ASSET OWNERSHIP AND RISK AVERSION*

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Abstract

I suggest a model for two managers/owners and two assets, where the optimal allocation of ownership rights is jointly determined by the parties' risk aversion and the specificity of their investments. The managers are motivated by both verifiable and non-contractible benefits. The most risk averse manager should own at least one of the two assets, if the risk bearing costs associated with the non-contractible benefits are low compared to the risk bearing costs associated with the verifiable benefits. There is a tendency for integration to dominate non-integration when the two managers have very different risk preferences. Third party participation can reduce the total risk bearing costs or can strengthen the incentives to invest. The results are illustrated with a numerical example. In one interpretation of the model, the two managers are seen as two companies with complementary competencies who do a joint venture.

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1. Introduction

Williamson (1975, 1985) and Klein, Crawford and Alchian (1978) observed that specific investments can play an important role to determine optimal asset ownership. Building on this idea, Grossman and Hart (1986), Hart and Moore (1990) and Hart (1995) suggest formal models to show the benefits and costs of integration with respect to the hold-up problem. Risk aversion is usually ignored in these and in other incomplete contracts papers.

There are situations, however, where the classical trade-off found in the moral hazard literature between incentives and risk sharing can add insights also to ownership issues. If the investments are one-sided, the trade-off is straightforward. The party who makes the specific investment should be the sole owner of the asset, unless the risk bearing costs then are too high compared to alternative ownership arrangements (Holmstrom and Milgrom 1991, Hanson 1995).[1]

Following Grossman-Hart-Moore I assume that there are two parties who both make asset- and relationship-specific investments. I let these investments result in non-contractible and verifiable benefits, which often is the case when companies do joint projects.[2] In this setting, it is not so obvious who should own the assets, since both the relative investment specificity and the relative risk aversion of the two managers must be considered. The formal model is built up by adding a linear form of the asset specificity technology found in Hart (1995) to a linear moral hazard model (Holmstrom and Milgrom 1987). Multitask effects are suppressed.

In section 3 I discuss the interpretation of the model. I have in mind a case where two companies with complementary competencies do a joint project. In addition to the work done by the project organisation (a joint venture), the project requires substantial effort by managers and experts within the two parent companies. The parent companies are motivated by their share of the verifiable project profits and future benefits from new opportunities that the parties expect to discover. The latter (non-contractible) benefits are to some degree relationship- and asset-specific.

Different ownership structures are then compared. I show that it can be optimal for the most risk averse manager to own all the assets, if the risk-bearing costs associated with the non-contractible benefits are moderate compared to the those associated with the verifiable

[1] Holmstrom and Milgrom (1991) consider a classical principal-agent relationship, where the risk averse agent (e.g. a sales representative) invests in a relationship-specific asset (e.g. goodwill). Hanson (1995) studies manufacturers in a developing country (Mexico) who divide asset ownership between themselves and sub-contractors to share natural risk (although only the manufacturers make specific investments).

[2] Holmstrom and Milgrom (1991, 1994) also include both verifiable and private benefits, but they only model one-sided investments. Further, they do not explicitly include an asset specificity technology. Finally, they study a multitask environment, while I let the parties perform only one task each. Another interesting model that combines a linear moral hazard approach and the allocation of decision rights is found in Holmstrom and Tirole's (1991) paper on transfer pricing.

benefits. I also show that integration is more likely to dominate non-integration when the managers have very different risk preferences.

In a numerical example I illustrate how the optimal ownership structure is jointly determined by the parties' risk aversion and the specificity of their investments. By changing the risk bearing costs for the non-contractible benefits, I consider three cases. In the first case, high risk aversion and asset ownership go together. In the second case, that result is only true for moderate total risk aversion levels. While in the third case, low risk aversion and asset ownership go together.

In section 6 I allow a third party to break the budget balancing constraint. If she plays the role of a traditional investor, she buys a right to a certain percentage of the verifiable profits. Then the total risk bearing costs are reduced, but so are the incentives. The third party could also be paid ex-ante to gear up the investments of the two managers. The resulting improved incentives from the verifiable profits must be weighed against the increased total risk bearing costs.

In the final section, I discuss the model and the results in a wider context. I argue that the model seems realistic from a bounded rationality perspective, and that it does capture trade-offs that are important also under more complex settings.

2. The model

There are two assets and two productive parties, manager 1 and manager 2. At $t = 0$ the parties make unverifiable investments in human capital (e_1 and e_2). The effort levels determine two types of benefits at $t = 1$.

First, each productive manager has an uncertain non-contractible benefit (observable to manager 1 and 2 at $t = 1$ but not verifiable to third parties).[3] This benefit is dependent upon whether the two parties choose to cooperate or not at $t = 1$. Cooperation cannot be verified. In the case of no cooperation, the benefit will further depend on the ownership structure.

Define asset ownership as the right to deny other parties access to the asset (Hart and Moore 1990). Consider three ownership structures. Either manager 1 owns both assets (which, following Hart (1995), I call Type 1 integration - T1), manager 2 owns both assets (Type 2 integration - T2), or each manager owns the asset most specific to her investments (Non-integration - NI).

Assume independent technologies that are linear in an agent's effort e_i ($i \in \{1,2\}$). If the two managers choose to cooperate, their non-contractible benefits are given by

[3] Note that benefits (and costs) can be monetary in nature even if they are not verifiable to third parties.

$$\Gamma_1 = e_1 + \varepsilon_1$$

$$\Gamma_2 = e_2 + \varepsilon_2$$

where $e_i \geq 0$, $E[\varepsilon_i] = 0$ and $Var[\varepsilon_i] = \sigma_i^2$. Manager 1's benefits are dependent only on manager 1's effort and an uncertain error term.[4] In the more general case, Γ_i could be a function of both the two managers' effort levels.

Second, there is an uncertain verifiable profit stream that the managers can contract on. Both the productive managers are risk averse, so the optimal contract must trade off incentives and risk sharing considerations. In the tradition of Holmstrom and Milgrom (1987, 1991) I assume that contracts are restricted to be linear in profits and that the players have mean-variance preferences.

The managers' shares of the profit stream Π are

$$\pi_1 = a\Pi + t_1$$

$$\pi_2 = b\Pi + t_2 ,$$

where a, b, t_1 and t_2 are constants. Assume for now that there is no third party to break the budget balancing constraint, so that $b = 1 - a$ and $t_1 + t_2 = 0$.

The verifiable benefits are assumed to have similar technologies as the non-contractible.

$$\Pi = \zeta_1 e_1 + \zeta_2 e_2 + \varepsilon_3$$

where ζ_1 and ζ_2 are positive constants, $E[\varepsilon_3] = 0$ and $Var[\varepsilon_3] = \sigma_3^2$. In other words, there is a linear relation between the verifiable profits and the non-contractible benefits. This is obviously a special case, but it is not clear whether the relation should be convex or concave, if it was not to be linear in nature. Note that although the value added of each manager can technologically be separated, the managers can only contract on an aggregated measure.[5]

Assume that the benefits enter a manager's utility function in an additive way, and define $\theta_i^C \equiv \Gamma_i + \pi_i$ as a manager's total benefits at t = 1 when cooperation takes place. If the two parties choose not to cooperate, their total benefits are reduced to

$$\theta_1^{NC} \equiv \gamma_k \Gamma_1 + \pi_1$$

$$\theta_2^{NC} \equiv \lambda_k \Gamma_2 + \pi_2$$

[4] Observe that the variances are not affected by the effort levels of the two managers. Choate and Maser (1992) have shown (in a setting without explicit contracts) that risk aversion tends to augment the importance of asset specificity when risk bearing costs increase with effort levels.

