DIVIDING THE GAINS FROM INTERNATIONAL ECONOMIC COOPERATION: TWO-SIDED MORAL HAZARD AND HETEROGENEOUS HUMAN CAPITAL IN A MODEL OF COALITIONAL BARGAINING BETWEEN MULTINATIONAL CORPORATIONS AND HOST COUNTRY ENTERPRISES

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Dividing the Gains from International Economic Cooperation:

Two-sided Moral Hazard and Heterogeneous Human Capital in a Model of Coalitional

Bargaining between Multinational Corporations and Host Country Enterprises

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ABSTRACT

We use the logic of *ex-ante* coalitional bargaining to explain the stylized fact that technology licensors typically cannot extract the entire surplus generated by their international licensing transactions. We assume a multinational corporation capable of supplying an 'external management' input (*e.g.* supply-chain management) and two types of host-country enterprise--one able to supply only an 'internal management' input (*e.g.* labor supervision) and the other able to provide both types of management. Cooperation with the first type requires profit sharing, but as this does not give adequate incentives to either side, the result is a Nash equilibrium in input levels. In order to avoid this suboptimal outcome, licensors bid up the rents they offer to the second type, which can be incentivized to supply first-best levels of both inputs through contracts specifying only a fixed per-period licensing fee.

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1. Introduction

   The empirical evidence on international technology licensing shows that the average licensor appropriates "less than half of the surplus associated with the license transaction." (Caves, 1996) Theoretical explanations for this stylized fact recently reviewed by Glass and Saggi (2002) involve either imperfect information or inadequate protection of intellectual property (IP) rights. The first type of model (e.g., Gallini and Wright, 1990 and Wright, 1993) focuses on the difficulty the licensor faces in signaling the quality of his/her technology to the licensee prior to signing a contract. In this case, there may be a separating equilibrium in which, for example, low cost technology licensors must leave some rents with the licensee. Similarly, the IP models of Markusen (2001) and Yang and Maskus (2001) involve cases in which the licensor has no legal recourse in the event the licensee defects and starts a competing business, and must therefore 'bribe' him/her to prevent this from happening.

   This paper uses the logic of *ex-ante* coalitional bargaining to provide an alternative explanation for Caves' stylized fact. In our model, it is competition among licensors for licensees with superior human capital endowments, rather than imperfect information *per se*, that drives the result. As in the first group of models cited above, however, imperfect information plays a central role because, as in Chan and Hoy's (1991) discussion of joint ventures, two non-verifiable inputs are involved. Where the licensee is only able to provide one of these, the result is a Nash equilibrium in input levels. To avoid this two-sided moral hazard problem, licensors bid up the rents they offer to licensees who can supply both inputs, as cooperating with such partners makes it possible to achieve a first-best solution.

Our setup is based on Eswaran and Kotwal's (1985) two-sided moral hazard model of tenure choice, which, as Eswaran and Kotwal pointed out in their conclusion, provides a useful framework for thinking about any cooperative enterprise requiring both 'internal' and 'external' management. (For a recent example, see Chen and Rozelle (1999), which applies the model to Chinese township enterprises.) We assume a multinational corporation (MNC) that possesses an ownership advantage--the patent for a production process for example--has a physical capital endowment, and is also able to provide an external management input-- such as supply-chain management or international marketing. At the same time, however, an internal management input, such as labor supervision or dealing with the local government-- is also required. This can only be provided by a host country enterprise (HCE). There are assumed to be two types of HCE--the first (type T1) can provide both internal and external management while the second (type T2) is only able to provide internal management. Neither type has its own physical capital.

Since both internal and external management are assumed to be unverifiable, these inputs must be induced through the appropriate choice of incentives. A first-best optimal outcome can be achieved with type T1 HCEs through a contract in which they pay only a fixed per-period licensing fee, keep all of the profit over and above this amount, and provide both inputs. When the HCE is type T2, however, the MNC must provide the external management and incentives must be created for both parties. This requires a profit-sharing arrangement (we consider the case of an equity joint venture) and results in the management inputs being set at sub-optimal (Nash equilibrium) levels (since each firm receives only a fraction of its marginal product).

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We consider an *ex-ante* coalitional bargaining game in which MNCs and HCEs can form coalitions with whichever other agents will give them the best terms. With sufficiently many agents, we show that the core of this game 'shrinks' to an outcome in which the MNC can capture the total surplus from projects with type T2 HCEs but not from projects with type T1s. The reason is that any T2 HCE can be replaced by some subset of the remaining T2s with no loss of total grand coalition economic surplus. This is possible because, since T2s shirk their internal management input in the profit-sharing Nash equilibrium, they always have resources to spare for new projects. T1s cannot be excluded without a drop in total surplus because, since their inputs are supplied at first-best levels, they are supplied with the maximum amount of capital that they can efficiently use. This implies that, were one of them to be excluded and its capital reassigned, the remaining T1 HCEs' resources would be 'spread too thin'. Similarly, the loss of an excluded MNC's capital could not be made up by the remaining MNCs.

The remainder of our paper is organized as follows. Section 2 presents the model, while Section 3 explains the solution concept. In Section 4, it is shown that, when the number of agents exceeds some critical value the core 'shrinks' to the outcome described above. Section 5 concludes.

2. A two-sided moral hazard model of international economic cooperation

Our model has four factors—external management effort (t), internal management effort (s), raw labor (L) and capital (K). Coalitional bargaining takes place between three sets of agents: a set of MNC's {M}, a set of HCE's whose external management skills are equal to those of the MNC's {T1}, and a set of HCE's without any ability in external

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management {T2}. Both types of HCE's are able to provide the internal management input, but MNCs are not. For the sake of expositional clarity, let us suppose that there are equal numbers of T1 and T2 HCEs (#T1 = #T2) and that the total number of MNCs and HCEs is the same (#T1+ #T2 = #M). All agents are risk neutral. Both types of management effort are assumed to be unverifiable inputs and thus cannot be specified in the contract; capital has no alternative use (*i.e.* the interest rate is zero). Labor is hired by the HCE and paid for by both MNC and HCE, using the same sharing rule that applies to profit. Assuming constant returns to scale, the presence of a fixed factor (capital) implies decreasing returns to scale in the other two factors, ensuring that the agents' maximization problems are well-defined.

Revenue (q) for a project involving K units of capital is given by:

(1) $q = \theta f (t, s, L, K)$

where θ is a random variable determined by the state of nature with an expected value of one and f is a neoclassical production function with the usual properties. The state of nature is assumed to be unverifiable even after its realization, so that neither firm can determine the other's effort from knowledge of its own input and the profit. While under risk neutrality the firms are concerned solely with the expected value: $E[q] = f (t, s, L, K)$—a non-stochastic function—uncertainty about the state of the world nonetheless affects their behavior by making shirking possible.

Each MNC owns the same amount of capital (K^*). As in the Eswaran-Kotwal model, there are also assumed to be upper bounds on the levels of effort that individual firms are capable of supplying: $s \in [0, s^{max}]$, $t \in [0, t^{max}]$. Here, an additional assumption is added: these maximum effort levels are just sufficient for a single MNC-HCE pair to

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achieve a first best solution. In the cases we wish to consider here, it is effort shirking rather than insufficient resources that limits the ability of the MNC and the HCE to achieve the first-best outcome. This suggests that a single MNC-HCE pair should be at least capable of attaining the first best in a project of size K^*. The assumption that a first best outcome could not be achieved in a project larger than this is made solely to clarify the exposition.

Let the wage paid to labor be denoted by w, the opportunity cost of external management effort by v, that of internal management effort by u and let:

(2) $L^* = \text{argmax}\{ f(t^{\max}, s^{\max}, L, K^*) - v\, t^{\max} - u\, s^{\max} - w\, L \}.$

(L^* is the first-best optimal level of the raw labor input for a single MNC's capital (K^*) with internal and external management effort set at their maximum levels for a single agent.)

Then we have:

(3) $s^{\max} = \text{argmax}\{ f(t^{\max}, s, L^*, K^*) - v\, t^{\max} - u\, s - w\, L^* \}$, for types T1 and T2.

(The maximum amount of labor supervision a single HCE of either type is capable of providing is just equal to what would be required for the first-best outcome for a single MNC's capital with external management set at $t^{\max}$ and the raw labor input at the first-best level, L^*.)

(4) $s^{\max} = 0$, for type M.

MNCs are incapable of supervising labor.

(5) $t^{\max} = \text{argmax}\{ f(t, s^{\max}, L^*, K^*) - v\, t - u\, s^{\max} - w\, L^* \}$, for types M and T1,

(The maximum amount of external management that a single MNC or T1 HCE is capable of providing is just equal to what would be required for the first-best outcome for a single

MNC's capital with labor supervision set at $s^{\max}$ and the raw labor input at the first-best

level, L^*.)

(6) $t^{\max} = 0$, for type T2.

(Type T2 HCEs are incapable of external management.)

Each MNC divides up its capital into 'projects', each of which we may imagine

being assigned to a single HCE under a single contract. Contract terms and assignments

of HCEs to projects result from an *ex-ante* bargaining process, which we model below as

a coalitional game. Contracts specify a MNC profit share ($\beta \in [0,1]$, the size of the

project ($K \in \Re_+$) and an integer ($I \in \Im$) unique to each project which we may simply

think of as its 'name'. There may also be a licensing fee ($a \in \Re_+$), which we will assume

is directly proportional to the size of the project (K) so that we may define a as a

payment per unit of capital invested. T1 HCEs only sign 'pure' licensing agreements

while T2 HCEs only sign joint-venture contracts. Different projects may be of different

sizes and may be taken by the same HCE (under different contract terms) or by different

HCEs; MNCs may or may not divide their endowments in the same way.

