the lowest necessary human capital investment in any regime, which is denoted by I.

Summarizing corollary 1-4, the following proposition is straightforward.

Proposition 5: compared with non-integration, integration brings about better control and thus better coordination ex post, but induces ex post incentive loss.

Proof: in Regime 2, the probability of loss of control is $1-\hat{s}+\frac{1}{2}(\hat{s}-\tilde{s})$, while in regime 1, the probability is $1-\tilde{s}+\frac{\tilde{s}-0.5}{2}$. By the fact that $0.5<\tilde{s}<\hat{s}<1$, the former is less than $1-\tilde{s}<\ 1-\tilde{s}+\frac{\tilde{s}-0.5}{2}$. So integration induces better control. But corollary 4 says that integration brings about too much coordination, which means that the sometimes the benefit of coordination produced by better control is outweighed by incentive loss. ▌

If we do not take into account ex ante incentive effect, proposition 5 predicts that the more important the benefit of coordination is, the more probable regime 2 dominates regime. In subsection 3.1, we assume $v_{cd}=v(I,e)+k$ and let k measures the importance of the coordination benefits. In fact, k has no incentive effects, and the bigger k is, the bigger loss project "in", compared with project "cd", leads to. Remember that the ex ante expected social surplus in Regime i is denoted by W^i, Then we have:

Proposition 6: if $c_w'''(.)\geq 0$ and $\frac{\partial^3 v}{\partial e^3}(I,e)\leq 0$, then there exist some $\chi>0$ such that $\frac{dW^1(I,k)-W^2(I,k)}{dk}\leq -\chi$ for any $k\geq 0$.

Proof: see appendix. ▌

Theorem 1: There exist some k' such that $W^1(k)\leq W^2(k)$ if and only if $k\geq k'$.

Proof: let $k'=\min\{k\,|\,W^1(k)\leq W^2(k)\}$. We need to prove that the set $\{k\,|\,W^1(k)\leq W^2(k)\}$ is not empty.

By proposition 6, $W^1(k)-W^2(k)\leq\ W^1(0)-W^2(0)-\chi k$. Then for k is big enough, $W^1(k)-W^2(k)\leq 0$. ▌

That is, if and only if the benefit of ex post coordination is large enough to outweigh ex post incentive loss, integration dominates non-integration.

4.2 Ex Post Control vs. Ex Ante Incentive

This subsection is used to demonstrate the tradeoff between ex post control and ex ante incentive. To exclude the influence of ex post incentive, we assume that $c''_w(e) = \infty$ for $e > \tilde{e} > 0$ and $c'(e) << 0.5v'(\tilde{e})$ for $0 \le e \le \tilde{e}$. Thus ex post, in any regime M2 will chooses effort $\tilde{e}$ ex post. In the discussion below, we neglect argument $\tilde{e}$ in all functions. And let $\tilde{c} = c_w(\tilde{e})$. Thus when ex ante M2 makes investment I, ex post the value of project "cd" to M1 is $v_{cd}(I)$.

Since there is no ex post incentive problem, $V(I,s) = sv_{cd}(I) - \tilde{c}$ for all s. In this setting, $\tilde{s} = \hat{s} = 1$ for any I. And the calculation of subsection 3.2 tells that in Regime 1, the social surplus is $W^1(I) = \frac{15}{16}(v_{cd}(I) - \tilde{c})$ and M2's payoff is $U^1(I) = \frac{9}{16}(v_{cd}(I) - \tilde{c})$. The calculation in subsection tells that in Regime 2, the social surplus is $W^2(I) = v_{cd}(I) - \tilde{c}$, and M2's payoff is $U^2(I) = 0.5(v_{cd}(I) - \tilde{c})$.

If there is no incentive effect, $W^2(I) > W^1(I)$, since regime 2 captures more benefit of coordination through better control. But there is incentive effect, by the following lemma comparing the optimal investment level in the two regimes.

Lemma 7: $I^1 > I^2$.

Proof: $\hat{I}^i$ is the maximizer of the problem $\max U^i(I) - c_i(I)$. Given the assumptions about function $v_{cd}(.)$ and $c_i(.)$, the problem has an unique solution that satisfies the first order condition: $U^{i'}(I) = c'_i(I)$. Remember that $v_{cd}(I) = v(I) + k$. Then $\hat{I}^i$ is determined by $\alpha_i v'(I) = c'_w(I)$, where $\alpha_1 = \frac{9}{16}$ and $\alpha_2 = 0.5 < \alpha_1$.