[5] The analyses and results are very similar when there are two profit streams (or signals) available for contracting.

where γ_k, $\lambda_k \in [0,1)$ are constants that depend on the ownership structure $k \in K \equiv \{T1, T2, NI\}$. This assumption is fairly strong in the sense that total and marginal benefits move together. That does not necessarily need to be the case, but it is consistent with Hart and Moore (1990) and Hart (1995). [6]

As is becoming standard in the literature, assume a symmetric Nash bargaining solution at t = 1. That is, cooperation takes place after renegotiations, and the gains are split 50:50. For a given contract, manager 1 and 2 then maximise[7]

$$U_1 = E\,[\,½(\theta_1^{C} + \theta_2^{C}) + ½(\theta_1^{NC} - \theta_2^{NC})\,] - ½\, r_1 \,\mathrm{Var}\,[\,½(\theta_1^{C} + \theta_2^{C}) + ½(\theta_1^{NC} - \theta_2^{NC})\,] - c_1(e_1)$$

$$U_2 = E\,[\,½(\theta_2^{C} + \theta_1^{C}) + ½(\theta_2^{NC} - \theta_1^{NC})\,] - ½\, r_2 \,\mathrm{Var}\,[\,½(\theta_2^{C} + \theta_1^{C}) + ½(\theta_2^{NC} - \theta_1^{NC})\,] - c_2(e_2)$$

where $r_i > 0$ denotes manager i's risk aversion and $c_i(e_i)$ her private costs. Assume $c_i'(e_i) > 0$ and $c_i''(e_i) > 0$.

Define $\varphi_k \equiv ½(1+\gamma_k)$ and $\psi_k \equiv ½(1+\lambda_k)$, which can be interpreted as the two managers' respective bargaining positions. Leaving out the index k and the terms that are unaffected by e_1 and e_2 respectively, the maximisation problems of the two managers (for a given ownership structure and profit sharing contract) then simplify to

$$e_1 = \underset{e_1}{\mathrm{Argmax}}\, U_1 = \underset{e_1}{\mathrm{Argmax}}\, \{\, \varphi\, e_1 + a\, \zeta_1\, e_1 - c_1(e_1)\,\}$$

$$e_2 = \underset{e_2}{\mathrm{Argmax}}\, U_2 = \underset{e_2}{\mathrm{Argmax}}\, \{\, \psi\, e_2 + (1-a)\, \zeta_2\, e_2 - c_2(e_2)\,\}$$

with first-order conditions

(1a) $\quad c_1'(e_1) = \varphi + a\, \zeta_1$

(1b) $\quad c_2'(e_2) = \psi + (1-a)\, \zeta_2$

The managers' reaction functions $e_1(a)$ and $e_2(a)$ are implied by these conditions. Differentiate both sides of equations (1a) and (1b) with respect to a to find the marginal reaction functions

(2a) $$\frac{d\,e_1}{d\,a} = \frac{\zeta_1}{c_1''(e_1)}$$

(2b) $$\frac{d\,e_2}{d\,a} = -\frac{\zeta_2}{c_2''(e_2)}$$

[6] The verifiable profits could also depend on whether cooperation takes place or not, but this complication would not add any significant new insights.

[7] The preferences correspond to negative exponential utility functions, where all benefits and costs can be represented in monetary units and the error terms are normally distributed.

For a given ownership structure, optimal incentives are found by maximising the expected joint surplus Ω, which, allowing for correlation between all the three error terms, is given by

$$(3)\qquad \Omega(a) = (1+\zeta_1)\, e_1(a) + (1+\zeta_2)\, e_2(a) - c_1(e_1(a)) - c_2(e_2(a))$$
$$- \tfrac{1}{2} r_1 [\, \varphi^2\sigma_1^2 + (1-\psi)^2\sigma_2^2 + a^2\sigma_3^2 + 2\varphi(1-\psi)\sigma_{12} + 2\varphi a\sigma_{13} + 2(1-\psi)a\sigma_{23} \,]$$
$$- \tfrac{1}{2} r_2 [\, (1-\varphi)^2\sigma_1^2 + \psi^2\sigma_2^2 + (1-a)^2\sigma_3^2 + 2(1-\varphi)\psi\sigma_{12} + 2(1-\varphi)(1-a)\sigma_{13} + 2\psi(1-a)\sigma_{23} \,]$$

where σ_{ij} denotes the covariance between two error terms ($i, j \in \{1, 2, 3\}$, $i \neq j$). After finding the first-order condition with respect to a, use (1) and (2) to solve for the optimal incentives

$$(4)\qquad a^* = \frac{\frac{\zeta_1}{c_1''}(\zeta_1 + 1 - \varphi) - \frac{\zeta_2}{c_2''}(1-\psi) + r_2\left(\sigma_3^2 + (1-\varphi)\sigma_{13} + \psi\sigma_{23}\right) - r_1(\varphi\sigma_{13} + (1-\psi)\sigma_{23})}{\frac{\zeta_1^2}{c_1''} + \frac{\zeta_2^2}{c_2''} + (r_1 + r_2)\,\sigma_3^2}$$

where c_i'' is short for $c_i''(e_i)$. Observe that the incentives for manager 1 from the verifiable profit stream decrease in r_1 and increase in r_2, as is usual for moral hazard models. More interestingly, they decrease in φ and increase in ψ, since a manager who has strong incentives from her private benefits does not need strong incentives from the profit stream. This means that the incentive coefficient for a manager is reduced when ownership of assets is transferred to her (although total incentives for her are strengthened). This is the opposite of what Holmstrom and Milgrom (1994) hypothesise, and reflects a single task (per manager) versus a multitask setting (where the tasks are substitutes in an agent's cost function).[8]

If $\sigma_{13} = \sigma_{23} = 0$, $\zeta_1 = \zeta_2 = 1$ and $c_1'' = c_2'' = 1$, a* simplifies to

$$a^* = \frac{1 + \psi - \varphi + r_2\sigma_3^2}{2 + (r_1 + r_2)\sigma_3^2}$$

Of course, $a^* = \tfrac{1}{2}$ if $\varphi = \psi$ and $r_1 = r_2$, since the two managers then are equal in every respect.

3. An interpretation of the model

A classical interpretation of the model would be that manager 2 in combination with asset 2 supplies an input to manager 1, who with asset 1 uses this input to produce output that is sold

[8] Note that while I study a relationship among peers (companies), Holmstrom and Milgrom focus on a more traditional principal-agent relationship (using sales agents as example).

on the output market (Hart 1995). I had, however, a different example in mind when I wrote this paper.

Say that there are two companies with complementary competencies that decide to do a joint project. To do so they need to set up a project organisation. It is organised as a separate legal entity, so that revenues from the project are verifiable. The costs of project employees and the investments in physical assets are deducted before the profits are calculated and can be contracted upon in advance.