It is convenient to begin by considering the outcome associated with a single

contract. Let the $j^{\underline{th}}$ HCE be party to a total of J contracts, and let its $i^{\underline{th}}$ contract be for a

project of size K_{ij}. We may break the problem down into two steps. First, we solve for

the optimal amount of labor for the HCE to hire, for any given contract parameters

(α,β) and values of s, t and K_{ij}. Second, we solve for the values of s and t that the MNC

and HCE would optimally choose, knowing what amount of labor will be hired as a result

and, again, taking contract parameters as given.

In general, each contract specifies an MNC profit share, β_{ij}, and a licensing fee (per unit of capital), α_{ij}. (The pure licensing agreement is then a special case in which $\beta_{ij} = 0$.) Since the HCE's share in the wage bill is assumed equal to his profit share, the first step involves solving:

(7) $L(\mathbf{a}_{ij}, \beta_{ij}, t, s, K_{ij}) = \underset{\{L\}}{\mathrm{argmax}}\ (1 - \beta_{ij}) f(t, s, L, K_{ij}) - \mathbf{a}_{ij} K_{ij} - (1 - \beta_{ij}) w L$

This implies that the HCE will hire the first-best level of labor for given values of the contract terms, unverifiable effort levels and the project size. In what follows, the gross surplus (*i.e.* the surplus before netting out opportunity costs) resulting from the choice of $L(\mathbf{a}_{ij}, \mathbf{b}_{ij}, t, s, K_{ij})$ is denoted by:

(8) $\phi(\alpha_{ij}, \beta_{ij}, t, s, K_{ij}) = f(t, s, L(\mathbf{a}_{ij}, \beta_{ij}, t, s, K_{ij}), K_{ij}) - w L(\mathbf{a}_{ij}, \beta_{ij}, t, s, K_{ij})$

The analysis for the second step of the solution procedure depends on whether the contract in question is for a pure licensing agreement or a joint venture. First consider the first case, which will be chosen if HCE j is type T1. In this case, the HCE will supply both types of effort. The MNC will not participate in external management because, since the licensing fee is fixed, it has no incentive to do so. The T1 HCE chooses values for t and s that maximize its profit net of opportunity cost (hereafter, 'net profit') by solving:

(9) $\underset{\{t, s\}}{\max}\ \pi_T = \phi(\mathbf{a}_{ij}, \beta_{ij}, t, s, K_{ij}) - \mathbf{a} K_{ij} - v t - u s$
        s.t. $0 < s < s^{\max}, 0 < t < t^{\max}$

where v and u are the opportunity costs of external and internal management effort, respectively. (It is assumed there is no alternative activity for the MNC's capital, *i.e.* that

its opportunity rent is zero. Note also that, under the rent contract, the HCE is responsible for the entire wage bill.) The first-order conditions are:

$$(10) \quad t_L = \mathrm{argmax}\{\phi\,(\boldsymbol{a}_{ij},\,\boldsymbol{b}_{ij},\,t,\,s,\,K_{ij}) - v\,t - u\,s_R\} \text{ for } \sum_{i=1}^{J} K_{ij} \leq K^*$$

(An Interior Solution: When total investment in the projects for which the HCE has contracts is less than or equal to K^*, it has sufficient resources to supply the first-best level of external management effort for all projects.)

$$(11) \quad t_L = t^{\max}\,K_{ij} / \sum_{i=1}^{J} K_{ij}, \text{ for } \sum_{i=1}^{J} K_{ij} > K^*$$

(A Corner Solution: When total investment in the projects for which the HCE has contracts is greater than H*, it does not have sufficient resources to supply the first-best level of external management effort for all projects. In this case, the amount of effort it supplies to any given project depends on its size in proportion to the total amount invested in all of its projects.)

$$(12)\ s_L = \mathrm{argmax}\{\phi\,(\boldsymbol{a}_{ij},\,\beta_{ij},\,t,\,s,\,K_{ij}) - v\,t_R - u\,s\}, \text{ for } \sum_{i=1}^{J} K_{ij} \leq K^*$$

(An Interior Solution: When total investment in the projects for which the HCE has contracts is less than K^*, it also has sufficient resources to supply the first-best level of internal management effort for all projects.)

$$(13)\ s_R = s^{\max}\,K_{ij} / \sum_{i=1}^{J} K_{ij}, \text{ for } \sum_{i=1}^{J} K_{ij} > K^*$$

(A Corner Solution: When total investment in the projects for which the HCE has contracts is greater than K^*, it also does not have sufficient resources to supply the first-

best level of internal management effort for all projects. In this case, the amount of effort it supplies to any given project is again determined by its size in proportion to the total investment in all of his projects.)

In a joint-venture, it is assumed (as with share tenancy in the Eswaran and Kotwal model) that effort levels are determined as a Nash equilibrium. Existence is guaranteed (by Kakutani's fixed point theorem) because the agents' action sets, $[0, s^{max}]$, $[0, t^{max}]$, are compact and convex; we will further assume that the equilibrium is uniquely determined by the contract terms. For given values of β_{ij} and K_{ij} and a conjecture of the HCE's effort level, the MNC chooses an effort level that solves:

(14) $\max_{\{t\}} \pi_M = \beta_{ij} \phi\ (a_{ij}, \beta_{ij}, t, s, K_{ij}) + a\ K_{ij} - v\ t$
        s.t. $0 < t < t^{max}$

Similarly, the HCE solves:

(15) $\max_{\{s\}} \pi_T = (1 - \beta_{ij})\ \phi\ (a_{ij}, \beta_{ij}, t, s, K_{ij}) - a\ K_{ij} - us$
        s.t. $0 < s < s^{max}$

The first order conditions for these two problems give the agents' reaction functions in a joint venture. In this case, as we will see below that each T2 HCE is assigned to projects with total investment less than K^*, we need only consider the interior solutions. As in the Eswaran and Kotwal model, reaction functions are given by:

(16) $t(s) = \tau(s; \beta_{ij}, K_{ij})$

(17) $s(t) = \sigma(t; \beta_{ij}, K_{ij})$

Solving these equations simultaneously gives us the joint-venture Nash equilibrium (analgous to Eswaran and Kotwal's share tenancy equilibrium):

(18) $t_N = t_N (\beta_{ij}, K_{ij})$

(19) $s_N = s_N (\beta_{ij}, K_{ij})$

Before proceeding with the description of the coalitional game, it is useful to give a diagrammatic description of how profits would vary with the profit share and licensing fee parameters in a joint venture. Figure 1 shows achievable net profits for the MNC (on the vertical axis) and the HCE (on the horizontal axis). The curve from the origin through $\beta*$ (the joint profit frontier) shows how total joint profits change as we vary the MNC's profit share, with β decreasing from one (at the origin), to the joint-profit maximizing value ($\beta*$), to zero (once again at the origin). The shape of this curve is due to the fact that the MNC's profit share determines not only how profit is divided but also, *via* incentive effects, how much profit there is to divide. Thus for example, when the MNC's share is one, the HCE contributes no effort while a share of zero implies that the MNC does not contribute. In either case, joint profit is zero.

The value of the MNC's profit share determines a total level of joint net profit, which is given by the joint profit isoquant passing through the corresponding point on the frontier. In Figure 1, these isoquants are given by lines with a slope of negative one. Division of profits *via* licensing fee payments corresponds to a movement away from the frontier along one of these schedules. Thus the figure provides a convenient summary of how the firms' net profits are determined in a joint venture. First, total net profits are given by a point on the frontier corresponding to the profit share (β). Then, the firms move along the corresponding isoquant to a point (X) determined by the licensing fee (α).

With only two firms, there would be only one project—involving the MNC's entire endowment—and this would be undertaken by a single HCE. In this case, in a joint venture the MNC's optimal contract will specify the profit-maximizing share (β^*) together with a licensing fee (α_M^* in Figure 1) that leaves the HCE with only its reservation net profit. Similarly, under pure licensing agreements, licensing fees are set at levels under which the HCEs' participation constraint binds while the output is first-best optimal subject to the constraints on the firms' effort levels. This suggests the following definition, which may be applied to both one-MNC-one-HCE and multi-agent cases:

Definition 1: The *Eswaran-Kotwal Principal-agency Outcome* (EKPAO) for a given population of MNCs and HCEs is that outcome under which:

(1) joint profit is maximized in all projects,

(2) each MNC receives the entire joint profit attributable to its capital.

3. The bargaining game

The sequence of events we've described so far is summarized in Figure 2. First, firms engage in an *ex-ante* bargaining process that determines how the MNCs divide their capital among the HCEs and the contract terms that each firm receives. After this, the firms choose Nash equilibrium effort levels for each of their projects in the event that a joint venture was chosen. These levels are uniquely determined by the corresponding contracts. In the event that a pure licensing agreement is chosen, the HCE will supply both unverifiable inputs at levels as close as possible to first best. At the same time, each HCE simultaneously solves the optimal amount of labor for each of its projects. Finally,

the state of nature is realized, profit is realized and payoffs are received in accordance with contract terms.

