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Authors
Bardhan, Pranab
Singh, Nirvikar

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UNIVERSITY OF CALIFORNIA, BERKELEY

Department of Economics

Berkeley, California 94720

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MULTINATIONAL RIVALRY AND NATIONAL ADVANTAGE:
SOME THEORETICAL CONSIDERATIONS

Pranab Bardhan and Nirvikar Singh

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Abstract

In this paper we try to model the consequences of oligopolistic competition (actual or potential) among multinational firms and their strategic interaction with host government policies, from the point of view of host country objectives. We focus on how such rivalry affects the terms of contracts such as the extent of indigenization in a joint venture, the level of transfer prices, the wage rate for domestic labor and the incentive payments by the host government to encourage the entry of a rival firm.

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Multinational Rivalry and National Advantage: 
Some Theoretical Considerations

by

Pranab Bardhan and Nirvikar Singh*
University of California at Berkeley and at Santa Cruz

The growing theoretical literature on the transactions between host countries and multinational corporations has largely ignored the consequences of rivalry among the multinationals. Yet on a global basis the concentration of firms in a number of major industries has been steadily declining—see, e.g., Vernon (1977)—giving host countries a wider range of choice and increasing their bargaining power over time. Fagre and Wells (1982) show how the outcome of negotiations between a multinational and a host government in Latin America (one index of which is the extent of foreign ownership of subsidiaries) is influenced by the extent of competition by other multinationals: a larger number of competing parent corporations at the 3-digit SIC industry level seems distinctly associated with lower bargaining success on their part. In the existing game-theoretic literature on joint ventures in developing countries there is some analysis of bargaining\(^1\) between a multinational corporation (MNC) and a domestic firm (or government) but the strategic issues arising from multinational rivalry have so far remained unanalyzed.

*We are grateful to Patrick Bolton for discussion on an earlier draft.

\(^1\)See in this context a very useful application of a generalized Nash bargaining model in Svejnar and Smith (1984).
In this paper we try to model the consequences of such oligopolistic competition (actual or potential) among multinational firms and their strategic interaction with host government policies, from the point of view of host country objectives. Of the many different aspects of such interaction we concentrate on two: in Part I of this paper there is a local-foreign joint venture producing a final good which uses two substitute intermediate products as input, one provided by the parent MNC and the other by a rival MNC (in an alternative version in Part II we have the joint venture producing an intermediate good used abroad by the parent MNC in competition with another MNC) and the host country government chooses the optimum extent of indigenisation in the joint venture (or an optimum profits tax) under the circumstances; in Part III of the paper we have the rival MNC as a potential entrant in the host country market where the incumbent MNC has a contract with the host country customer (as a downstream buyer of, say, intermediate products) and we look into conditions under which it pays the host country to provide incentives to the rival MNC to enter the market. In all of this we draw upon the current industrial organization literature, on that of strategic substitutes or complements in Part I and II and on that on entry-prevention through contracts with customers in Part III, and apply the ideas to the case of host country negotiation with MNCs. Our focus is on how the MNC rivalry affects the terms of contracts with the host country, like the extent of indigenization in the joint venture, the level of transfer prices, the wage rate for domestic labor and the incentive payments to encourage entry. For example, we find in Part
I of the paper that transfer prices charged by the MNCs may be lower under rivalry (with price competition) than under collusion, and with linear and symmetric input demand functions it is optimal for the host country not to have complete indigenous ownership (otherwise appropriate changes in transfer prices make it worse for the country). Indigenization is even less likely when output or employment goals are important in the host country's objectives. Complete indigenization may, however, be optimal in the alternative case in Part II where the joint venture produces an intermediate product that is then exported for use in production abroad by the partner MNC in competition with its rival. In Part III we show how the host country can use the rivalry between the partner MNC and a potential entrant MNC to get better terms in negotiation: the host country may extract more surplus from the incumbent by encouraging entry.
I