Fro the implicit function $I(\alpha)$ determined by $\alpha v'(I) = c'_w(I)$, it is easy to compute that $\frac{dI}{d\alpha} = \frac{v'}{c''_w - \alpha v''} > 0$. So $I^1 > I^2$. ▌

This lemma is extension to the asymmetric information setting of the insight from GHM that ownership is an incentive for ex ante human capital investment. If there is no control problem ex post and thus only ex ante incentive matters, according to this lemma, Regime 1 always dominates Regime 2.

Proposition 7: compared with non-integration, integration brings about better control and thus better coordination ex post, but induces ex ante incentive loss.

Proof: straightforward from the discussion above. ▌

Given k measures the importance of the coordination benefits, we have:

Proposition 8: $\frac{dW^1(\hat{I}^1,k)-W^2(\hat{I}^2,k)}{dk} < -\frac{1}{16}$ for all $k \geq 0$.

Proof: here life is much easier than in proposition 6, since $\hat{I}^i$ is independent with k. Compute straightforwardly, $W^1(\hat{I}^1,k)=\frac{15}{16}(v(\hat{I}^1)+k-\tilde{c})$, and $W^2(\hat{I}^2)=v(\hat{I}^2)+k-\tilde{c}$. Then $\frac{dW^1(\hat{I}^1,k)-W^2(\hat{I}^2,k)}{dk}=-\frac{1}{16}<0$. ▌

Theorem 2: There exist some k' such that $W^1(\hat{I}^1,k)-W^2(\hat{I}^2,k)\leq 0$ if and only if $k \geq k'$.

Proof: similar to the proof of theorem 1. ▌

That is, if and only if the benefit of ex post coordination is large enough to outweigh ex ante incentive loss, integration dominates non-integration.

5. Evidences

This section provides two empirical evidences. The first is a case study about the classic General Motor-Fisher integration in 1926. And the second is a series of empirical research on retailing contracts.

5.1 GM-Fisher Reexamined

The event that General Motors acquired all Fisher Bodies interest in 1926 is extensively cited as evidence in the theories of the firm since Klein et al (1978). In 2000 three papers[12] by Coase, Freeland, and Casadesus-Masanell & Spulber respectively published in Journal of Law and Economics reexamine this classic story. Their common point is that hold-up problem and the relationship-specific physical investment are not problem when GM acquisition of Fisher Body. There obviously existed no important incentive problem in this instance either. About the motivation of integration, Coase says little; Freeland's point is that "the primary factors leading to vertical integration were GM management's fears over the Fisher brothers' impending departure, coupled with problems of financing new body plants"[13]; Casadesus-Masanell & Spulber hold that

[12] See Coase, R., The Acquisition of Fisher Body by General Motors, 15-31; Freeland, R., Creating Holdup through Vertical Integration: Fisher Body Revisited, 33-66; Casadesus-Masanell, R. & D. Spulber, The Fable of Fisher Body, 67-104.

[13] P33.

"vertical integration was directed at improving coordination of production and inventories, assuring GM of adequate supplies of auto bodies, and providing GM with access to the executive talents of the Fisher brothers"[14].

In a word, integration is in large part for coordination, that is coordinately using Fisher's assets, including the design of car bodies and the supplies of closed bodies, and for this purpose it is important to control Fisher brothers' human assets that are critical for closed body production[15]. In addition, the integration occurred in 1926 because about that time closed bodies was coming to have strategic importance[16], and thus the benefits of coordination are increased. Below we elaborate on these three points.

From 1924, the automobile market began to transform, "the design and the styling of closed bodies became the primary method of achieving product differentiation and defining a new line of cars"[17]. Acquiring Fisher Body, GM not only "increased (its) output but also deprived competitors of closed-body capacity", thus establish its competitive advantage. That is the third point.

The coordination between GM and Fisher Body includes two kinds. One is technical coordination. Responding to that transformation in 1924 auto market, GM took the "policy of introducing annual model changes…"[18]. Then "with annual model changes, redesigns of chassis and bodies would require ongoing consultation and coordination between Fish and the car divisions." It is hard to contract on design and innovation since they are notoriously difficult to foresee and describe. That is why GM wanted final authority over it.