Note that once the terms of and parties to each contract are determined, expected profits are a forgone conclusion in a joint venture because of our assumption that the Nash equilibria are unique. Thus, the initial bargaining game has well-defined payoffs under both types of contract. We may therefor model the bargaining process as a characteristic-form game. The first step is to describe a set of feasible contracts for a coalition, then use this contract set to define an outcome—a vector of profits for each of the coalition members. This in turn allows us to define a characteristic function—a mapping from each possible coalition to a 'profit possibility set' giving all possible outcomes for that coalition. Finally, we may define the core of the game given by the set of all MNCs and HCEs together with the characteristic function. This allows us to make predictions about what contract terms will result from the bargaining process—these will simply be those terms leading to outcomes in the core.[3]

We may define a coalition to be a non-empty subset of the total population of agents, $M_C + T_C$, where $M_C \in M$, $T_C \in T1 + T2$. Then let C^j be the set of contracts to which coalition member j is a party and J be the number of such contracts:

(20) $\quad C^j = \{(\beta_{1j}, a_{1j}, K_{1j}, I_{1j}), (\beta_{2j}, a_{2j}, K_{2j}, I_{2j}),... (\beta_{Jj}, a_{Jj}, K_{Jj}, I_{Jj})\}.$

(Recall that β is the MNC's share, a, the licensing fee, K, the size of the project and I, its 'name'.) Let $C = \{C^1,..., C^{Mc + Tc}\}$. For C to 'make sense' as a set of contracts

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[3] For a good introduction to characteristic form games, see the Appendix to Mas-Colell *et al.*(1995), Chapter 18.

for projects, each involving one coalition MNC and one HCE, it must be 'feasible' in the following sense:

Definition 2: C is *feasible* for coalition $M_C + T_C$ if:

(a) $$\sum_{j \in Mc} \sum_{i=1}^{J} K_{i,j} = \sum_{j \in Tc} \sum_{i=1}^{J} K_{i,j} = M_C K^*$$

(Investment in both coalition MNC and HCE projects sums to the total capital endowment for the coalition.[4])

(b) $\forall\, I_{ij}\, \exists\, I_{kl}$ s.t. $I_{ij} = I_{kl}$ ($j \,^1\, l;\ j, l \in M_C + T_C$)

(For each of a given firm's contracts there is a counter-party.)

(c) $I_{ij} = I_{kl} \Rightarrow I_{mn} \,^1\, I_{ij}, I_{kl}\ \forall\, n \,^1\, j, l$

(There may only be one counter-party for a given contract.)

(d) $I_{ij} = I_{kl} \Rightarrow j \in M_C$ iff $l \in T_C;\ j \in T_C$ iff $l \in M_C$

(One coalition MNC and one coalition HCE must be party to each contract. Coalition MNCs (HCEs) may not have contracts with HCEs (MNCs) who are not in the coalition.)

(*e*) $I_{ij} = I_{kl} \Rightarrow (\beta_{ij}, \boldsymbol{a}_{ij}, K_{ij}) = (\beta_{kl}, \boldsymbol{a}_{kl}, K_{kl})$

(The MNC and the HCE sign the same contract for a given project.)

If new HCEs join a coalition and/or old HCEs are excluded, some projects may be cancelled and the capital involved divided into different projects and reassigned. The following definitions are helpful in giving a formal description of this process:

Definition 3: Let $N_0 = (N_0{}^1{}_1, ...N_0{}^1{}_{A1}, ..., N_0{}^{Lc}{}_1, ...N_0{}^{Lc}{}_{ALc})$ be the set of projects of a group of MNCs (M_C) belonging to coalition $M_C + T_C$. We denote the set of projects in

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[4] Note that this condition also implies that C is not feasible if some capital is left unused, *i.e.* if there are some projects for which there are no contracts.

N_0 owned by MNC j (as well as its cardinality) by Aj and use superscripts to index MNCs, subscripts to index projects. A *repartition* of N_0 assigns the capital originally in N_0 to a new set of projects N' $= (N'^1_1, ...N'^1_{B1},..., N'^{Lc}_1, ...N'^{Lc}_{BLc})$, where the set of projects in N' owned by MNC j (as well as its cardinality) is given by Bj.

Definition 4: N' is a *feasible* repartition of N_0 if:

$$(21) \quad \sum_{i=1}^{Aj} K(N_0{}^j{}_i) = \sum_{i=1}^{Bj} K(N'{}^j{}_i) \ , \ \forall j \in M_C$$

where $K(N^j{}_i)$ is the amount of capital invested in project $N^j{}_i$. That is, a repartition is feasible if the total investment for given MNC's projects in N' equals the total for its projects in N_0. (Repartitioning has no effect on ownership.)

Definition 5: An *assignment* for HCEs (T_C) in the coalition $M_C + T_C$ and any repartition N' $= (N'^1_1, ...,N'^1_{B1},..., N'^{Lc}_1, ...,N'^{Lc}_{BLc})$ assigns to each project in N' a HCE $t(N'^j{}_i) \in T_C$ and effort levels $s(N'^j{}_i)$, $t(N'^j{}_i)$.

Definition 6: A *feasible* assignment is an assignment satisfying:

$$(22) \quad s(N'^j{}_i) \leq s^{max} \ K_{ij} / \sum_{i=1}^{J} K_{ij}, \text{ for all projects assigned to each member } (j) \text{ of } T1 \cap T_C$$

$$(23) \quad t(N'^j{}_i) \leq t^{max} \ K_{ij} / \sum_{i=1}^{J} K_{ij}, \text{ for all projects assigned to each member } (j) \text{ of } T1 \cap T_C$$

$$(24) \quad s(N'^j{}_i) \leq s_N(\beta^*, K(N'^j{}_i)), \text{ for all projects assigned to each member } (j) \text{ of } T2 \cap T_C$$

$$(25) \quad \sum_{i=1}^{J} s(N'^j{}_i) \leq s^{max}, \text{ for each member } (j) \text{ of } T2 \cap T_C$$

A feasible assignment is thus simply an allocation of coalition HCE effort to the coalition MNCs' capital that is physically possible for the type T1s, given the constraints on their effort levels, and both incentive compatible and consistent with the effort level constraints for the type T2s. (See Figure 3 for an example of a set of projects (Figure 3.1), a repartition (Figure 3.2) and a feasible assignment of projects in the repartition to two HCEs (Figure 3.3).)

Total profit for each firm will be given by the sum of its attributable profit from each of the projects for which it has a contract. For the $j^{\underline{th}}$ agent, we have:

$$(26) \quad \pi^j (C^j) \; = \; \sum_{i=1}^{J} \pi^M (C^j_i) \; ; \; j \, \in \, M_C$$

$$= \; \sum_{i=1}^{J} \pi^T (C^j_i) \; ; \; j \, \in \, T_C$$

In a joint venture, $\pi^M (C^j_i)$ and $\pi^T (C^j_i)$, net profits for the $j^{\underline{th}}$ MNC or HCE's $i^{\underline{th}}$ project, are given by:

$$(27) \; \pi^M (C^j_i) = \beta_{ij} \, \phi(\alpha_{ij}, \, \beta_{ij}, \, t_N(\beta_{ij}, K_{ij}), \, s_N(\beta_{ij}, K_{ij}), \, K_{ij}) - v \, t_N(\beta_{ij}, K_{ij}) + \boldsymbol{a}_{ij} K_{ij}$$

$$(28) \; \pi^T (C^j_i) = (1 - \beta_{ij}) \, \phi(\alpha_{ij}, \, \beta_{ij}, \, t_N(\beta_{ij}, K_{ij}), \, s_N(\beta_{ij}, K_{ij}), \, K_{ij}) - u s_N(\beta_{ij}, K_{ij}) - \boldsymbol{a}_{ij} K_{ij}$$

Under a pure licensing agreement, we have:

$$(29) \quad \pi^M (C^j_i) = \boldsymbol{a}_{ij} K_{ij}$$

$$(30) \quad \pi^T (C^j_i) = \phi(\alpha_{ij}, \, \beta_{ij}, \, t_L, \, s_L, \, K_{ij}) - u s_L - v t_L - \boldsymbol{a}_{ij} K_{ij}$$

(Recall that ϕ is defined in (8) to be gross surplus (before netting out opportunity costs) maximized over L for given values of $\alpha_{ij}, \, \beta_{ij}, \, t, \, s$ and K_{ij}.)

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We may define the outcome for a coalition under a particular set of contracts as the set of the net profits that each member achieves:

Definition 7: $\pi_C(C) = \{\pi^1(C^1),...\,\pi^{Mc+Tc}(C^{Mc+Tc})\} \in \Re^{Mc+Tc}$ is the *outcome* for coalition $(M_C + T_C)$ under $C = \{C^1,..., C^{Mc+Tc}\}$.

For each coalition $(M_C + T_C)$, we may further define a profit possibility set:

Definition 8: The *profit possibility set* for coalition $(M_C + T_C)$, $V(M_C + T_C) \in \Re^{Mc+Tc}$, is given by:

(31) $V(M_C + T_C) = \{\ \pi_C(C)\mid C \text{ is feasible for } (M_C + T_C)\} - \Re^{Mc+Tc}_{+}.$

Note that our profit possibility set includes both outcomes for the coalition under every feasible set of contracts and, assuming the possibility of free disposal, any vector assigning lower profits (or arbitrarily large losses) to one or more of the coalition members.

Our multi-agent scenario thus takes the form of a game in characteristic form: $(M + T, V)$. We may now define the core of this game in the usual way. First, let an outcome for the grand coalition $(M + T)$ be a list of net profits $\pi_{GC} = (\pi_{GC}^1,...\,\pi_{GC}^{M+T})$ $\in \Re^{M+T}$, and let π_{GC}^j be the profit for the $j^{\underline{th}}$ coalition member under π_{GC}. A blocking coalition may then be defined as follows:

Definition 9: An outcome, π_{GC}, is *blocked* by coalition $(M_C + T_C)$ if there exists $\pi_C \in V(M_C + T_C)$ such that:

(i) $\pi_{GC}^l \leq \pi_C^l, \ \forall\, l \in (M_C + T_C)$

(ii) $\pi_{GC}^j < \pi_C^j, \ \text{for some } j \in (M_C + T_C)$

Finally, we may define the core of $(M + T, V)$:

Definition 10: The *core* of (M + T, V) is the set of all outcomes, π_{GC}, for which there is no coalition, $(M_C + T_C)$, such that $(M_C + T_C)$ blocks π_{GC}.