However, the project requires also substantial effort by managers and experts within the two parent companies. Since these resources are not part of the joint venture as such, it is difficult to verify the costs of their efforts. In fact, these investments may to some degree be unobservable to the other party. The costs are therefore not part of the contract. The model in this paper is meant to provide insights into how the project contract can be designed to give the best possible incentives for the parent companies to make such investments anyway. How individual employees are motivated is not included in the model.

The parent companies have two types of incentives. They get a certain share of the (verifiable) profits of the project, and there are some non-contractible benefits, that to some degree are dependent upon the parties' continued cooperation after (or outside) the contracted project. First, consider the verifiable profits. Usually it is difficult for third parties to verify the value added each manager contributes to these profits. Therefore I have assumed that there is only one profit stream to be contracted on.

Second, as the project evolves, the two parent companies and the project organisation may discover new opportunities related to the project at hand. At the project start, the nature of these opportunities is unknown, so they cannot be contracted on. The opportunities could be pursued by each of the two companies independently. However, larger benefits can be realised if they choose to cooperate. Then the human capital of both parent organisations, the project's assets and the project organisation can again be combined in a fruitful pursuit of the opportunities in a new project. If negotiations break down, a company will do better if it still has access to some of the assets (e.g. production facilities and distribution networks). Access to these assets at the end of the initial project is determined in an ex-ante contract. Either one parent company can take over the entire project organisation with assets, or the two companies split the assets according to their existing competencies. In the latter case, a company keeps assets that are close to its existing products and markets, and the overlying project organisation is dissolved.

An important driver of the results in this paper is that the activities of the parent companies at the same time contribute to the present project's verifiable profits and to the value of a future project. In other words, the parent companies cannot shift their focus away from the contracted project and over to investing in future opportunities, if their incentives to do the latter are strengthened. This may seem as a strong assumption, but in my particular setting that is not necessarily so. The value of the future project depends crucially on the investments in the present project, as the same assets will be used and hence the same competencies will be needed. Furthermore, a parent company does not know what the future opportunities will be at the project start and can thus not direct its employees towards working with these only. Finally, many possible opportunities can materialise during the project, but an evaluation of these opportunities may not be possible before the project end, for instance because feedback from the market on the existing project is needed. Then it would not make sense to funnel the investments to a particular opportunity before that evaluation is performed.

4. Comparative analysis

Assume that the value of a manager's outside option is given by

$$1 > \gamma_{T1} > \gamma_{NI} > \gamma_{T2} \geq 0$$

$$1 > \lambda_{T2} > \lambda_{NI} > \lambda_{T1} \geq 0$$

Then, it follows directly from the definitions of φ and ψ that

(5a) $1 > \varphi_{T1} > \varphi_{NI} > \varphi_{T2} \geq ½$

(5b) $1 > \psi_{T2} > \psi_{NI} > \psi_{T1} \geq ½$

With these assumptions, the value of the outside option increases with the number of assets the manager controls. If we defined a discrete function f for a specific technology, so that $f(\varphi) = \psi$, then this function would decrease in φ, since a strengthening of one manager's bargaining position (through a transfer of ownership rights) results in a weakening of the other manager's position.

However, to gain insights into how risk aversion can affect optimal asset ownership, it proves useful to first analyse how the expected joint surplus is affected by *one-sided* changes in the parties' bargaining positions (even though φ in reality can be increased only if ψ is reduced and vice versa). To simplify the analysis, assume quadratic cost functions

$$c_i(e_i) = ½\, e_i^2 \,, \; i \in \{1, 2\}$$

so that optimal incentives are constant over effort levels (since c_i'' is a constant). Fixed cost elements are ignored. (1a) and (1b) then imply

$$e_1 = \varphi + a\,\zeta_1$$

$$e_2 = \psi + (1\text{-}a)\,\zeta_2$$

Due to the envelope theorem, the partial derivatives of the maximum expected joint surplus (Ω^*) with respect to φ and ψ are given by

$$\frac{\partial \Omega^*}{\partial \varphi} = 1 - \varphi + \zeta_1 (1 - a^*) - r_1 \left(\varphi \sigma_1^{\,2} + (1-\psi)\sigma_{12} + a^* \sigma_{13} \right) + r_2 \left((1-\varphi)\sigma_1^{\,2} + \psi \sigma_{12} + (1 - a^*)\sigma_{13} \right)$$

$$\frac{\partial \Omega^*}{\partial \psi} = 1 - \psi + \zeta_2 a^* + r_1 \left((1-\psi)\sigma_2^{\,2} + \varphi \sigma_{12} + a^* \sigma_{23} \right) - r_2 \left(\psi \sigma_2^{\,2} + (1-\varphi)\sigma_{12} + (1 - a^*)\sigma_{23} \right)$$

where a* denotes the optimal incentive coefficient found in (4). Note that these derivatives theoretically can be negative, since an increase in φ or ψ does not only strengthen the respective manager's incentives, it also increases the risk bearing costs. However, it does not seem realistic in this setting that a reduction in the asset specificity can leave the parties worse off, so one would expect the parameters to be such that the derivatives are positive.

To focus on risk aversion and asset specificity, assume otherwise symmetrical technologies.

DEFINITION 1: The production technologies are symmetrical if $\zeta_1 = \zeta_2 \equiv \zeta$, $\sigma_1^2 = \sigma_2^2 \equiv \sigma_\Gamma^2$, $\sigma_{13} = \sigma_{23} \equiv \sigma_{\Gamma\Pi}$ and the managers' cost functions are identical.

Assume such symmetry, define $\sigma_3^2 \equiv \sigma_\Pi^2$, and use the expression for a* from (4) to find the following relation

(5)
$$\frac{\partial \Omega^*}{\partial \varphi} > \frac{\partial \Omega^*}{\partial \psi}$$

$$\Updownarrow$$

$$(\psi - \varphi)(r_1 + r_2)\left[\, \sigma_\Pi^2 + (\sigma_\Gamma^2 + \sigma_{12})\{2\zeta^2 + (r_1 + r_2)\sigma_\Pi^2\} - 4\zeta\sigma_{\Gamma\Pi} - 2(r_1 + r_2)\sigma_{\Gamma\Pi}^{\;2} \,\right]$$
$$+\; (r_1 - r_2)\left[\, \zeta(\sigma_\Pi^2 + 2\sigma_{\Gamma\Pi}) - 2\zeta^2(\sigma_\Gamma^2 + \sigma_{12} + \sigma_{\Gamma\Pi}) - (r_1 + r_2)\{\sigma_\Pi^2(\sigma_\Gamma^2 + \sigma_{12}) - 2\sigma_{\Gamma\Pi}^2\} \,\right] > 0$$

The expression in the upper square brackets is typically positive, so that $\varphi < \psi \Leftrightarrow \partial\Omega^*/\partial\varphi > \partial\Omega^*/\partial\psi$, if the two managers are equally risk averse ($r_1 = r_2$). The expression in the lower square brackets, on the other hand, can be both positive and negative, depending on the parameters.

It can be shown that the second-order derivatives both are negative constants (since Ω^* is quadratic in φ and ψ). Hence, $\Omega^*(\varphi, \psi)$ is concave in both φ and ψ. Furthermore, with symmetrical production technologies, $\partial^2\Omega^*/\partial\varphi^2 = \partial^2\Omega^*/\partial\psi^2$.

a) Type 1 versus Type 2 integration

Consider type 1 integration versus type 2 integration. Remember that the results of this section do not rule out non-integration as the optimal ownership structure.