Suppose a joint venture between an MNC and a local firm (private or public) in a less-developed country (LDC) produces a final good that uses three inputs, one domestic (say, labor) and two substitute intermediate products supplied by the partner MNC (firm A) and a rival MNC (firm B). To keep computations simple we assume that the final good is totally reexported by the LDC (so that domestic consumer surplus does not enter the developing country's objective function). The production function in the joint venture is given by

\[ Q = \min\{F(q_A, q_B), \lambda\} , \]

where \( Q \) is output, \( q_A \) and \( q_B \) are inputs (say, components) provided by MNCs A and B and \( \lambda \) is an indigenous input (say, labor). The profits of the joint venture are given by

\[ \pi = (p-c)Q - p_A q_A - p_B q_B , \]

where \( p, c, p_A \) and \( p_B \) are prices of output and of inputs \( \lambda, q_A \) and \( q_B \) respectively. The joint venture takes all these prices as given.

The developing country's objective is

\[ \max_{\lambda \in [0,1]} (1-\lambda)\pi = \max_{\lambda \in [0,1]} W(\lambda) , \]

where \( \lambda \) is the MNC's share of profits.
With constant marginal costs, \( m_A \) and \( m_B \), in producing \( q_A \) and \( q_B \), the objective of the partner MNC A is

\[
\max_{p_A} \pi^A = (p_A - m_A)q_A + \lambda[(p-c)Q - p_Aq_A - p_Bq_B]
\]

and that of MNC B is

\[
\max_{p_B} \pi^B = (p_B - m_B)q_B
\]

The sequence of decision-making is as follows: the LDC first decides on \( \lambda \) (by choosing the extent of indigenization or corporate profit tax rate on the joint venture); the MNCs then compete in supplying inputs to the joint venture; the latter gets to decide on inputs and outputs. At each stage, previous-stage decisions are taken as given.

The joint venture's profit maximization with respect to the two foreign inputs yields the input demand functions \( f^A(p_A, p_B, c) \) and \( f^B(p_A, p_B, c) \) as given by the first-order conditions:

\[
(p-c)f_1^A = p_A \tag{1}
\]

\[
(p-c)f_2^B = p_B \tag{2}
\]

Given \( f^A \) and \( f^B \), profit maximization by the two MNCs, if there is Bertrand-competition between them in the input prices \( p_A \) and \( p_B \), yields the first-order conditions:

\[
(1-\lambda)[f^A + (p_A - m_A)f_1^A] + \lambda[(p-c)(f_1^A + f_2^B)] - m_Af_1^A - p_Bf_1^B = 0 \tag{3}
\]
\[ f^B + (p_B - m_B)f^B_2 = 0 \] (4)

Equation (3), using (1) and (2), simplifies to

\[ (1-\lambda)f^A + (p_A - m_A)f^A_1 = 0 \] (3')

Equations (3') and (4) implicitly define \( p_A(\lambda,c) \) and \( p_B(\lambda,c) \).

The LDC maximizes \((1-\lambda)\pi\) with respect to \( \lambda \). Assuming an interior solution and using (1) and (2), we get from the first-order condition

\[ -\pi + (1-\lambda)[\frac{-\delta p_A}{\delta \lambda} q_A - \frac{\delta p_B}{\delta \lambda} q_B] = 0 \] (5)

**Proposition 1.** \( \frac{\delta p_A}{\delta \lambda} < 0 \), and if the inputs supplied by MNCs A and B are strategic complements, \( \frac{\delta p_B}{\delta \lambda} < 0 \).

For proof, see Appendix, section A. We follow the definition of strategic complements or substitutes as given in Bulow, Geanakoplos and Klemperer (1985): if an "aggressive" strategy (i.e., lowering price in price competition, greater quantity in quantity competition) by A lowers (raises) firm B's marginal profits, then the goods are strategic substitutes (complements).