Next, we show that joint venture contracts will be pairwise efficient—only the optimal share (β^*) leads to outcomes in the core:

Proposition 1: Pairwise Efficiency. For unblocked outcomes, we must have $\beta = \beta^*$ for all joint venture contracts.

Proof: Suppose there is a project for which a joint venture is optimal and the corresponding contract is (β, a, K, I) where $\beta \neq \beta^*$. (We drop subscripts and the parameter (I) in what follows to simplify the notation.) MNC and HCE profits will be given by:

(32) $\pi^M (\alpha, \beta, K) = \Pi^M (\beta, K) + \alpha$

(33) $\pi^T (\alpha, \beta, K) = \Pi^T (\beta, K) - \alpha$

where $\Pi^i (*)$ is net profit before licensing fee payments for $i = $ M,T. Since β^* maximizes joint profit we must have:

(34) $\Pi^M (\beta*, K) + \Pi^T (\beta*, K) > \Pi^M (\beta, K) + \Pi^T (\beta, K)$

=> $\Pi^M (\beta*, K) - \Pi^M (\beta, K) > \Pi^T (\beta, K) - \Pi^T (\beta*, K)$

Letting $\Pi^M (\beta*, K) - \Pi^M (\beta, K) = G^M$, $\Pi^T (\beta*, K) - \Pi^T (\beta, K) = G^T$, we have:

(35) $G^M > - G^T$

Switching from β to $\beta*$ would thus imply one of the following three possibilities:

1) Net profit before side payments rises by more for the MNC than it falls for the HCE[5]: $G^M > 0$; $G^T < 0$ => $|G^M| > |G^T|$ or $|G^M| - |G^T| > 0$ (by (35)). In this case, the MNC would enjoy higher net profits even if it had to compensate the HCE by enough to leave

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[5] This would be the case for values of β corresponding to points on the downward sloping portion of the frontier in Figure 1 between β^T and $\beta*$.

the HCE's net profit unchanged. Changing the side payment to $\alpha' = \alpha - |G^T|$ would give

us:

(36) $\pi^M (\alpha', \beta*, K) = [\Pi^M (\beta, K) + \alpha] + [|G^M| - |G^T|] > \Pi^M (\beta, K) + \alpha = \pi^M (\alpha, \beta, K)$

(37) $\pi^T (\alpha', \beta*, K) = [\Pi^T (\beta, K) - \alpha] + [|G^T| - |G^T|] = \Pi^T (\beta, K) - \alpha = \pi^T (\alpha, \beta, K)$

Thus, the outcome under (α, β, K) for a given MNC-HCE pair will be blocked by the

grand coalition. Under $(\alpha', \beta*, K)$ net profits increase for the MNC in question while

leaving profits for the HCE, as well as all other MNCs and HCEs, unchanged (as required

by Definition 9).

2) Net profit before side payments rises by more for the HCE than it falls for the MNC[6]:

$G^M < 0$; $G^T > 0$ $\Rightarrow$ $|G^T| > |G^M|$ or $|G^T| - |G^M| > 0$. This is the same case as (1), with the

roles of MNC and HCE reversed. Here, the HCE would enjoy higher net profits even if

he had to compensate the MNC by enough to leave its net profit unchanged. Changing

the side payment to $\alpha' = \alpha + |G^L|$ gives us:

(38) $\pi^M (\alpha', \beta*, K) = [\Pi^M (\beta, K) + \alpha] + [|G^M| - |G^M|] = \Pi^M (\beta, K) + \alpha = \pi^M (\alpha, \beta, K)$

(39) $\pi^T (\alpha', \beta*, K) = [\Pi^T (\beta, K) - \alpha] + [|G^T| - |G^L|] > \Pi^T (\beta, K) - \alpha = \pi^T (\alpha, \beta, K)$

As in case (1), the outcome under (α, β, K) for a given MNC-HCE pair will be blocked

by the grand coalition. Under $(\alpha', \beta*, K)$ net profits increase for the HCE while leaving

profits for the MNC, as well as all other MNCs and HCEs, unchanged.

3) Net profit before side payments rises for both agents[7]: $G^M > 0$; $G^T > 0$. In this case:

(40) $\pi^M (\alpha', \beta*, K) = [\Pi^M (\beta, K) + \alpha] + G^M > \Pi^M (\beta, K) + \alpha = \pi^M (\alpha, \beta, K)$

(41) $\pi^T (\alpha', \beta*, K) = [\Pi^T (\beta, K) - \alpha] + G^T > \Pi^T (\beta, K) - \alpha = \pi^T (\alpha, \beta, K)$

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[6] This would be the case for values of β corresponding to points on the downward sloping portion of the frontier in Figure1 between β^M and $\beta*$.

[7] This would be the case for values of β corresponding to points on the upward sloping portions of the frontier in Figure 3.1, *i.e.* between O and β^T and between O and β^M.

Once again, the outcome under (α, β, K) for a given MNC-HCE pair will be blocked by the grand coalition. ⌘

When joint venture contracts include licensing fees, firms can set optimal incentives *via* the share parameter, then contend for the resulting maximized joint profit through bargaining over the fee. Thus only constrained efficient outcomes are in the core—it will always be in all firms' best interest to maximize total surplus.

We may now establish our earlier assertion that capital must be optimally allocated between members of T1 and T2:

Proposition 2: For unblocked outcomes, it is necessary that each T1 HCE be assigned to projects with total investment of K_{T1}, such that K_{T1} satisfies the first order condition:

$K_{T1} [\pi_L{}^J{}_1 (\delta t_L / \delta K_{T1}) + \pi_L{}^J{}_2 (\delta t_L / \delta K_{T1})] = -[\pi_L{}^J(t_L(1), s_L(1), 1)) - \pi_N{}^J(t_N(1), s_N(1), 1)]$,

where:

(42) $\pi_L{}^J (t_L(1), s_L(1), 1) = \phi(t_L, s_L, 1) - v\, t_L - u\, t_L$

(joint net profit for a project of unit size under a pure licensing agreement)

(43) $\pi_N{}^J(t_N(1), s_N(1), 1) = \phi(t_N(1), s_N(1), 1) - v\, t_N(1) - u\, s_N(1)$

(joint net profit for a project of unit size in a joint venture)

(We let $\pi_L{}^J{}_i$ denote the derivative of $\pi_L{}^J (t_L(1), s_L(1), 1)$ with respect its ith argument.)

Proof: First, note that the left-hand side of the first-order condition gives the fall in joint profit from the T1 HCE's original projects which would result from assigning it an additional project of unit size. This occurs because the management effort inputs are spread out over more and/or bigger projects than before. The right-hand side gives the increase in joint net profit from the T1 HCE's new project resulting from the switch from

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a joint venture to a pure licensing agreement. Thus, when a T1 HCE has projects with a total area of K_{T1}, the benefit of assigning an additional unit-sized project would be exactly equal to the fall in joint profit on its existing projects.

We have assumed that $t^{\max}$ and $s^{\max}$ are the first-best optimal management effort levels for a single MNC's total endowment, K^*. This implies that $K_{T1} \geq K^*$, since for $K_{T1} < K^*$, the constraints are non-binding and the left-hand side of the first-order condition is zero. We will further assume that $K_{T1} < 2K^*$—otherwise, as shown in Proposition 3, joint venture contracts never lead to outcomes in the core. It's easy to see that, were some HCE $X \in$ T1 to have contracts for projects involving investment of more than K_{T1}, there would have to be some other HCE, Y, whose projects involved investment less than or equal to K^*. (Assuming equal numbers of MNCs and HCEs, total capital available is #T K^*. If one HCE has projects involving a total investment of $A > K_{T1} \geq K^*$, the remaining capital (#T $K^* - A$) is not sufficient for every HCE to be assigned projects with a total investment of K^*.)

In this case, the outcome would be blocked by the grand coalition. A repartition could be found in which all projects remained the same with the exception of one of those assigned to X, P_0. P_0 could be divided into two smaller projects, P_1 and P_2. An assignment corresponding to this repartition could be found under which all projects other than P_0 were assigned to their original HCEs, P_1 was assigned to X and P_2 was assigned to Y. It would naturally be feasible for this assignment to specify that effort levels remained unchanged on projects other than P_0. Since the total area of Y's projects would be less than K^*, if the area of P_2 were sufficiently small the assignment could also feasibly specify that total management effort supplied to P_1 and P_2 was higher than the

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level formerly supplied to P_0. By the first-order condition, this will be true regardless of whether $Y \in T1$ or $Y \in T2$. Provided that Y pays X a suitable side payment no agent will be worse off than before and at least one will be better off, as required by Definition 9.

A similar argument can be used to show that the outcome will be blocked if X has projects with an area less than K_{T1}. In this case, it will be possible to raise overall joint profit by partitioning one of the HCE's joint-venture projects and reassigning part of it to X. (The assumptions that no projects are left unassigned and that $K_{T1} < 2K^*$ assure that there will be at least one joint venture.) By paying that HCE a suitable side payment, X can be better off without affecting any other grand coalition member, as required by Definition 9. ⌘

The intuition behind Proposition 2 is simply that if the allocation of capital to HCEs is inefficient, there will always be some way to raise joint profits through a reallocation. New projects can be carved out of the projects of HCEs with more capital than they can use efficiently and these can be made available to those HCEs with less than optimal total project sizes. As long as the recipients of the new projects suitably compensate their donors, the grand coalition can satisfy the requirements for a blocking coalition. Thus, only when each T1 HCE has projects for which the required investment sums to exactly K_{T1} will the outcome be unblocked. Since $K_{T1} > K^*$ and the total amount of capital available is just $(\#T1 + \#T2)K^*$, this implies that the average member of T2 has projects involving investments that sum to less than K^*. Using an argument similar to that of Proposition 2, it would be straightforward to show that Nash equilibrium effort levels must be achievable on all projects assigned to members of T2 for outcomes to be unblocked. No member of T2 may farm an area so large that the total effort required for

Nash equilibria on all projects exceeds $s^{\max}$. As we show below that, with sufficiently many agents, T2 HCEs receive zero net profits under unblocked outcomes, whether or not each of them is assigned the same total area would be a matter of indifference.