The other kind of coordination is competitive strategic coordination from which the role of control over human assets is salient. That is, Fisher Body only supplied GM. Theoretically an exclusive dealing contract could reach the same purpose. But if we bear in mind that controlling Fisher brothers, the management of Fisher Body, is key to reach the coordination, the shortage of the exclusive dealing contract is clear. It cannot prevent Fisher brothers' human assets used for GM's competitors; if Fisher brothers are not employees of GM, they are free to cooperate with GM's competitors[19] whereas if Fisher brothers are, they could hardly do this.

In addition, the failure of these two kinds of coordination through contracts is of type "uneven distribution of benefits". Let the design of bodies coordinated with GM's annual model change, they are hardly useful for other automakers. If GM's competitive strategy is not taken into account, supplying GM's competitors is "highly profitable for Fisher", which was repeated acknowledged by GM management[20].

Thus GM-Fisher story is a perfect evidence for our theory here, at for the benefits side of our theory. Integration is made for coordination, and for this purpose the core point is to control the managers' human capital. And integration occurs only if the benefits of coordination are large enough.

---

[14] P67.
[15] "GM's management believed that Fisher's physical assets would remain relatively useless without the continued involvement of the Fishers", P53.
[16] Freeland, P52, "A second factor contributing to vertical integration was Fisher's increasing strategic importance".
[17] Freeland, P52.
[18] Freeland, P50.
[19] In fact they did. In 1925 GM's Chevrolet could not be supplied with enough closed bodies so as to reduce production schedules, but Fisher expanded its business with Chrysler.
[20] Freeland, P51.

5.2 Retail Contracting

Manufacturers sell their product to consumers through the retail outlets owned by themselves (vertical integration) or though through independent retailers (separation). Extensive empirical work has been done on this choice. Lafontaine and Slade (1997) provided a good survey. In retail contracting, as they pointed out, generally there are no important specific assets, or investment in specific assets. Thus the arguments based on asset specificity cannot apply here. In the other hand, some arguments based on agency costs or multitask-incentive get some support, the following two regularities are seemingly contradictory with the prediction of incentive theory: (i) risk is positively related to the use of integration (ii) large units tend to be company-owned. Besides the regularities consistent with incentive theory, the theory here can explain these two easily. As to (i), risk is measured by "% forecast error"[21] or the things related to demand fluctuation such as "variation of detrended sectoral sales"[22]. It is more appropriate to say that these things measure contractual difficulty. Thus (i) means that the more difficult to coordination through contracts, the more we need to integrate, as implied by the theory here. As to (ii), it is easier to understand through our theory, since the large units mean large benefits of coordination, and thus tend to be integrated with.

There are more regularities in retail contracting that it is easy to understand by our theory but hard by incentive theory. Our theory implies that integration is for control at the costs of incentive while the incentive theory says that integration is used to balance incentive. The difference is that "control" is related to alienable payoff and "incentive" to private (inalienable) payoff.

An important issue of integration is to control the retailing prices. After resale price maintenance (RPM) becomes illegal in US, retailing prices are uncontractible between the franchisor and the franchisees. Thus to control the prices, the franchisor has to own the retailing outlet themselves. Lafontaine (1995) examined the price dispersion within franchised restaurant and fast food chains in the metropolitan Pittsburg and Detroit areas, and found that the prices in franchised and corporate units (owned by the franchisors) are systematically different, and the later are systematically lower. In Lafontaine and Slade (1997) found that this systematical price differential exist for a large extent of franchise[23]. This price difference is hard to be explained by incentive theory, but easy by our theory, if we are willing to introduce positive demand externality.

A fact provided by Slade (1996) also supports that price is the concern of franchisors when owning a retailing outlet. Before RPM was illegal, the commission contract, where agents are paid by a fixed salary plus a ***small*** commission per liter of gasoline, was common in US oil-retail market. But after RPM in the commission contract became illegal in US, it disappeared in the US market. If only incentive is concerned, how that could happen? The set of feasible incentive contracts did not change with RPM becoming illegal. But using coordination-incentive trade-off, we can explain the fact easily. The commission contract is a lower-power incentive contract since the commission is small. The oil company is willing to use this contract since it can decide the retail prices and the benefits from this control outweigh the loss from lower incentive. When, with RPM becoming illegal, these benefits disappear, the incentive loss makes this contract unprofitable for the company and thus disappears.