In general, type 1 integration is more likely to dominate type 2 integration if (φ_{T1} - φ_{T2}) is large compared to (ψ_{T2} - ψ_{T1}). Further, when $\varphi_{T1} - \varphi_{T2} \approx \psi_{T2} - \psi_{T1}$, the manager with the worst bargaining positions (in absolute terms) is more likely to own the assets, since the expected joint surplus is concave in φ and ψ. To focus on risk aversion, assume symmetrical asset specificity technologies.

DEFINITION 2: The asset specificity technologies are symmetrical if $\varphi_{T1} = \psi_{T2}$, $\varphi_{NI} = \psi_{NI}$ and $\varphi_{T2} = \psi_{T1}$.

DEFINITION 3: Manager 1's (2's) bargaining position is on the margin more *important* for the joint surplus than manager 2's (1's) bargaining position, if $\partial\Omega^*/\partial\varphi > \partial\Omega^*/\partial\psi$ ($\partial\Omega^*/\partial\psi > \partial\Omega^*/\partial\varphi$) for all $\varphi = \psi \in [½, 1)$.

LEMMA 1: A manager should always own at least one of the two assets, if her bargaining position (on the margin) is more important for the joint surplus than the other manager's bargaining position, and the production and asset specificity technologies are symmetrical in nature.

PROOF: Due to the symmetrical asset specificity technologies, define $k_1 \equiv \varphi_{T1} = \psi_{T2}$ and $k_2 \equiv \varphi_{T2} = \psi_{T1}$, where $k_1 > k_2$. For notational purposes also define $\Omega^*_1(\varphi, \psi) \equiv \partial\Omega^*/\partial\varphi$ and $\Omega^*_2(\varphi, \psi) \equiv \partial\Omega^*/\partial\psi$. Type 1 integration then dominates type 2 integration if and only if

$$\int_{k_2}^{k_1} \Omega_1(k, k_2)dk > \int_{k_2}^{k_1} \Omega_2(k_2, k)dk$$

If manager 1's bargaining position (on the margin) is the most important for the joint surplus, then $\Omega^*_1(k_2, k_2) > \Omega^*_2(k_2, k_2)$.[9] The inequality is then trivially satisfied, since Ω^* is equally concave in both arguments under symmetrical production technologies. Similar if manager 2's bargaining position (on the margin) is the most important for the joint surplus. QED.

For lemma 1 to be of value, we must understand under what settings a manager's bargaining position is expected to be the most important.

Define $M \equiv \zeta(\sigma_\Pi^2 + 2\sigma_{\Gamma\Pi}) - 2\zeta^2(\sigma_\Gamma^2 + \sigma_{12} + \sigma_{\Gamma\Pi}) - (r_1 + r_2)\{\sigma_\Pi^2(\sigma_\Gamma^2 + \sigma_{12}) - 2\sigma_{\Gamma\Pi}^2\}$.

In a situation with symmetrical production and asset specificity technologies, we know from (5) and lemma 1 that the most risk averse managers should own at least one of the assets if $M > 0$. Although there does seem to be a large range of parameters where that will not be the case, M will be positive if σ_Γ is small compared to σ_Π.

DEFINITION 4: The risk bearing costs associated with the non-contractible benefits are unimportant, if $\sigma_\Gamma \rightarrow 0$.

[9] $\varphi = \psi = k_2$ can be interpreted as a joint ownership structure.

PROPOSITION 1: The most risk averse manager should always own at least one asset, if the risk bearing costs associated with the non-contractible benefits are unimportant, and the production and asset specificity technologies are symmetrical in nature.

PROOF: $\sigma_{12}, \sigma_{\Gamma\Pi} \rightarrow 0$, if $\sigma_\Gamma \rightarrow 0$. Then (5) simplifies to

$$(6) \qquad \frac{\partial \Omega^*}{\partial \varphi} > \frac{\partial \Omega^*}{\partial \psi} \quad \Leftrightarrow \quad (\psi - \varphi)(r_1 + r_2) + (r_1 - r_2)\zeta > 0$$

According to definition 3, the most risk averse manager's bargaining position is then (on the margin) the most important for the joint surplus, and the proposition follows directly from lemma 1. QED.

The intuition behind this perhaps somewhat surprising result is simple. If one of the managers is very risk averse, then it is costly to motivate her through the explicit contract on the uncertain verifiable profit stream. Instead it is better to give her ownership rights, so that she is highly motivated by the less risky non-contractible benefits. The two managers can thus be given balanced total incentives at a lower cost.

Note that proposition 1 also holds if the non-contractible benefits are uncertain in nature, but the managers are less worried about this uncertainty than the uncertainty of the verifiable profit stream. That is, the most risk averse manager should own assets, if the risk aversion rates for the non-contractible benefits are much lower than the rates for the verifiable profit stream.

In the interpretation of the model given in section 3, it does seem realistic to consider situations where the non-contractible benefits are less risky than the verifiable profit stream. The downside risk is limited, since the parties do not commit to any costs to pursue the new opportunities before $t = 1$.[10] And, the parties could very well be able (at $t = 0$) to relatively accurately predict the valuation (at $t = 1$) of the new opportunities, even if they do not understand the nature of these opportunities sufficiently to contract upon them. However, we should also consider the other case, where the non-contractible benefits are more risky.

DEFINITION 5: The risk bearing costs associated with the verifiable benefits are unimportant, if $\sigma_\Pi \rightarrow 0$.

PROPOSITION 2: The least risk averse manager should always own at least one asset, if the risk bearing costs associated with the verifiable benefits are unimportant, and the production and asset specificity technologies are symmetrical in nature.

[10] Since the downside risk is limited for the non-contractible benefits within the relevant time range, these benefits could be seen as call options that can be exercised at $t = 1$. Then the parties would actually prefer the uncertainty of these benefits to be high, since the value of a call option increases with uncertainty. If that was the case, however, my model is not correctly specified, since to arrive at the mean-variance preferences, the error terms are implicitly assumed to be normally distributed.

PROOF: $\sigma_{\Gamma\Pi} \to 0$, if $\sigma_\Pi \to 0$. Then (5) simplifies to

$$(7) \qquad \frac{\partial \Omega^*}{\partial \varphi} > \frac{\partial \Omega^*}{\partial \psi} \quad \Leftrightarrow \quad (\psi - \varphi)(r_1 + r_2) - (r_1 - r_2) > 0$$

According to definition 3, the least risk averse manager's bargaining position is then (on the margin) the most important for the joint surplus, and the proposition follows directly from lemma 1. QED.

Now the least risk averse manager should own assets, since ownership does have an impact on the risk bearing costs, while the explicit contract does not. So the most risk averse manager can instead be motivated by the risk free explicit contract.