Proposition 3: $K_{T1} < 2K^*$ is a necessary condition for joint venture contracts to lead to unblocked outcomes.

Proof: With $K_{T1} \geq 2K^*$, any coalition including a T2 HCE can make itself better off by repartitioning all of that HCE's projects and reassigning the new projects to some subset of T2. The assumption $2 * (\#T2) = \#M$ implies that it would be feasible for such a reassignment to specify higher effort levels on the new projects, even assuming that their new T1 HCEs also continued to supply the same effort levels to their original projects. Thus, the coalition M + T1 blocks any outcome that can be achieved by a coalition including members of T2, providing that the increased overall joint profit is suitably divided. ⌘

Proposition 3 shows that, for joint ventures to be observed in this model, the total investment available must be too large to be efficiently used by type T1 HCEs alone. Otherwise, it would be optimal for all MNCs to assign their capital to T1 HCEs and all T2 HCEs would be relegated to their alternative activity. Thus, the role of the HCEs that participate in joint ventures is simply to 'fill in' for more qualified licensees.

4. Surplus division and the core

This section considers the division of joint profits under unblocked outcomes. With only one MNC and one HCE, there may be an arbitrary number of projects of differing sizes (K_i), each with a different licensing fee (α_i). In this case, there are only

two possible blocking coalitions (each consisting of only a single firm). Since a firm acting alone can earn only the return from its alternative activity, as the (sole) member of such a coalition the MNC or the HCE would earn zero net profits. Thus only outcomes in which one of the firms incurs an opportunity loss are blocked and all values of α_i satisfying $\pi^j \geq 0; j = M,T$ will lead to core outcomes. The Eswaran-Kotwal principal-agency outcome (Definition 1) is in the core (since the HCE's participation constraint is met) but so are both the outcome in which the HCE receives all net profits and the continuum of other outcomes between these two extremes.

With sufficiently large numbers of agents, it can be shown that under core outcomes MNCs capture all net profits from partnerships with members of T2 but that this is not the case with members of T1. With large numbers of T2 HCEs, any one of them earning more than its reservation return can be replaced by some subset of the others without any fall in overall net profit. This is the case because, under the joint venture Nash equilibria, these HCEs are not fully employed, and thus have effort to spare for new projects. Members of T1, on the other hand, have a stronger bargaining position since, by Proposition 2, net profits are higher under pure licensing agreements. This makes it possible for them to block any imputations under which their participation constraints are binding.

Our next proposition establishes a sufficient condition for an outcome under which some member of T2 earns positive net profits to be blocked:

Proposition 4: An outcome under which some HCE $t \in$ T2 earns a strictly positive net profit (π^t) from a contract with some MNC $m \in$ M is blocked if there exists a

feasible repartition (N') of all the projects of members of T2 and a feasible assignment for N' and T2\$t$ under which $s(\mathrm{N'}^j_i) = s_\mathrm{N}(\beta^*, K(\mathrm{N'}^j_i))$ $\forall\, \mathrm{N'}^j_i \in \mathrm{N'}$.

Proof: With $s(\mathrm{N'}^j_i) = s_\mathrm{N}(\beta^*, K(\mathrm{N'}^j_i))$ for all projects in the repartition, the coalition $M + T1 + T2\backslash t$ can generate the same joint profit per MNC (π^J) as the grand coalition. Let the kth member of $T\backslash t$ earn net profit (π^k) both under the initial outcome and as a blocking coalition member. MNCs in M will together earn:

$$(44) \quad (\#M)(\pi^J) - \sum_{k\in T\backslash t} \pi^k$$

while the amount they earn under the initial outcome is:

$$(45) \quad (\#M)(\pi^J) - \sum_{k\in T\backslash t} \pi^k - \pi^t$$

Since (44) is greater than (45) for $\pi^t > 0$, it must be possible for all MNCs in M to earn the same or higher profits in coalition with $T\backslash t$ than as grand coalition members. At the same time, profits for HCEs in $T\backslash t$ are unchanged in coalition with MNCs in M, so $M + T\backslash t$ satisfies the definition of a blocking coalition (Definition 9). ⌘

With small numbers of agents, the repartition required for Proposition 4 may not be feasible. In such cases, there would be a relative scarcity of HCE management effort, implying that no group of MNCs could achieve the same level of revenue with even one fewer joint-venture partner. Since $s^{\max} > s_\mathrm{N}(\beta^*, K^*)$, however, it is easy to show that with a sufficient number of firms the conditions for Proposition 4 can be met. We show this formally in the following proposition:

Proposition 5: $s^{max} > s_N(\beta*, K*) => \exists\, \Omega$ such that when $\#M = 2 * (\#T2) > \Omega$, a necessary condition for an outcome to be unblocked is that all members of T2 earn zero net profits.

Proof: With $K_{T1} > K*$ (by Proposition 2) and $\#T1 = \#T2 = \frac{1}{2}\,\#M$ (by assumption), total investment in projects with T2 HCEs must be less than $(\#T2)K*$. This implies that total internal management effort for all T2 HCEs must sum to less than $(\#T2)s^{max}$, *i.e.*:

$$\sum_{j\in T2}\ \sum_{i=1}^{J} s(N^j_i)\ <\ (\#T2)*s^{max}.\ \text{(Recall that } N^j_i \text{ is the } i^{th} \text{ project of firm } j.)$$

For a given value of K_{T1}, there must then be some integer, Ω , such that:

$$\#M = 2*(T2) \geq \Omega => (\#T2)*s^{max}\ -\ \sum_{j\in T2}\ \sum_{i=1}^{J} s(N^j_i) \geq s_N(K*)$$

i.e. with $\#T2 = \Omega / 2$, there is sufficient excess T2 internal management effort available to completely supply projects with a total investment of $K*$ at Nash interior solution equilibrium levels. With $\#M > \Omega$, it would therefor be possible for any set of $(\#T2 - 1)$ of the T2 HCEs to supply their management inputs at Nash interior solution equilibrium levels to projects involving total investment of $(\#T2)K*$. Since total investment in projects with T2 HCEs would always be less than this amount, the repartition and assignment required by Proposition 4 would be feasible.

It is also evident that no T2 HCE can earn a strictly negative net profit—any such loss-making HCE could form a single-agent blocking coalition by working entirely in its alternative activity. ⌘

A similar argument shows that, for an outcome to be unblocked, each T1 HCE must earn a net profit equal to the entire amount by which profit attributable to his projects exceeds what could have been earned in a joint venture: $K_{T1} [\pi_L^J(t_L(1), s_L(1), 1)) - \pi_S^J(t_N(1), s_N(1), 1)]$. Again, it is convenient to first give a sufficient condition for this to be the case, then show that this condition will always be met with large enough numbers of agents.

Proposition 6: If $mK_{T1} = nK^*$ for some integers $m < \#T2$, $n < \#M$ and there are n MNCs whose share contracts involve a total of K_{T1} or more units of capital, then a necessary condition for an unblocked imputation is that each member of T2 earns a net profit of:

(46) $\pi_{T1}^* = K_{T1} [\pi_L^J(t_L(1), s_L(1), 1)) - \pi_N^J(t_N(1), s_N(1), 1)]$.

Proof: Suppose some HCE $\tau \in$ T1 earns less than π_{T1}^*. This outcome would be blocked by a coalition consisting of the n MNCs with joint venture contracts involving K_{T1} or more units of capital and m members of T1 including τ. This coalition would have exactly enough capital for all of its projects to be carried out under pure licensing agreements and for each of its HCEs to be assigned a total of K_{T1} units of capital. Thus all MNCs and HCEs other than t could receive net profits at least as high as they earned in the grand coalition. If HCE τ were assigned K_{T1} units of the capital formerly invested in joint ventures, he would then enjoy net profits per unit of capital on those projects of $K_{T1}[\pi_L^J(t_L(1), s_L(1), 1)) - \pi_N^J(t_N(1), s_N(1), 1)]$—the amount by which the switch from share to rent raised net profit (since all MNCs earn the same net profits as before). This

would increase net profit for τ, assuming he earned less than this amount in the grand coalition, without lowering net profit for any other agent (as required by Definition 9).

It can also be shown that no member of T1 can earn more than $\pi_{T1}*$. If $\tau \in$ T1 earns more than $\pi_{T1}*$, he must have a contract with some MNC **m** that allows him a net profit per unit of capital greater than $\pi_L{}^J(t_L(1), s_L(1), 1)) - \pi_N{}^J(t_N(1), s_N(1), 1)$. Since none of **m**'s T1 HCEs earn profit per unit of capital less than this amount, his net profit could be higher in a coalition with no members of T1 and only the minimum number of T2 HCEs necessary for Nash interior solutions on projects with a total area of $K*$. If these joint venture HCEs earned zero net profits, just as they did as grand coalition members, **m**'s net profit would increase. Again, the conditions for a blocking coalition (Definition 9) would be satisfied. ⌘

Proposition 7: $K_{T1} > K* => \exists \Omega$ such that when #M $> \Omega$, the conditions for Proposition 6 are satisfied.