**Proposition 2.** If the two input demand functions are linear and if the inputs are ordinary substitutes of each other, \( \frac{\delta p_A}{\delta \lambda} < 0 \) and \( \frac{\delta p_B}{\delta \lambda} < 0 \).
This Proposition follows from Proposition 1, since linear demands and substitutes with price competition imply that they are strategic complements.

From equations (3') and (4) it is also easy to check that the transfer prices $p_A$ and $p_B$ are lower (for small $\lambda$) with price competition than if there were no MNC rivalry (i.e., they were in collusion).

**Proposition 3.** If the two input demand functions are linear and symmetric, if the two inputs are substitutes and if the input utilization function $F$ is characterized by decreasing returns to scale, then the optimal $\lambda$ satisfies equation (5), i.e., there is an interior solution.

For proof, see Appendix, section B.

The above Propositions were derived under Bertrand competition. What if we introduce Cournot competition (which is "less competitive" in the sense of higher prices and lower quantities)? How does this affect the conditions of the joint venture, i.e., $\lambda$?

With quantity competition between the two MNCs, using very similar proofs, we can derive the following Propositions.

**Proposition 4.** $\frac{\delta q_A}{\delta \lambda} > 0$, and if the two inputs are strategic substitutes, $\frac{\delta q_B}{\delta \lambda} < 0$. 
Proposition 5. If the two input demand functions are linear and if the inputs are ordinary substitutes of each other, then with quantity competition, \( \frac{\delta q_A}{\delta \lambda} > 0 \) and \( \frac{\delta q_B}{\delta \lambda} < 0 \).

Also, Proposition 3 about an interior solution for \( \lambda \) is still valid with quantity competition.

Since prices are lower with price competition (given linear demands), for any \( \lambda \), we can say that \( W \equiv (1-\lambda)\pi \) under price competition (let us call it \( W^P \)) is larger than \( W \) under quantity competition (let us call it \( W^Q \)). But we cannot determine which involves a higher \( \lambda \). Since \( \frac{\delta W}{\delta \lambda} = -\pi + (1-\lambda) \frac{\delta \pi}{\delta \lambda} \), and the first component is smaller for price competition, but the second component is larger for price competition (as increasing \( \lambda \) reduces \( p_A \) and also \( p_B \)); while for quantity competition increasing \( \lambda \) increases \( q_A \) but reduces \( q_B \).

So far we have assumed that the joint venture maximizes its own profit, i.e., it is what Katrak (1983) calls an "autonomous subsidiary". If, however, the partner MNC \( A \) has sufficient control over the management of the joint venture, the latter may be influenced to choose input levels \( q_A \) and \( q_B \) to maximize \( \pi^A \), rather than \( \pi \), i.e., it acts as what Katrak (1983) calls a global profit maximizer. Then we have

Proposition 6. \( q_A \) will be chosen such that its marginal product, \( p_{11} \), falls to zero.

For proof see Appendix, section C.
Proposition 7. If the joint venture maximizes $\pi^A$, it is in the interest of the developing country to set $\lambda = 0$, i.e., the case of complete indigenous ownership.

For proof see Appendix, section C.

The significance of Proposition 7 is as follows. If the LDC sets $\lambda = 0$, then there is no reason for the joint venture to maximize $\pi^A$. If it maximizes $\pi$ instead, then the country would wish to set $\lambda > 0$ by Proposition 3. So if the LDC can pre-commit itself in this manner, it can induce the joint venture not to act simply as an agent of the MNC A. Of course, there may be alternative scenarios based on different assumptions; for example, (i) if the joint venture maximizes some weighted average of $\pi$ and $\pi^A$, it may be in the LDC's interest to choose $\lambda > 0$, or (ii) rather than the country being able to pre-commit, there might be a bargaining game between the host country and the MNC A.