Finally, consider the less extreme case, where there are risk bearing costs associated with both the non-contractible benefits and the verifiable profit stream. From the definition of M, note that M > 0 is more likely when $(r_1 + r_2)$ is small, if $\sigma_\Pi^2 (\sigma_\Gamma^2 + \sigma_{12}) - 2\sigma_{\Gamma\Pi}^2 = \sigma_\Pi^2\sigma_\Gamma^2 (1 + \rho_{1,2} - 2\rho_{\Gamma,\Pi}) > 0$. That is typically the case, since it is unlikely that the correlation between the private benefits and the verifiable profit stream is much higher than the correlation between the two private benefits. In other words, the most risk averse manager is more likely to own assets if the *total* risk aversion $(r_1 + r_2)$ is small.

To better illustrate the trade-offs between the ownership structures under this more ambiguous setting, consider two special cases. First, assume that all the error terms are perfectly correlated and that the verifiable and the non-contractible benefits are equally important ($\rho_{1,2} = \rho_{\Gamma,\Pi} = 1$ and $\zeta = 1$). For $\varphi = \psi$, (5) then simplifies to

$$(8) \qquad \frac{\partial \Omega^*}{\partial \varphi} > \frac{\partial \Omega^*}{\partial \psi} \quad \Leftrightarrow \quad (r_1 - r_2)(\sigma_\Pi - 2\sigma_\Gamma) > 0$$

That is, the most risk averse manager should own at least one of the two assets if $\sigma_\Pi > 2\sigma_\Gamma$ (and the production and asset specificity technologies are symmetrical in nature). Note that $\sigma_\Pi = 2\sigma_\Gamma$ if the non-contractible benefits in total are as risky as the profit stream. In other words, the most risk averse manager tends to own assets, if the total non-contractible benefits are less uncertain than the verifiable profit stream.

Second, assume that there is no correlation between the error terms, while, as before, the verifiable and the non-contractible benefits are equally important. That is, $\rho_{1,2} = \rho_{\Gamma,\Pi} = 0$ and $\zeta = 1$. For $\varphi = \psi$, (5) then simplifies to

$$(9) \qquad \frac{\partial \Omega^*}{\partial \varphi} > \frac{\partial \Omega^*}{\partial \psi} \quad \Leftrightarrow \quad (r_1 - r_2)\left[\sigma_\Pi^2 - 2\sigma_\Gamma^2 - (r_1 + r_2)\sigma_\Pi^2\sigma_\Gamma^2\right] > 0$$

In other words, unlike in (8), the total level of risk aversion is again relevant. The most risk averse manager will now own assets when the non-contractible benefits and the profit stream are equally risky, in the sense that $\sigma_\Pi = 2\sigma_\Gamma$, only if $(r_1 + r_2)\sigma_\Gamma^2 \leq ½$.

Seen together, (8) and (9) indicate that if all the three error terms are equally correlated, the most risk averse manager is more likely to own assets for high levels of correlation.

b) Integration versus Non-integration

In general, type 1 integration is more likely to dominate non-integration if $(\varphi_{T1} - \varphi_{NI})$ is large compared to $(\psi_{NI} - \psi_{T1})$, and type 2 integration is more likely to dominate non-integration if $(\psi_{T2} - \psi_{NI})$ is large compared to $(\varphi_{NI} - \varphi_{T2})$.

Assume for simplicity that the asset specificity technologies are symmetrical ($\varphi_{T1} = \psi_{T2} \equiv k_1$, $\varphi_{NI} = \psi_{NI} \equiv k_{NI}$ and $\varphi_{T2} = \psi_{T1} \equiv k_2$). Take $\varphi = \psi = k_2$ as a starting point. This can be interpreted as a joint ownership structure. Figure 1 shows how the expected joint surplus, $\Omega^*(\varphi, \psi)$, then increases in its two arguments. I assume that manager 1's bargaining position (on the margin) is the most important, so that type 1 integration dominates type 2 integration.

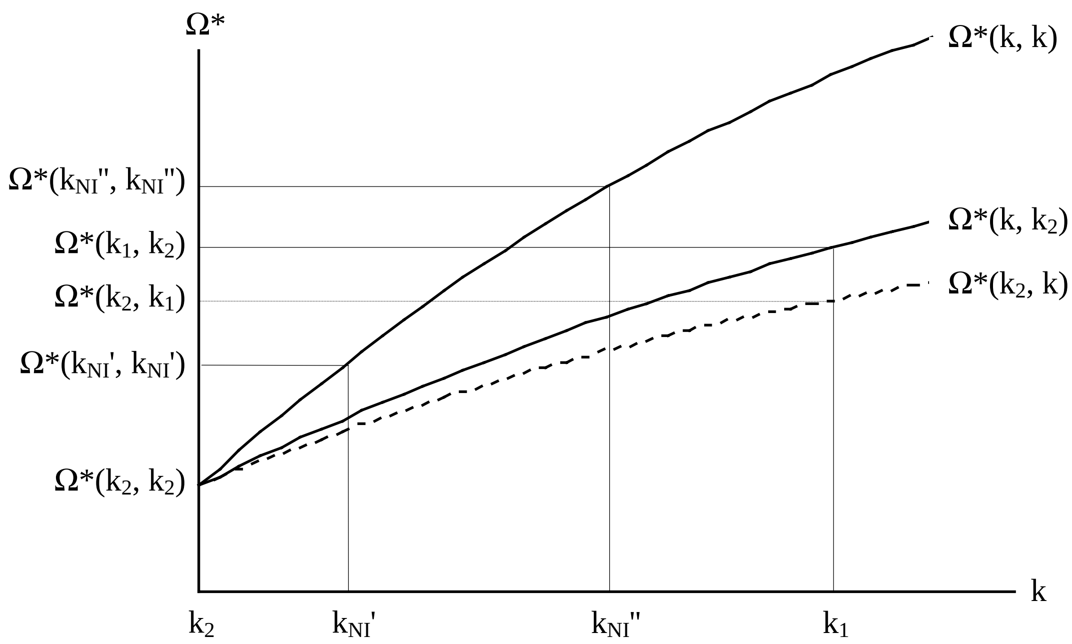


Figure 1.[11]

Starting at $\varphi = \psi = k_2$ (joint ownership), the managers can choose between three (other) ownership structures. One of the managers can give up her claims to both assets. If manager 1 remains the sole owner (type 1 integration), then φ is increased from k_2 to k_1,

[11] The diagram is generated using $\zeta_1 = \zeta_2 = 1$, $\sigma_1 = \sigma_2 = 0.25$, $\sigma_3 = 1.00$, $\sigma_{12} = \sigma_{13} = \sigma_{23} = 0$, $r_1 = 4.5$, $r_2 = 1.5$ and $k_2 = 0.5$.

while ψ still equals k_2. And, if manager 2 remains the sole owner (type 2 integration), ψ is increased from k_2 to k_1, while φ still equals k_2. The managers can also choose to both give up ownership rights to one asset each, so that each manager becomes the sole owner of the asset most specific to her investments. Then both φ and ψ are strengthened from k_2 to k_{NI}.

In the diagram I have indicated two possible k_{NI} values. Integration dominates non-integration for k_{NI}', while it does not for k_{NI}".