Proof: $K_{T1} > K* => K_{T1} = (x/y) K*$ for some integers $x > y > 0$, such that x and y have no common factors other than one (assuming are K_{T1} and $K*$ rational). This implies that x MNCs would have exactly enough capital for y members of T1 to undertake projects totaling K_{T1} each. Let the average MNC in the grand coalition have joint venture contracts involving investment of K_{T2}. (With $K_{T1} > K*$ (by Proposition 2) and #T1 = #T2 = ½ #M (by assumption), we must have $K_{T2} < K* < K_{T1}$.) Clearly the x MNCs having the largest total area under share contracts must together assign a total of at least xK_{T2} units of capital to T2 HCEs. While we may have $xK_{T2} < K_{T1}$ (since $K_{T2} < K_{T1}$), there must be some integer I such that $(I\,x)K_{T2} > K_{T1}$.

The conditions for Proposition 6 are then satisfied by letting $\Omega = \max[I\,x, 2\,I\,y]$.

This guarantees that there will be enough MNCs and T1 HCEs so that we may choose m = $I\,y$, $n = I\,x$ in Proposition 6. (With #T1 = ½ #M by assumption, #M = $2\,I\,y$ => #T1 = $I\,y$.) ⌘

Finally, we must show that outcomes satisfying propositions one through seven are themselves unblocked—*i.e.* that the core is not empty:

Proposition 8: With sufficiently many firms, the core consists of the set of all imputations resulting from contracts with the following characteristics:

(1) Pairwise Efficiency: Joint venture contracts specify the optimal MNC share (β*).

(2) Efficient Capital Use: Capital is optimally divided among members of T1 and T2.

(3) Binding Participation Constraints for HCE joint venture partners: All members of T2 earn zero net profits.

(4) Non-binding Participation Constraints for pure licensees: Each member of T1 earns at least $\pi_{T1}* = K_{T1} [\pi_L^J(t_L(1), s_L(1), 1)) - \pi_N^J(t_N(1), s_N(1), 1)]$.

Proof: Any coalition $(M_C + T1_C + T2_C)$ for which $(\#M_C K^* - \#T1_C K_{T1}) \geq 0$ cannot earn net profits greater than:

(47) $\#T1_C K_{T1} [\pi_L^J(t_L(1), s_L(1), 1))] + (\#M_C K^* - \#T1_C K_{T2}) \pi_N^J(t_N(1), s_N(1), 1)$.

The first term gives total net profit attributable to capital committed to pure licensing agreements—net profit per unit of capital times total capital invested. The second term gives total net profit attributable to capital in joint ventures—net profit per unit of capital times the total capital invested in joint ventures. This expression may be rewritten as:

(48) $\#T1_C K_{T1} [\pi_L{}^J(t_L(1), s_L(1), 1)) - \pi_N{}^J(t_N(1), s_N(1), 1)] +$

          $\#M_C K^* \ \pi_N{}^J(t_N(1), s_N(1), 1) + \#T1_C \ 0.$

Thus coalition net profit may be no greater than the sum of the firms' net profits in the grand coalition. Clearly, for any firm to earn more as a coalition member, some other firm must earn less, implying that $(M_C + T1_C + T2_C)$ does not satisfy the requirements for a blocking coalition (given in Definition 9).

          For coalitions $(M_C + T1_C + T2_C)$ for which $(\#M_C K^* - \#T1_C K_{T1}) < 0$, it is optimal to assign all the available capital to members of $T1_C$ and net profits cannot exceed:

(49) $\#M_C K^* [\pi_L{}^J(t_L(1), s_L(1), 1))]$.

          This expression can be rewritten as:

(50) $\#M_C K^*[\pi_L{}^J(t_L(1), s_L(1), 1)) - \pi_N{}^J(t_N(1), s_N(1), 1)] +$

          $\#M_C K^* \pi_N{}^J(t_N(1), s_N(1), 1) + \#T2_C \ 0.$

          Since $(\#M_C K^* - \#T1_C K_{T1}) < 0$, net profits must be strictly less than:

(51) $\#T1_C K_{T1} [\pi_L{}^J(t_L(1), s_L(1), 1)) - \pi_N{}^J(t_N(1), s_N(1), 1)] +$

          $\#M_C K^* \pi_N{}^J(t_N(1), s_N(1), 1) + \#T2_C \ 0.$

In this case, total coalition net profit is less than the sum of each firm's net profit in the grand coalition. Again, for any firm to earn more as a coalition member, some other agent must earn less, implying that $(M_C + T1_C + T2_C)$ does not satisfy the requirements for a blocking coalition (given in Definition 9).

          Thus, we find that contracts with the four characteristics given in Proposition 8 lead to unblocked outcomes. Given Propositions 1 – 7, this completes the proof.   ⌘

          The intuition behind Proposition 8 is easy to see from an example. Suppose there are four MNCs and four HCEs: M = {1, 2, 3, 4}, T1 = {L1, L2} and T2 = {JV1, JV2}.

Let each of the MNCs have one unit of capital ($K^* = 1$) and the optimal amount of capital for one member of T1 be 1.5 ($K_{T1} = 1.5$). Figure 4.1 shows one possible arrangement that could lead to a core outcome. First, note that the division of projects in this figure is optimal—each member of T1 has contracts for 1.5 units of capital. Suppose that L2 proposed taking over the project assigned to JV2. This would not lead to an unblocked outcome. By the first order condition given in Proposition 2, MNC 4's net profits would fall as a result, because L2's resources would then be 'spread too thin'. This implies that with only JV1 and JV2 MNC 4 could form an effective blocking coalition.

Next, we may note two features of the unblocked outcome for MNC 4's projects. First, outcomes specifying suboptimal shares on these projects would be blocked because, even without any change in the assignment of HCEs to projects, net profits could be raised by switching to the optimal profit share. By increasing the amount of the side payment by an appropriate amount, MNC 4 could make itself better off without making JV1 and JV2 worse off. Second, suppose that one HCE joint venture partner, say HCE JV1, earned more than a zero net profit. This outcome would be blocked by a coalition including all agents except JV1, because HCE JV2 would be able to supply all of MNC 4's capital at the Nash equilibrium level of labor supervision effort. It could thus be given a contract for JV1's project as shown in Figure 4.2 under which he got zero net profits, making MNC 4 better off while leaving JV2's net profit unchanged.

Figure 4.3 shows how the outcome could be blocked if L2 earned less than $\pi_{T1}^*(K^*/ K_{T1}) = 2/3\, \pi_{T1}^*$ from its contract with MNC 3. Under these circumstances, L2 could form a blocking coalition with MNCs 1, 2 and 4 and L1. Assuming that initially all of MNC 4's capital was invested in joint ventures, as in Figure 4.1, this would generate

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an increase in net profits which, if given to MNC 4, would raise its net profit without making any coalition member worse off.

5. Conclusion

We have seen that joint venture partners lose all bargaining power whenever there are enough firms so that a coalition that excludes one of the T2 HCEs can still achieve interior solutions for all joint venture projects. Under these circumstances, MNCs are able to capture the total net profit attributable to these projects because they are the only firms with capital. They can simply terminate the contract of any T2 HCE demanding more than its reservation return and replace it with some subset of the remaining members of T2. These HCEs can be chosen in such a way that they will be able to supply their Nash equilibrium effort levels to the excluded HCE's projects while continuing to supply their original projects with the same level of management effort as before. While members of T2 may also terminate all of an MNC's contracts, the remaining MNCs cannot expand their endowment of capital to maintain the total supply. Thus the threat of termination by a joint venture partner does no more than prevent HCEs from earning less than their reservation returns.

Members of T1 enjoy a stronger bargaining position. Although they also lack capital, they add value to a coalition because of their superior external management capability. As they are able to supply both unverifiable inputs, they can be given pure licensing agreements, which raise net profits by giving the HCE its entire marginal product rather than only a share of it. Thus, MNCs compete for the services of this type of HCE until their returns under either type of contract are equal. Under the resulting

unblocked outcome, T1 HCEs capture the entire amount of the value they add relative to T2 HCEs.

Note that it is not the type T1s' superior external management capability *per se* that drives this result. In a first-best world, MNCs would be indifferent between the two types of HCE--total profits would be the same under either contract, regardless of the HCE's type, because management input levels could be contractually specified. What gives the T1 HCE an advantage in our model is the fact that management is unverifiable. MNCs bid up the T1 HCEs' share in the surplus not simply because they can supply both management inputs, but rather because being able to do so makes them uniquely able to achieve first-best outcomes.

The fact that T1 HCEs earn more than their reservation return is interesting in light of Grossman and Hart's (1983) demonstration that participation constraints will be binding in cases where the agent's utility function is additively separable in action and reward. Here, we have additive separability because utility and net profit are equivalent. How then is it possible for T1 HCEs to earn a positive surplus? The problem lies in the definition of 'alternative activity'. With only one principal and one agent, as in the Grossman and Hart framework, this is unambiguous--the agent may either work for the principal or move into an entirely different, exogenously given, activity. With more than one principal, however, the situation becomes more complicated. In addition to working for the principal, the agent really has a number of alternative activities—working not only in another activity but also for one or more of the other principals. Taking into account these additional opportunities, the participation constraint still binds. It is only with respect to the return in the T1 HCE's alternative activity that it is non-binding.

An obvious policy implication of our result is that restrictions on MNC shares in joint ventures are counterproductive. Under our assumptions, such restrictions do nothing to improve on the unrestricted Nash equilibrium in effort levels and will actually lower joint profits if the maximum allowable MNC share is set below its optimal level. A better policy would be to assist HCEs in developing external management skills through training programs. By improving local firms' ability to achieve first-best outcomes, this would make them more attractive as partners for MNCs and, as a result, strengthen their bargaining position relative to firms elsewhere.