Going back to the case of the joint venture maximizing $\pi$, the objective function of the LDC may include, as it often does, some other welfare goals. For example, we may have

$$W = (1-\lambda)\pi(\lambda) + \phi c l,$$

where $\phi$ is some weighting factor, if we interpret the latter term as giving some importance to the wage bill and employment (or "appropriate" indigenous technology), or $\phi$ may be the income tax rate on wages so that along with $(1-\lambda)$ as a profits tax rate $W$ may represent tax
revenue for the government. Note that \( L = Q = F(q_A, q_B) \), so that in \( W \) both higher output and profits are valued.

If the relative weight or profits in \( W \) is higher, i.e. \( \phi < 1 - \lambda \), the objective function is qualitatively similar to before, with \((p-c)\) being replaced by \( p - c(1 - \frac{\phi}{1-\lambda}) \). Again it can be shown that with linearity and symmetry in input demand functions \( \lambda = 0 \) or \( 1 \) cannot be a solution for the developing country. In fact there are additional positive terms in \( \frac{\delta W}{\delta \lambda} \), making a higher \( \lambda \) more likely.

If \( \phi > 1 - \lambda \), the solution is qualitatively like that of \( W = \phi c \), and again \( \lambda = 0 \) will not be a solution, since \( \frac{\delta L}{\delta \lambda} > 0 \) at \( \lambda = 0 \), but \( \lambda = 1 \) cannot be ruled out in this case. It seems when output or employment goals are important, indigenization is less likely. This is because the indigenized firm produces less, being faced with higher input prices, and this reduces welfare.

As a final possibility, we may mention that \( c \) may be a control variable of the LDC, if it, for example, sets a minimum wage for the joint venture (or otherwise determines the price of other indigenous inputs). Whether the objective function \( W \) is \( c\phi \) or \((1-\lambda)\pi\), or some weighted sum of the two, with linear and symmetric input demand functions, \( \frac{\delta p_A}{\delta c} < 0 \) and \( \frac{\delta p_B}{\delta c} < 0 \), and a well-defined solution, \( c > 0 \), is possible.
II

In section I MNC rivalry took the form of competition in the supply of imported components for a joint venture producing a final good. In this section we shall take an alternative case in which the joint venture produces a component or an intermediate product that is then exported for use in production abroad by partner MNC A which has a rival, MNC B. What are the LDC's optimal choices of \( \lambda \) and \( c \) under the circumstances, and how are they related to the nature of competition between the MNCs?

Assume fixed proportions in the use of the intermediate good by partner MNC A, and let \( t \) be the price paid by it for the intermediate good. Then we have the profits of the MNCs as

\[
\pi^A = (p_A - t)f^A(p_A, p_B) + \lambda(t-c)f^A(p_A, p_B)
\]

\[
\pi^B = p_Bf^B(p_A, p_B)
\]

\( p_A \) and \( p_B \) are now the prices of the final output of A and B respectively, net of other (constant marginal) costs. Note that B obtains its components from elsewhere, and \( p_B \) is net of that cost also. The demand for output of A, and with fixed proportions the demand for its intermediate product, is given by \( f^A \); similarly \( f^B \) is the demand for output of B. As before, \( \lambda \) is the MNC partner firm A's share in profits of the joint venture and \( c \) is the price of the indigenous input with which the intermediate good is produced.
Now suppose the intermediate good is a specific component usable only by firm A, so that A is a monopsonist and sets the price \( t \). From the equation for \( \pi^A \) one can see that for \( \lambda < 1 \), firm A will set \( t = c \), assuming \( c \) is the lower bound. In that case the LDC share in the profits of the joint venture is zero, and since those profits are zero, \( \lambda \) is an irrelevant choice variable. (It may be noted that even if \( t \) is chosen by the joint venture, the same result holds if it acts as an agent of MNC firm A.) The general objective function of the developing country, \( (1-\lambda)(t-c)f^A + \phi cf^A \), where \( \phi \), as before, is the weight given to wages and employment, now reduces to \( \phi cf^A \); and \( c \) is the interesting choice variable for the developing country.

**Proposition 8.** Given linear and symmetric demand curves for MNC outputs, the developing country will choose a lower \( c \) in the case of price competition between the two MNCs than in quantity competition.