Mathematically, type 1 integration dominates non-integration, when the asset specificity technologies are symmetrical, if

$$(10) \qquad \int_{k_{NI}}^{k_1} \frac{d\Omega^*(k, k_2)}{dk} dk > \int_{k_2}^{k_{NI}} \left(\frac{d\Omega^*(k,k)}{dk} - \frac{d\Omega^*(k, k_2)}{dk} \right) dk$$

Three factors decide the trade-off. Where k_{NI} is located on the interval (k_2, k_1), how large [$d\Omega^*(k, k)/dk - d\Omega^*(k, k_2)/dk$] is for $k \in (k_2, k_{NI})$ and how large $d\Omega^*(k, k_2)/dk$ is for $k \in (k_{NI}, k_1)$.

To again focus on risk aversion, assume symmetrical production technologies, and, to simplify, set $\rho_{1,2} = \rho_{\Gamma,\Pi} = 0$. The two integrands in (10) are then given by

$$(11) \qquad \frac{d\Omega^*(k,k)}{dk} - \frac{d\Omega^*(k, k_2)}{dk} = (1-k) + r_1(1-k)\sigma_\Gamma^2 - r_2 k \sigma_\Gamma^2 + \zeta \frac{\zeta^2 - (k - k_2)\zeta + r_2 \sigma_\Pi^2}{2\zeta^2 + (r_1 + r_2)\sigma_\Pi^2}$$

$$(12) \qquad \frac{d\Omega^*(k, k_2)}{dk} = (1-k) - r_1 k \sigma_\Gamma^2 + r_2(1-k)\sigma_\Gamma^2 + \zeta - \zeta \frac{\zeta^2 - (k - k_2)\zeta + r_2 \sigma_\Pi^2}{2\zeta^2 + (r_1 + r_2)\sigma_\Pi^2}$$

Again consider the two extreme cases that I discussed in propositions 1 and 2.

PROPOSITION 3: If the risk bearing costs associated with the non-contractible benefits are unimportant, and the production and asset specificity technologies are symmetrical in nature, then integration is more likely to dominate non-integration if the risk preferences of the two managers are very different.[12]

PROOF: According to proposition 1, type 1 integration dominates type 2 integration when manager 1 is more risk averse than manager 2, if the risk bearing costs associated with the non-contractible benefits are unimportant. [$d\Omega^*(k, k)/dk - d\Omega^*(k, k_2)/dk$] decreases in r_1 when $\sigma_\Gamma \to 0$, while $d\Omega^*(k, k_2)/dk$ then increases. The inequality in (10) is therefore more likely to hold for the same values of k_2, k_{NI} and k_1, the larger r_1 is. Same effect if r_2 decreases (as long as $a^* < 1$). Similar if manager 2 is the most risk averse. That is, integration is more likely, if $|r_1 - r_2|$ is large. QED.

[12] Although (11) and (12) are shown for the case where $\rho_{1,2}$, $\rho_{\Gamma,\Pi} = 0$, propositions 3 and 4 are valid also when $\rho_{1,2}$, $\rho_{\Gamma,\Pi} > 0$. Note that σ_{12} and $\sigma_{\Gamma\Pi}$ both are irrelevant if $\sigma_\Gamma \to 0$, while $\sigma_{\Gamma\Pi}$ is irrelevant if $\sigma_\Pi \to 0$.

PROPOSITION 4: If the risk bearing costs associated with the verifiable profit stream are unimportant, and the production and asset specificity technologies are symmetrical in nature, then integration is more likely to dominate non-integration if the risk preferences of the two managers are very different.

PROOF: According to proposition 1, type 1 integration dominates type 2 integration when manager 1 is less risk averse than manager 2, if the risk bearing costs associated with the verifiable benefits are unimportant. [$d\Omega^*(k, k)/dk - d\Omega^*(k, k_2)/dk$] increases in r_1 when $\sigma_\Pi \rightarrow 0$, while $d\Omega^*(k, k_2)/dk$ then decreases. The inequality in (10) is therefore more likely to hold for the same values of k_2, k_{NI} and k_1, the smaller r_1 is. Same effect if r_2 increases (as long as $a^* < 1$). Similar if manager 2 is the least risk averse. That is, integration is more likely, if $|r_1 - r_2|$ is large. QED.

Propositions 3 and 4 are stated for only very extreme values of σ_Π and σ_Γ. The result does hold, however, also for most other parameter settings (although not always). We can therefore conclude that there is, in general, a tendency for integration to dominate non-integration when the two managers have very different risk preferences. The intuition being that if one of the managers is very risk averse, while the other is not, then her risk bearing costs are much more sensitive to changes in ownership structure. Hence, when it is good that she owns assets (because the risk bearing costs associated with the non-contractible benefits are low), she should own them all. While if it is very costly for her to own assets, she should not own any. In any case, they choose integration.

Note that asymmetries in the asset specificity and production technologies typically will skew the result, so that non-integration can be optimal even if the risk aversion preferences of the two managers are very different. Also remember that integration can dominate non-integration, even if the two managers have the same risk aversion (and the production and asset specificity technologies are symmetrical in nature), when non-integration does not strengthen the bargaining positions much compared to joint ownership, while integration does.

I should also comment on the role of the parameters ζ_1 and ζ_2 (which determine how important the verifiable profits are relative to the non-contractible benefits). All my results are valid regardless of what values these parameters take. In fact, the effects that are described in propositions 1 to 4 are even stronger when the verifiable profits are very important. Then the choice of ownership structure tends to become more sensitive to differences in risk preferences, although the ownership structure as such will be less important (since the managers are mainly motivated by the verifiable profit stream anyway).

5. A numerical example

In this section I go through three numerical settings to illustrate how the different ownership structures perform. For now, ignore third party participation. I assume that the two managers and the two assets are symmetrical in every respect, except for the risk aversion of the two managers and the asset specificity of their investments. The three cases differ only in the uncertainty of the non-contractible benefits.

Assume that these parameters are fixed

$\zeta_1 = \zeta_2 = 1$
$r_2 = 4$
$\sigma_3 = 1$
$\rho_{1,2} = \rho_{1,3} = \rho_{2,3} = ½$

Define $R \equiv r_1 / r_2$. R is then a measure of the relative risk aversion. Note that r_2 is fixed. Only r_1 is allowed to change.

To compare ownership structures, define an asset specificity technology that exhibits a weak form of symmetry, in the sense that there is a linear relation between the specificity of the two managers' investments

$\varphi_{T1} = 1 - ½A\eta_1$ $\psi_{T1} = 1 - ½\eta_2$
$\varphi_{NI} = 1 - ½A\eta_{NI}$ $\psi_{NI} = 1 - ½\eta_{NI}$
$\varphi_{T2} = 1 - ½A\eta_2$ $\psi_{T2} = 1 - ½\eta_1$

where $0 < \eta_1 < \eta_{NI} < \eta_2 \leq 1$, and $A \in (0, {}^{1}/\eta_2]$ can be interpreted as a measure of relative investment specificity. η_1 is used when a manager owns both assets, η_{NI} when she only owns one asset and η_2 when she does not own any asset at all.

Set $\eta_1 = 0.05$, $\eta_{NI} = 0.26$ and $\eta_2 = 0.50$. Manager 2's bargaining positions (i.e. her incentives for the non-contractible benefit) under the different ownership structures are then fixed at $\psi_{T1} = 0.750$, $\psi_{NI} = 0.870$ and $\psi_{T2} = 0.975$.