The goal of policy should thus be to move toward the first-best outcome, rather than simply to contend for the profits realized in the second-best equilibrium.. Our model suggests that such an approach has the potential to raise not only joint profits but also HCE profit shares as well.

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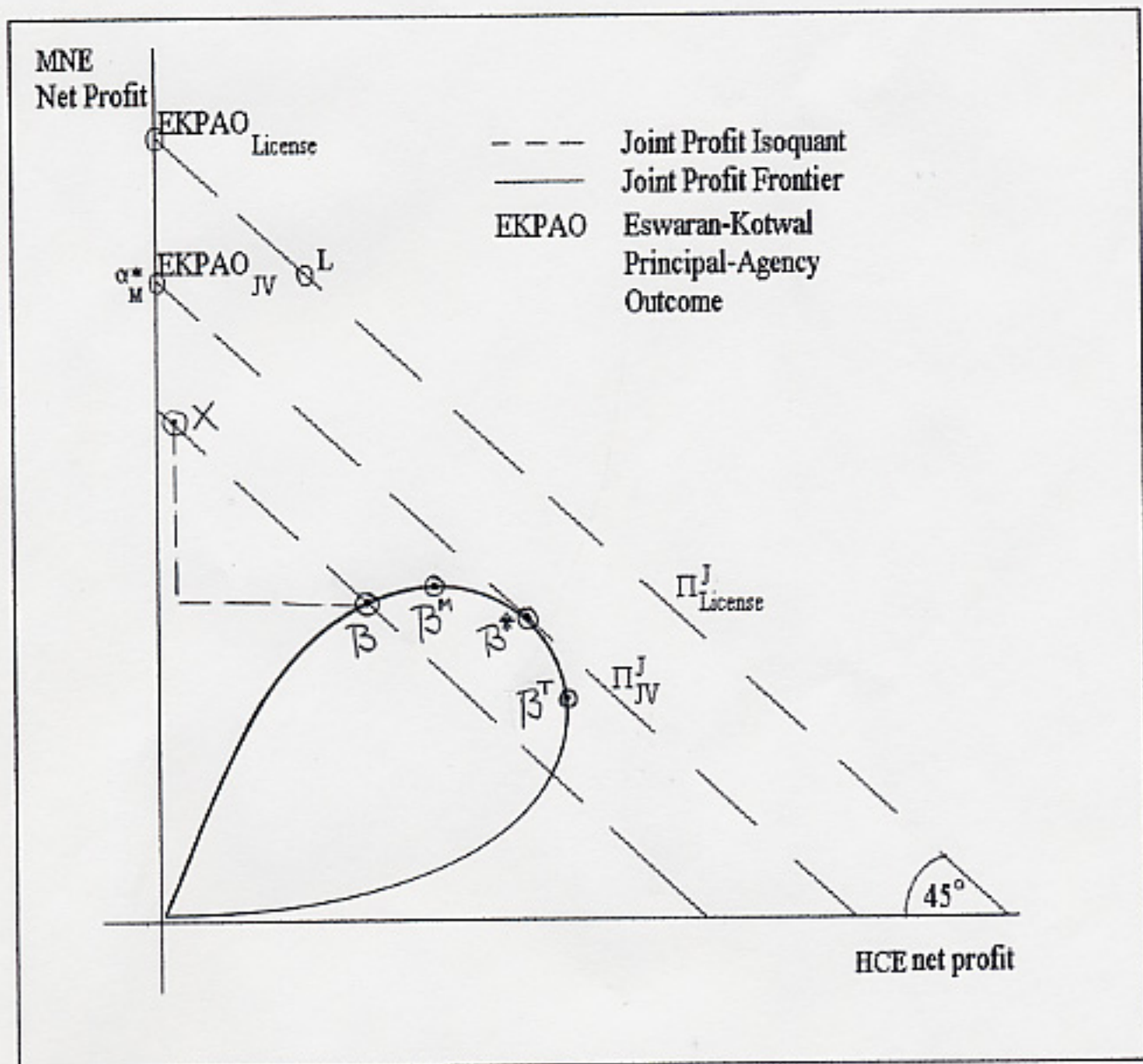
Figure 1. Division of surplus under joint venture and pure licensing contracts. The core shrinks to EKPAO$_{JV}$, in a joint venture, L under licensing. (Note that decreasing the MNE's share (β) implies a clockwise movement along the frontier.)
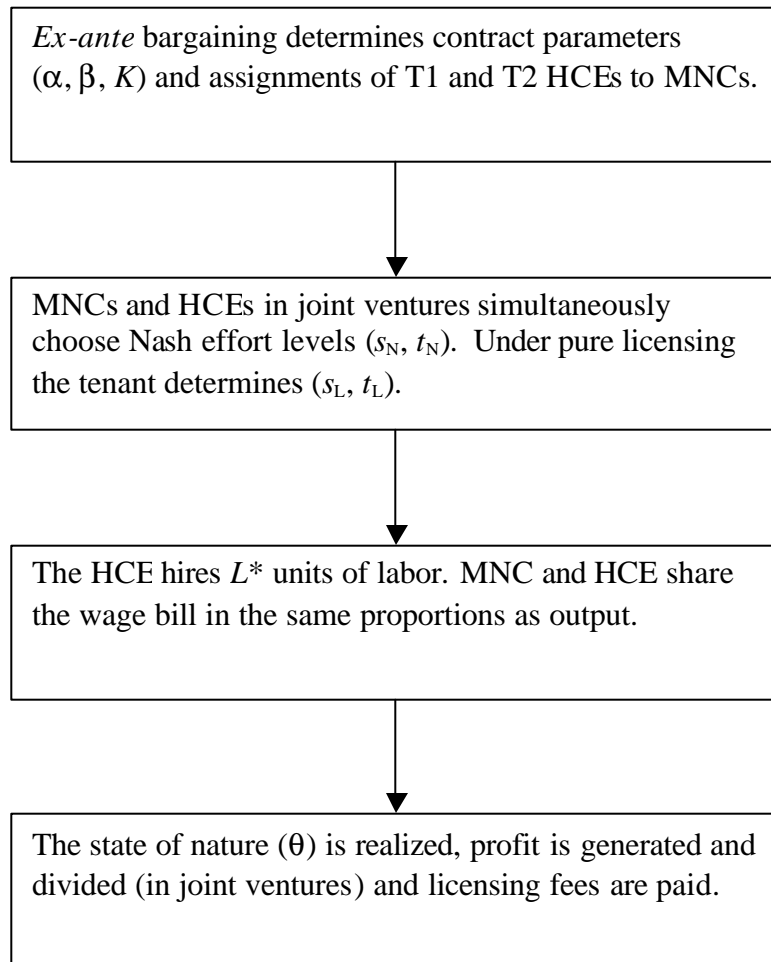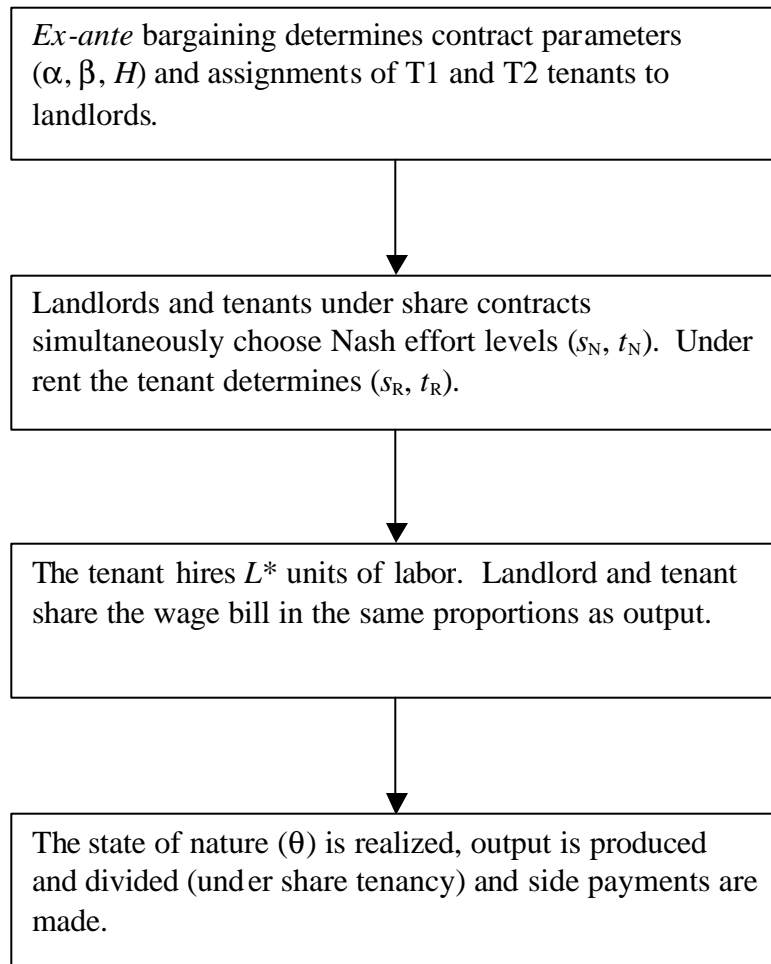
Ex-ante bargaining determines contract parameters (α, β, K) and assignments of T1 and T2 HCEs to MNCs.

MNCs and HCEs in joint ventures simultaneously choose Nash effort levels (s_N, t_N). Under pure licensing the tenant determines (s_L, t_L).

The HCE hires L^* units of labor. MNC and HCE share the wage bill in the same proportions as output.

The state of nature (θ) is realized, profit is generated and divided (in joint ventures) and licensing fees are paid.