---

[21] Anderson and Schmittlein (1984).
[22] Martin (1988); Norton (1988).
[23] Pp14, section II(vii).

In addition, why do the franchisors want to control retail outlets? The theory here suggests that they control for better coordination, in the terms of avoiding the free-riding of independent outlets on the value of franchisors' brand name. Lafontaine & Shaw (2001) , using an extensive longitudinal data set on franchising firms, show that after eight or more years stable franchisors maintain a stable rate of company-owned outlets to the franchised ones. The stable rates vary considerably across sectors, and they find that brandname value is a primary determinant, high brandname value franchisors targeting high rates of company ownership. They argue that that is because high-value franchisors need to exert more direct managerial control over outlets to avoid or reduce the free riding of franchisees on brandname value. In some cases, the effects on brandname value are measured by "outlet size" or "previous experience required". And they pointed out the effects of these two variables on company ownership is inconsistent with agency theory that predicts that bigger monitoring costs implied by big size or high managerial experience tend to less company ownership.

6. Conclusion

The paper first differentiates incentive and control problem a principal faces. "Control" means to let the agent make the desirable choice that does not require additional private cost, compared to other choices, like choice among different physical investment projects; and "incentive" means to let the agent make the desirable option that requires additional private cost, compared to some other option, like choosing among different effort levels and human capital investment levels. In the paper here, *control* means to let the agent to do the project coordinated with the principal's integrated strategy, rather than the project independent with it. Incentive has two meaning here. One is ex ante incentive, that is, to let the agent makes high level human capital investment ex ante. The other is ex post incentive, that is, to let the agent exert high level effort when working on the project.

Then the paper clarifies the role of ownership structure of physical assets in resolving control and incentive problem simultaneously. Giving the ownership of the critical physical assets to the principal, compared to giving it to the agent, enhances control of the principal over the agent's human capital ex post and thus improve the benefit of coordination, but reduces both ex ante incentive and ex post incentive of the agent. Following GHM, we define "integration" as the structure that the principal owns the asset with which the agent works. Then the paper shows that integration happens if and only if the benefit of coordination is large enough to outweigh the incentive losses.

In the end, the paper present some empirical evidences that support our main conclusion that ownership structure of physical assets is determined by the tradeoff between benefit of coordination and incentive loss. These facts are hard to be explained by the other theories of the firm, but are consistent with the theory presented here.

Appendix

Proof of lemma 2 in subsection 3.2:

Denote by P the offer made by M1. Then if M2 accepts it M1 gets $0.5v'_{cd} - P$; while if he refuses it M1 gets 0. Given s, M2 accepts it iff $V(0.5) + P \geq V(s)$. By lemma 1, M1 cannot induce any information from M2's choice at stage 1.Thus M1's problem is:

$\max_P \Pr ob(V(0.5) + P \geq V(s))(0.5v'_{cd} - P)$.

First notice that the solution is an internal point which satisfies $-V(0.5) < P < 0.5v'_{cd}$, since the extreme points lead to 0. Thus first order condition holds for the solution.

Let $P = V(s) - V(0.5)$. The problem changes to

$\max_s s(0.5v'_{cd} + V(0.5) - V(s))$, given than s distributed uniformly. By envelop theorem, $V'(s) = v_{cd}(e(s))$. Then the first order condition is:

$0.5v'_{cd} + V(0.5) - V(s) - sv_{cd}(e(s)) = 0$.

Notice $v'_{cd} = v_{cd}(e(0.5))$. Then $s = 0.5$ is a solution of the equation. Now we prove that it is the only solution. Notice that $e(s)$ is an increasing function. Thus $V(s) + sv_{cd}(e(s))$ is a strictly increasing function. Then for $s < 0.5$, $0.5v'_{cd} + V(0.5) > V(s) - sv_{cd}(e(s))$; for, $s > 0.5$ $0.5v'_{cd} + V(0.5) < V(s) - sv_{cd}(e(s))$. Therefore, $s = 0.5$ is the only solution of the first order condition.