Consider three cases

(i) $\sigma_1 = \sigma_2 = 0.1$
(ii) $\sigma_1 = \sigma_2 = 0.3$
(iii) $\sigma_1 = \sigma_2 = 0.5$

Let $\Omega_k^*(R, A)$ denote the maximum expected joint surplus for a given ownership structure. Solve $\Omega_{T1}^*(R, A) = \Omega_{NI}^*(R, A)$ and $\Omega_{NI}^*(R, A) = \Omega_{T2}^*(R, A)$ to find the indifference curves $A(R)|_{T1=NI}$ and $A(R)|_{NI=T2}$ for the three cases. These are shown in figure 2.

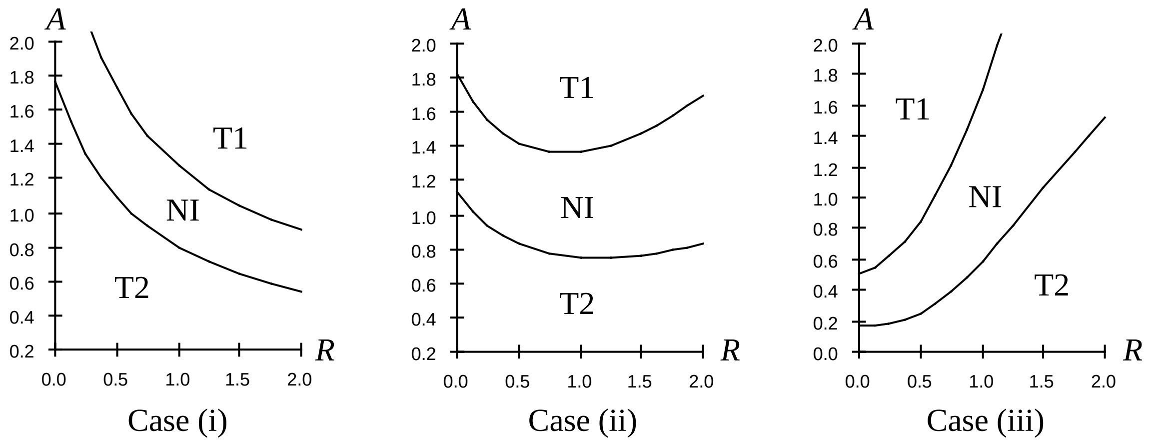


Figure 2.

Remember that R and A increase in manager 1's risk aversion and the specificity of her investments respectively, while manager 2's position is kept constant. For R = A = 1, both managers are equal in every respect. I have calibrated the model (by adjusting η_{NI}), so that non-integration then is the best ownership structure.

In case (i), where the risk bearing costs associated with the non-contractible benefits are relatively unimportant, a manager is more likely to own the assets, the more risk averse she is. This case corresponds to proposition 1 (which was stated for σ_1, $\sigma_2 \rightarrow 0$, and A = 1).

As the risk bearing costs associated with the non-contractible benefits become more important, that result is no longer valid for high levels of total risk aversion, see case (ii).

And, when these costs become even more important relative to the risk bearing costs associated with the verifiable profits, the opposite result is true for all levels of risk aversion, see case (iii). This corresponds to proposition 2 (which was stated for $\sigma_3 \rightarrow 0$ and A = 1). Note though that the risk bearing costs associated with the non-contractible benefits now are so high, that an increase in investment specificity (resulting in weaker incentives) actually will increase the expected joint surplus.

Finally, observe that while non-integration dominates integration in all three cases when A = R = 1, that is no longer the case if R takes a value very different from 1. Managers with very different risk preferences tend to integrate their operations, if the technology otherwise is symmetrical. This observation corresponds to propositions 3 and 4.

6. Third party participation

There are often external third parties that are willing to share the risk bearing costs, although they do not take part in the firm's value creation activities. Denote this ownership structure third party participation (TP). The third party can of course only bear risks associated with the verifiable benefits. The three parties' shares of the profits are then a, b and (1-a-b) for manager 1, 2 and the third party respectively.

In the model, the introduction of a non-productive risk averse third party relaxes the budget balancing constraint for the two managers. On the other hand, the third party's risk bearing costs must be included in the expected joint surplus function.[13]

$$(13) \qquad \Omega_{TP}(a, b) = (1 + \zeta_1)\, e_1(a) + (1 + \zeta_2)\, e_2(b) - c_1(e_1(a)) - c_2(e_2(b))$$
$$- \tfrac{1}{2} r_1 [\, \varphi^2\sigma_1^{\,2} + (1-\psi)^2\sigma_2^{\,2} + a^2\sigma_3^{\,2} + 2\varphi(1-\psi)\sigma_{12} + 2\varphi a\sigma_{13} + 2(1-\psi)a\sigma_{23}\,]$$
$$- \tfrac{1}{2} r_2 [\, (1-\varphi)^2\sigma_1^{\,2} + \psi^2\sigma_2^{\,2} + b^2\sigma_3^{\,2} + 2(1-\varphi)\psi\sigma_{12} + 2(1-\varphi)b\sigma_{13} + 2\psi b\sigma_{23}\,]$$
$$- \tfrac{1}{2} r_3 (1-a-b)^2\sigma_3^{\,2}$$

The productive managers' first-order conditions are given by

$$(14a) \qquad c_1'(e_1) = \varphi + a\,\zeta_1$$

$$(14b) \qquad c_2'(e_2) = \psi + b\,\zeta_2$$

After finding the first-order derivatives of (13) with respect of a and b, the optimal incentives can be found by using (14a), (14b) and the marginal reaction functions that the first-order conditions imply. Assuming quadratic cost functions, the optimal incentives are then given by

$$a^* = \frac{\left[\zeta_2^{\,2} + (r_2 + r_3)\sigma_3^{\,2}\right]\left[\zeta_1^{\,2} + \zeta_1(1-\varphi) + r_3\sigma_3^{\,2} - r_1\{\varphi\sigma_{13} + (1-\psi)\sigma_{23}\}\right] - r_3\sigma_3^{\,2}\left[\zeta_2^{\,2} + \zeta_2(1-\psi) + r_3\sigma_3^{\,2} - r_2\{(1-\varphi)\sigma_{13} + \psi\sigma_{23}\}\right]}{\left[\zeta_1^{\,2} + (r_1 + r_3)\sigma_3^{\,2}\right]\left[\zeta_2^{\,2} + (r_2 + r_3)\sigma_3^{\,2}\right] - \left[r_3\sigma_3^{\,2}\right]^2}$$

$$b^* = \frac{\left[\zeta_1^{\,2} + (r_1 + r_3)\sigma_3^{\,2}\right]\left[\zeta_2^{\,2} + \zeta_2(1-\psi) + r_3\sigma_3^{\,2} - r_2\{(1-\varphi)\sigma_{13} + \psi\sigma_{23}\}\right] - r_3\sigma_3^{\,2}\left[\zeta_1^{\,2} + \zeta_1(1-\varphi) + r_3\sigma_3^{\,2} - r_1\{\varphi\sigma_{13} + (1-\psi)\sigma_{23}\}\right]}{\left[\zeta_1^{\,2} + (r_1 + r_3)\sigma_3^{\,2}\right]\left[\zeta_2^{\,2} + (r_2 + r_3)\sigma_3^{\,2}\right] - \left[r_3\sigma_3^{\,2}\right]^2}$$

Normally a third party will receive a positive percentage of the profits, so that the incentives for the two productive managers are weakened. However, in some situations it can theoretically be optimal to let the third party strengthen the two managers' incentives instead, in the sense that $a + b > 1$. In the first case, the third party can be interpreted as an investor who pays the managers a fixed amount ex-ante, while in the latter case the third party must be paid ex-ante to gear up the investments of the two managers.