Figure 2. The sequence of events.

Ex-ante bargaining determines contract parameters
(α, β, *H*) and assignments of T1 and T2 tenants to
landlords.

Landlords and tenants under share contracts
simultaneously choose Nash effort levels (s_N, t_N). Under
rent the tenant determines (s_R, t_R).

The tenant hires *L** units of labor. Landlord and tenant
share the wage bill in the same proportions as output.

The state of nature (θ) is realized, output is produced
and divided (under share tenancy) and side payments are
made.

Figure 3.2. The sequence of events.
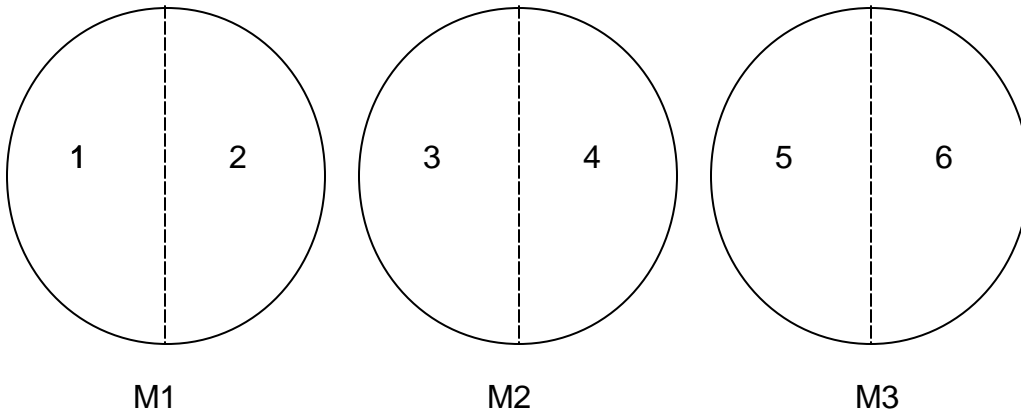
Figure 3.1. $N_0 = \{1, 2, 3, 4, 5, 6\}$ is the set of projects belonging to MNCs Mc = {M1, M2, M3}. (Circles represent each MNCs total capital.)
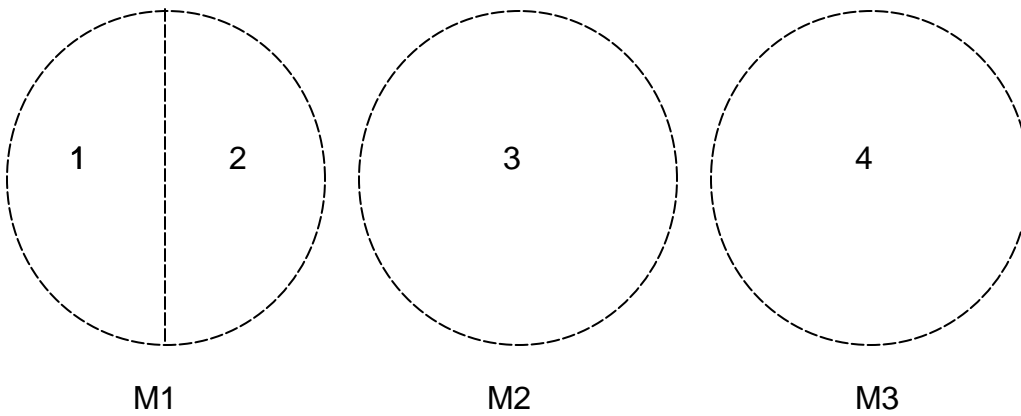
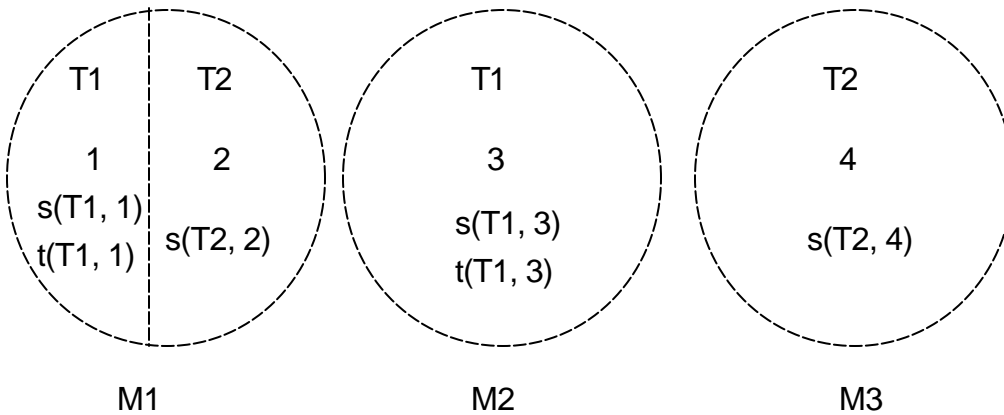Figure 3.2. N' = {1, 2, 3, 4} is a repartition of N_0.

Figure 3.3. Denoting HCE *i*'s effort levels for project *j* by $s(i, j)$, $t(i, j)$, N' is a feasible assignment for two HCEs, T1 and T2, provided that: $s(T1,1) \leq s^{max} / 3$, $s(T1,3) \leq 2\, s^{max} / 3$, $t(T1,1) \leq t^{max} / 3$, $t(T1,3) \leq 2\, t^{max} / 3$, $s(T2, 2) + s(T2,4) \leq s^{max}$, $s(T2,2) \leq s_N(2)$, $s(T2,4) \leq s_N(4)$.
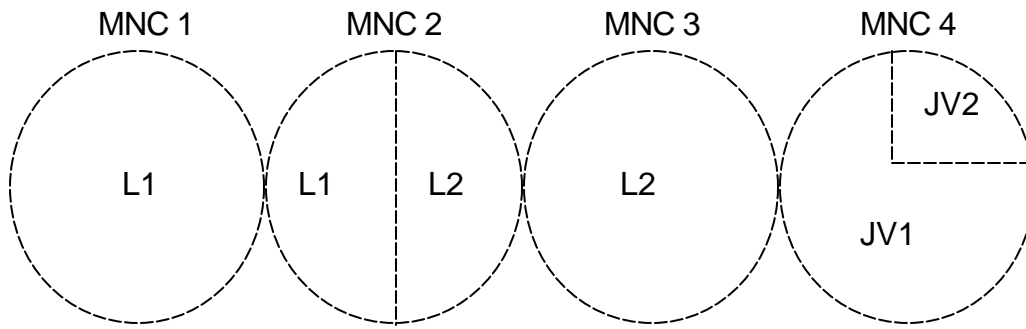
Figure 4.1. An assignment of capital belonging to MNCs 1 – 4 to licensees L1, L2 and joint venture partners JV1, JV2. This leads to an unblocked outcome if it is optimal for each licensee to be assigned 1½ units of capital. (The division of the remaining capital between the two joint venture partners is arbitrary.)
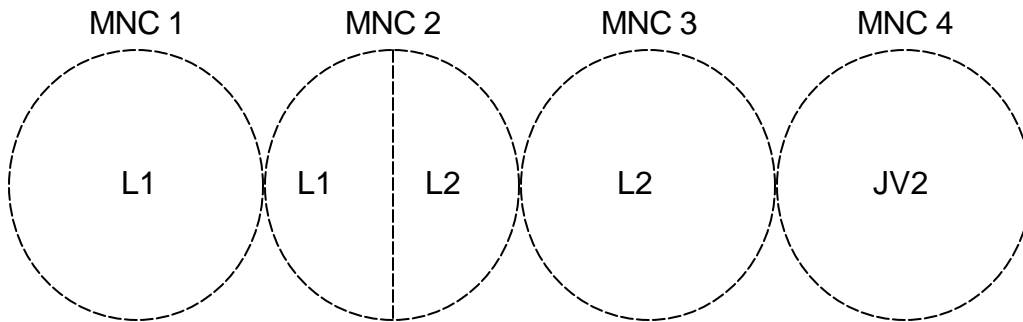

Figure 4.2. If JV1 earns more than its reservation return, the outcome is blocked by a coalition of all the other firms. All the capital formerly assigned to JV1 can be reassigned to JV2 with no loss in total profit and a gain for either JV2, MNC 4 or both.
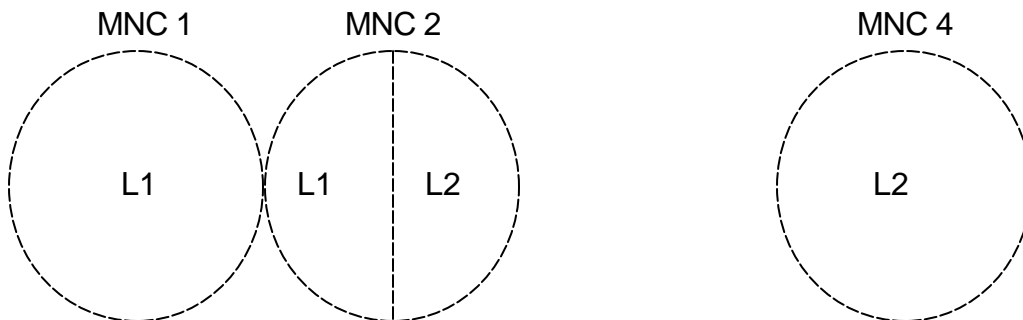

Figure 4.3. A coalition of L1, L2 and MNCs 1, 2 and 4 blocks any outcome in which MNC 3 tries to limit L2 to its reservation return. Profits remain unchanged for L1 and MNCs 1 and 2 while profits attributable to MNC 4's capital increase due to the switch from joint ventures to licensing.