Then optimal price $\hat{P} = 0$. And M2 accepts M1's offer if and only if $s \leq 0.5$. ▌

Proof of proposition 6:

In this proof, we neglect argument I in all functions since the discussion below holds true for any investment level I. To simplify notations, let $e_s = e(s)$, $v_s = v(e(s))$ and $\hat{v}_{cd} = v_{cd}(e_{0.5})$. Obviously $e_0 = 0$. So $v_0 = 0$. And let $W(s) = \max_e sv(e) - c_w(e)$. Then $V(s) = W(s) + sk$, given that $v_{cd}(e) = v(e) + k$. All derivatives are marked by prime "'".

The discussion in subsection 3.2 and 3.3 shows the difference between Regime 1 and Regime 2 is as follows. When $0.5 < s \leq \tilde{s}$, project "cd" is efficient and chosen in Regime 2 but in regime 1 project "in" is chosen with probability 0.5; while $\tilde{s} < s \leq \hat{s}$ project "in" is efficient and chosen in Regime 1, but in regime 2, M2 chooses project "cd" with probability 0.5. In all other cases, same projects are chosen with same effort since the side transfer between M1 and M2 has no incentive effects. Thus the difference of ex ante expected surplus between the two regimes is

$$2(W^1-W^2)(k)=\int_{0.5}^{\hat{s}} V(s)-V(0.5)-0.5\hat{v}_{cd}ds = \int_{0.5}^{\hat{s}} W(s)-W(0.5)-0.5v_{0.5}+(s-1)kds$$

.

Then $2\frac{d(W^1-W^2)}{dk}=\int_{0.5}^{\hat{s}}(s-1)ds+(V(\hat{s})-V(0.5)-0.5\hat{v}_{cd})\frac{d\hat{s}}{dk}$. And the first part of the right hand side is equal to $(\hat{s}-0.5)(\frac{\hat{s}+0.5}{2}-1)<0$. But the second part is positive. So we need to show that the first part outweighs the second one.

$\hat{s}$ is determined in lemma 5 by the equation $V(s)-\hat{P}=V(0.5)$, and $\hat{P}>0.5v'_{cd}$ is the solution of M1's problem $\max_P \Pr ob(V(s)-P\geq V(0.5))(P-0.5v'_{cd})$

Lemma a1: $\frac{d\hat{s}}{dk}=\frac{2(1-\hat{s})}{2v_{\hat{s}}+2k-(1-\hat{s})v'_{\hat{s}}e'_{\hat{s}}}$.

Proof: Lemma 5 shows that the optimal value is an internal point, thus the first order condition holds. Let $P=V(s)-V(0.5)$. Then M1's problem is changed to

$$\max_P(1-s)(V(s)-V(0.5)-0.5\hat{v}_{cd})=\max_P(1-s)(W(s)-W(0.5)-0.5\hat{v}_{0.5}-(1-s)k).$$

Thus the optimal value $\hat{s}$ satisfies the following first order condition:

$-W(\hat{s})-2k\hat{s}+(1-\hat{s})v_{\hat{s}}+2k+W(0.5)+0.sv_{0.5}=0$, given that $W'(s)=v_s$.

From this equation, by implicit function theorem, the lemma is proved. ▌

Lemma a2: When $c'''_w(.)\geq 0$ and $v'''(.)\leq 0$, e_s is a concave function.

Proof: We go to prove $e''_s\geq 0$. e_s is determined by the first order condition $sv'(e_s)=c'_w(e_s)$. Then $e''_s=\frac{v''(c''-sv'')-v'(c'''-v''-sv''')}{(c''-sv'')^2}$. Given that $v''\leq 0$, $v'>0$, $c''-sv''>0$, and $c'''-v''-sv'''\geq 0$, we get $e''_s\geq 0$. ▌

Lemma a3: v_s is a concave function of s.

Proof: $v(.)$ is a concave function, and the compound of two concave functions is a concave function. ▌

Corollary a1: $\frac{d\hat{s}}{dk} \le \frac{2(1-\hat{s})}{v_{\hat{s}}}$.