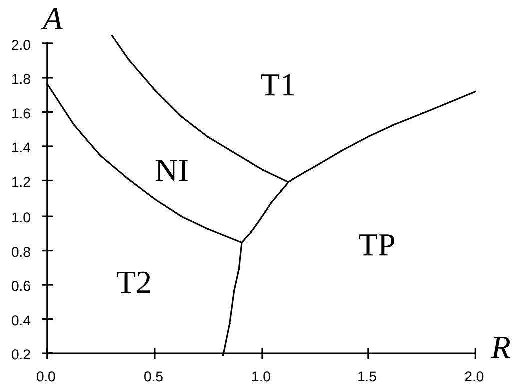
If the introduction of a third party to the monetary contract does not affect the residual control rights, the parties can choose freely among the ownership structure as before. In such an environment, the introduction of a third party can only improve upon the situation, since the monetary contract will deviate from the optimal two-party contract only if the expected joint surplus increases. That is of course always the case, unless $r_3 \rightarrow \infty$ (when the

[13] The third party does not necessarily need to be only one person. It can also be seen as the aggregate of a syndicate (Wilson 1968).

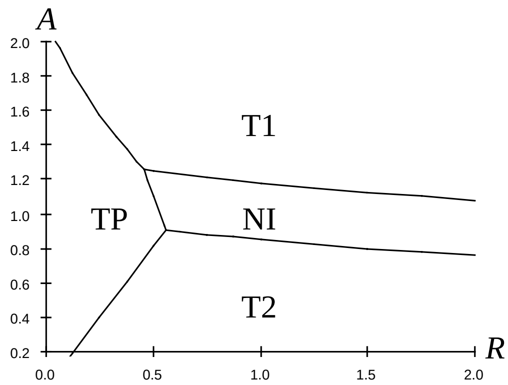
third party is unable to help with the risk sharing) or the budget balancing constraint is not binding for the two managers (optimal incentives add to one, even if a third party could take part).

However, a third party is often willing to take on such risks, only if the original owners give up some control rights. If for instance the third party can be part of the contract only when all the three parties share the residual control rights on both assets, then we have a much more interesting situation, since there then also are costs associated with the third party participation. Although the third party cannot be part of the renegotiation process, such a structure could be motivated by a fear on the third party's side that the two managers somehow can cheat on her. Therefore she wants the exit costs for both of the two parties to be as high as possible. When she has residual control rights, she can refuse them access to both assets if she finds out that they do indeed cheat. At the same time she wants both managers to be able to punish the other, in case there is some cheating that only the other party can detect (and there is no way this manager can prove the cheating to the third party).[14]

Assume such a setting, where $\varphi_{TP} = \varphi_{T2}$ and $\psi_{TP} = \psi_{T1}$, and consider the numerical example in section 5. First, set all the parameters as in case (i), and denote this case (iv). Second, let the risks associated with the verifiable profits be $\sigma_3 = 0.3$, instead of $\sigma_3 = 1$, and denote this case (v). In both cases, the risk aversion of the third party is set equal to the risk aversion of manager 2, so that $r_3 = 4$. In the first case, the third party plays the investor role, while in the second case she gears up the investments for the two managers. Figure 3 shows the optimal ownership for both cases, as determined by the relative risk aversion (R) and the relative investment specificity (A).



Case (iv)



Case (v)

Figure 3.

[14] The third party can also have all the residual control rights alone, if she can credibly commit to denying both managers access to the assets if one of them claims that the other is not willing to cooperate. A manager's outside option, and hence her bargaining position, is then the same as under joint ownership.

In case (iv), third party participation is optimal for high levels of total risk aversion, since the reduced risk bearing costs then outweigh the reduced incentives both from the non-contractible benefits and the verifiable profits. In case (v), however, third party participation is optimal for low levels of risk aversion. Only then can the incentives from the verifiable profit stream (a and b) be sufficiently strengthened to outweigh the reduced incentives from the non-contractible benefits and the increased total risk bearing costs.

In other words, the third party helps to gear up the investments when the total risk bearing costs associated with the verifiable profit stream are low (due to low levels of uncertainty and risk aversion). While she plays the role as an investor when the total risk bearing costs associated with the verifiable profit stream are high.

7. Concluding remarks

I show in this paper that the effects of risk aversion on ownership issues are not obvious. It can be smart to give ownership rights to the most risk averse manager, if risk bearing costs associated with non-contractible benefits are low. The least risk averse manager is then instead given a larger share of the verifiable profits. On the other hand, if the risk bearing costs associated with the non-contractible benefits are high, then the least risk averse manager is more likely to own assets. There is a tendency to integrate if the risk preferences are very asymmetrical. A non-productive third party may join as an investor when the risk bearing costs are high, while she instead can help to gear up the investments when the risk bearing costs are low.

Although I have used a simple model to demonstrate these results, they seem to be more general in nature. In fact, they can be seen as specialised cases of a very general (and hence not very useful) result. When there are several instruments available for motivation, the mix of these should reflect the relative costs of each for the parties involved.

I have somewhat arbitrarily assumed that there are two assets. There could of course be more. Then more ownership structures would be available to the parties. In the model, ownership is only important in the sense that it decides the parties' relative bargaining positions. The more assets there are (that are specific to investments), the more flexibility the parties have finding jointly favourable bargaining positions. If there is only one asset, non-integration becomes irrelevant. Note that an asset could be in the form of a brand name, a company name or an organisation mainly consisting of human capital.

Ownership rights are in general not as *digital* in nature as I assume. Instead there could for instance be a 51:49 division of ownership shares (which also decides the division of the profit stream). Then the majority owner can make many decisions without the agreement of the other party, but unanimity is required to rewrite the charter of the joint venture. The parties can in advance specify what type of decisions that both parties must agree upon. They may also specify specific decisions where the decision rights are given exclusively to one of the two parties, although she is not a majority owner. The model can be used to analyse such settings as well, since the (net) bargaining positions of the two parties can be seen as reflecting all types of decision rights.

The model seems robust with respect to bounded rationality considerations. Ex-ante, the two managers only need to agree on the ownership structure and a split of the profit stream. And, ex-post, they agree on a monetary transfer to ensure that the gains from cooperation are split according to their bargaining positions. Although they do not actually perform the calculations, they can over time learn what kind of arrangement that is mutually beneficial with respect to incentives. Also note that in the setting I gave for the model in section 3, large companies do worry about what joint venture structure that will generate the best incentives for both parties. Over time they have been observed to experiment with different governance structures to learn how to best motivate for innovation.

In the model I focus on asset ownership (a form of authority) and explicit profit sharing agreements. One could also imagine that reputation effects or other forms of trust could be used to reduce the hold-up problem. In Bragelien (1998) I therefore study asset ownership and implicit contracts. Together, these two papers reflect Bradach and Eccles' (1989) observation that price, authority and trust mechanisms are found both in markets and in firms.

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