Proof: by lemma a3, $v_s \ge v'_s e'_s s$ for any s. Obviously $\hat{s} \ge \frac{1}{2}$. Therefore $v_{\hat{s}} \ge v'_{\hat{s}} e'_{\hat{s}} \hat{s} \ge v'_{\hat{s}} e'_{\hat{s}} (1-\hat{s})$. Thus $2v_{\hat{s}} + 2k - (1-\hat{s}) v'_{\hat{s}} e'_{\hat{s}} \ge v_{\hat{s}}$. By lemma a1, the corollary is proved. ▌

Lemma a4: If $f(t)$ is a concave function, and $f(0)=0$, then $\frac{f(s)}{f(t)} \ge \frac{s}{t}$ for all $0 < s \le t$.

Proof: $f(s) = f(\frac{s}{t}t + \frac{t-s}{t}0) \ge \frac{s}{t} f(t) + \frac{t-s}{t} f(0)$. ▌

Lemma a5: If $f(t)$ is a concave function, then $\int_a^b f(t)dt \le f(\frac{a+b)}{2})(b-a)$.

Proof: for any $0 < x \le \frac{b-a}{2}$, $f(\frac{a+b)}{2}) - f(\frac{a+b)}{2} - x) \ge f'(\frac{a+b)}{2})x \ge f(\frac{a+b)}{2} + x) - f(\frac{a+b)}{2})$. Thus $\int_a^{\frac{a+b}{2}} (f(\frac{a+b}{2}) - f(t))dt \ge \int_{\frac{a+b}{2}}^b (f(t) - f(\frac{a+b}{2}))dt$. ▌

Lemma a6: $\hat{s} \ge \frac{\sqrt{3}}{2}$.

Proof: by lemma 5 in subsection 3.3, $V(s) - V(0.5) \ge 0.5\hat{v}_{cd}$, which implies that $\hat{s} \ge \frac{1}{2}$ and is equivalent to $\int_{0.5}^{\hat{s}} v_{cd}(e_s)ds \ge 0.5 v_{cd}(e_{0.5})$. By lemma a3, $v_{cd}(e_s)$ is a concave function of s. By lemma a5, the inequality is equivalent to $v_{cd}(e(\frac{\hat{s}+0.5}{2}))(\hat{s}-0.5) \ge 0.5 v_{cd}(e(0.5))$.

By this inequality,

$$\hat{s} - 0.5 \ge 0.5 \frac{v_{cd}(e(0.5))}{v_{cd}(e(\frac{\hat{s}+0.5}{2}))} = 0.5 \frac{v_{0.5}+k}{v_{\frac{\hat{s}+0.5}{2}}+k} \ge 0.5 \frac{v_{0.5}}{v_{\frac{\hat{s}+0.5}{2}}} \ge 0.5 \frac{0.5}{\frac{\hat{s}+0.5}{2}}.$$

The last inequality of the formula is implied by the fact that $\hat{s} \ge \frac{1}{2}$ and lemma a4. Then $s^2 - 0.25 \ge 0.5$. ▌

Lemma a7: $V(\hat{s})-V(0.5)-0.5\hat{v}_{cd} \leq \hat{s}v_{\hat{s}}-v_{0.5}$.

Proof: $V(\hat{s})-V(0.5)-0.5\hat{v}_{cd} = \hat{s}(v_{\hat{s}}+k)-c_w(e_{\hat{s}})-((v_{0.5}+k)-c_w(e_{0.5}))$

$= \hat{s}v_{\hat{s}}-v_{0.5}-(1-\hat{s})k-(c_w(e_{\hat{s}})-c_w(e_{0.5}))$. Since $\hat{s} \geq \frac{1}{2}$, $c_w(e_{\hat{s}})-c_w(e_{0.5}) \geq 0$. And $(1-\hat{s})k \geq 0$. The lemma then is proven. ▌

By lemma a7 and corollary a1,

$\frac{dW^1-W^2}{dk} < -\{(\hat{s}-0.5)(1-\frac{\hat{s}+0.5}{2})-(\hat{s}v_{\hat{s}}-v_{0.5})\frac{2(1-\hat{s})}{v_{\hat{s}}}\}$. Then to prove the proposition, we need to prove that the right-hand side of the inequality is less than $-\chi$ for some positive number χ. By lemma a4, $\frac{\hat{s}v_{\hat{s}}-v_{0.5}}{v_{\hat{s}}} = \hat{s}-\frac{v_{0.5}}{v_{\hat{s}}} \leq \hat{s}-\frac{0.5}{\hat{s}}$. Thus to prove the proposition, we only needs to prove that $(\hat{s}-0.5)(1-\frac{\hat{s}+0.5}{2})-2(1-\hat{s})(\hat{s}-\frac{0.5}{\hat{s}}) \geq \chi$, for all $1 \geq \hat{s} \geq \frac{\sqrt{3}}{2}$, by lemma a6. Rearranging the items, the inequality is equivalent to

$\frac{1}{4\hat{s}}g(\hat{s}) \geq \chi$, for $1 \geq \hat{s} \geq \frac{\sqrt{3}}{2}$, where $g(\hat{s}) = 6\hat{s}^3-4\hat{s}^2-5.5\hat{s}+4>0$.

In interval $[0.5,1]$, $g'(s)=0$ has the unique solution $s=\frac{4+\sqrt{115}}{18}<\frac{\sqrt{3}}{2}$, and $g'(1)=4.5>0$. Thus for $1 \geq \hat{s} \geq \frac{\sqrt{3}}{2}$, $g'(\hat{s})>0$. It is straightforward that $g(\frac{\sqrt{3}}{2})>0$. Thus for $1 \geq \hat{s} \geq \frac{\sqrt{3}}{2}$, $\frac{g(\hat{s})}{4\hat{s}}>0$. Since $1 \geq \hat{s} \geq \frac{\sqrt{3}}{2}$ is compact set and function $\frac{g(\hat{s})}{4\hat{s}}$ is continuous, there exist some $s' \in [\frac{\sqrt{3}}{2},1]$ such that $\frac{g(\hat{s})}{4\hat{s}} \geq \frac{g(s')}{4s'}>0$ for all $1 \geq \hat{s} \geq \frac{\sqrt{3}}{2}$. This proves the proposition. ▌

References

Aghion, P. and J. Tirole (1997), "Formal and Real Authority in Organizations," *Journal of Political Economy, 105*, 1-29.

Anderson, E. and D. Schmittlein, (1984), "Integration of the Sales Force: An Empirical

Examination", *Rand Journal of Economics*, 15, 385-395.

Baker, G., and T. Hubbard (2000), "Contractibility and Asset Ownership: On-board Cumputers and Governance in U.S. Trucking," Mimeo, Harvard Business School.

Baker, G., R. Gibbons and K. Murphy (2001), "Relational Contract and the Theory of the Firm", *Quarterly Journal of Economics*, ?, ?.

Baker, G., R. Gibbons and K. Murphy (2003), "Decision Rights, Payoff Rights, and Relationships in Firms, Contracts, and Other Governance Structures," working paper.

Berle, A. and G. Means (1968), The Modern Corporation and Private Property, New York: Harcourt, Brace and World, revised edition.

Bolton, P. and D. S. Scharfstein (1998), "Corporate Finance, the Theory of the Firm, and Organizations," *The Journal of Economic Perspectives*, 12, 95-114.

Casadesus-Masanell, R. and D. F. Spulber (2000), "The Fable of Fisher Body", *Journal of Law and Economics*, 43, 67-104.

Coase, R. H. (1937), "The Nature of the Firm", *Economica*, New Series, Ⅳ, 386-405.

Coase, R. H. (2000), "The Acquisition of Fisher Body by General Motors", *Journal of Law and Economics*, 43, 15-31.

Freeland, R. F. (2000), "Creating Holdup through Vertical Integration: Fisher Body Revisited", *Journal of Law and Economics*, 43, 33-66.

Gibbons, R. (2004), "Four Formal(izable) Theories of the Firm", manuscript.

Grossman, S. and O. Hart (1986), "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy*, 94, 691-719.

Hart, O. (1989), "An Economist's Perspective on the Theory of the Firm", in P. J. Buckley and J. Michie ed. *Firms, Organizations and Contracts, A Reader in Industrial Organization*, New York and London, Oxford Univ. Press, 199-218.

Hart, O. (1995), *Firms, Contracts, and Financial Structure*, Oxford: Oxford University Express.

Hart, O. and B. Holmstrom (2002), "A Theory of Firm Scope," working paper.

Hart, O. and J. Moore (1988), "Incomplete Contracts and Renegotiation," *Econometrica*, 56, 755-785.

Hart, O. and J. Moore (1990), "Property Rights and the Nature of the Firms," *Journal of Political Economy*, 98, 1119-1158.

Hart, O. and J. Moore (1999), "Foundations of Incomplete Contracts," *Review of Economic Studies*, 66, 115-138.

Hart, O. and J. Moore (2004), "Agree Now to Agree Later: Contracts that Rule Out but do not Rule in," working paper.

Hermalin, B. E. (1999), "The Firm as a Noneconomy: Some Comments on Holmstrom," *Journal of Law, Economics, and Organization*, 15, 103-106.

Holmstrom, B. (1982), "Moral Hazard in Teams," *Bell Journal of Economics*, 13, 324-340.

Holmstrom, B. (1999), "The Firm as a Subeconomy," *Journal of Law, Economics, and Organization*, 15, 74-102.

Holmstrom, B. and P. Milgrom (1991), "Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design," *Journal of Law, Economics, and Organization*, 7, 24-52.

Holmstrom, B. and P. Milgrom (1994), "The Firm as an Incentive System", *American Economic Review*, 84, 972-91.

Holmstrom B and J. Roberts (1998), "The Boundaries of the Firm Revisited," *Journal of*

Economic Perspectives, 12, 73-94.

Huang, Ray, (1990), *China: A Micro History*, New York: M. E. Sharpe, revised edition.

Klein, B., R. Crawford and A. Alchian (1978), "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process," *Journal of Law and Economics*, 21, 297-326.

Kreps, David (1990), "Cooperate Culture and Economic Theory", In Alt, J. and K. Shepsle, ed., *Positive Perspectives on Political Economy*, Cambridge, Cambridge University Press, 90-143.

Kreps, David (1999), "Markets and Hierarchies and (Mathematical) Economic Theory", in G. R. Carroll and D. J. Teece ed., *Firms, Markets, and Hierarchies*, New York, Oxford Univ. Press, 121-155.

Lafontaine, F. (1995), "Pricing Decisions in Franchised Chains: a Look at the Restraunt and Fast-Food Industry", NBER working paper 5427.

Lafontaine, F. and K. L. Shaw (2001), "Targeting Managerial Control: Evidence from Franchising", NBER working paper 8416.

Lafontaine, F. and M. E. Slade (1997), "Retail Contracting: Theory and Practice", *the Journal of Industrial Economics*, XLV, 1-25.

Maskin, E. and J. Tirole (1999), "Unforeseen Contingencies and Incomplete Contracts," *Review of Economic Studies*, 66, 83-114.

Martin, R. E. (1988), "Franchising and Risk Management", *American Economic Review*, 78, 954-968.

Milgrom, P. and J. Roberts (1992), *Economics, Organization, and Management*, Prentice Hall.

Mirrlees, J. (1999), "The Theory of Moral Hazard and Unobservable Behavior, Part I," *Review of Economic Studies*, 66, 3-22.

Moore, J. and R. Repullo (1988), "Subgame Perfection Implementation," *Econometrica*, 56, 1192-1220.

North, D. C. (1990), institution, institutional changes and economic performance, Cambridge: Cambridge University Press.

Norton, S. W. (1988), "An Empirical Look at Franchising as an Organizational Form", *Journal of Business*, 61, 197-217.

Rajan, R. G. and L. Zingales (2002), "The Firm as a Dedicated Hierarchy", *Quarterly Journal of Economics*, ?, ?.

Segal, I. (1999), "Complexity and Renegotiation: A Foundation for Incomplete Contracts," *Review of Economic Studies*, 66, 57-82.

Simon, H. (1951), "A Formal Theory of the Employment Relationship", *Econometrica*, 19, 293-305.

Slade, M. E. (1996), "Multitask Agency and Contract Choice: an Empirical Exploration", *International Economic Review*, 37, 465-486.

Tirole, J. (1999), "Incomplete Contracts: Where Do We Stand?," *Econometrica*, 67, 741-781.

Williamson, O. (1971), "The Vertical Integration of Production: Market Failure Considerations", *American Economic Review*, 61, 112-23.

Williamson, O. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications*. New York: Free Press.

Williamson, O. (1985), *The Economic Institutions of Capitalism*. New York: Free Press.

Williamson, O. (1991), "Comparative Economic Organization: The Analysis of Discrete Structural Alternatives", *Administrative Science Quarterly*, 36, 269-296.