For proof see Appendix, section D. With price competition, quantities are higher and prices lower. Now the LDC objective is proportional to \( c \) times the quantity produced. This means that the direct effect of increasing \( c \), which is the quantity, is larger for price competition than for quantity competition. With price competition, if the costs of firm A go up, both firms increase price: the goods are strategic complements with linear, symmetric demands. Hence quantity goes down more than it would if the goods were strategic substitutes. On the
other hand, with quantity competition, if the costs of $A$ increase, $q_A$ is reduced and $B$ increases $q_B$ (the goods are strategic substitutes). It turns out that this indirect negative effect is sufficiently smaller in magnitude for quantity competition than for price competition, ensuring that $c$ in the case of price competition is smaller than for quantity competition. On the other hand, if the MNCs collude, quantities are smaller, so that the direct effect of increasing $c$ is smaller for the LDC, and it turns out that this effect dominates the indirect effect through higher prices/lower quantities, so that $c$ under collusion is less than under price competition. Hence the LDC does worse, faced with MNC collusion rather than with price or quantity competition between the MNCs.

Let us now turn to the case where $t$, the price of the intermediate good, is chosen by the joint venture. (This case has some features that also apply to the situation when $t$ is chosen by the MNC, but set above $c$ for political or institutional reasons, for example, the need to show some plausible profits in the joint venture, as noted, for example, by Falvey and Fried (1986). We shall consider only the case of price competition (between the two MNCs) for exposition.

Proposition 9. Given linear and symmetric demand curves for MNC outputs, if the joint venture chooses $t$, the LDC with a general objective function $\bar{w} = (1-\lambda)(t-c)f^A + \phi c^A$ will choose $\lambda = 0$ (i.e., complete indigenization) and for the
welfare weight $\phi < \frac{1}{2}$ will choose the lowest possible $c$.\(^2\),\(^3\)

For proof, see Appendix, section E. This Proposition is in some contrast to the case in the preceding section when the MNCs compete in providing inputs to the joint venture. We may also compare these results to Katrak's (1983) observation that the equilibrium level of indigenization may be lower for the global profit maximizing joint venture (maximizing $\tau^A$) than for the autonomous subsidiary. Note that his focus on the opportunity cost of capital is not ruled out in our model, since the indigenous input here could be capital instead of labor, or a composite, if there are fixed proportions.

If the welfare weight is large enough there will, however, be an interior solution for $c$ (say, the optimal minimum wage policy). The critical value of the welfare weight $\phi$ will depend on the parameters of the linear demand functions.

\(^2\)This is only a sufficient condition, and ensures that the effect on welfare for a given output is negative (as well as the effect on output being negative, which always holds). $\phi < \frac{1}{2}$ ensures that this is true since $\tau_c = \frac{1}{2}$ for $\lambda = 0$.

\(^3\)For the case of $\phi < \frac{1}{2}$, the optimum value of $t$ with collusion between the MNCs is less than that of $t$ under price competition and the latter is less than under quantity competition.
III

In this section, we examine from a different perspective the central issue of this paper, which is: how can an LDC government use rivalry between multinational firms in its bargaining or negotiation of terms with a multinational firm? Unlike in the previous sections, rivalry here takes the form of potential entry by one multinational firm into the LDC, which enters into a contract with another multinational. We examine how, by encouraging possible entry by offering favorable terms or initial investment incentives to the potential entrant, the LDC may obtain more favorable contract terms from the incumbent firm.

In order to focus on the strategic aspects of the entry decision and the contract between the LDC and the incumbent firm, we abstract from some of the issues tackled in previous sections. Thus we assume that there is one unit of surplus to be divided among the LDC and the two firms. This can be thought of as representing the profit from a fixed amount of output. It is possible to allow output, and hence the surplus, to vary with different contracts or entry decisions without changing our qualitative results. Abstracting from output decisions allows the modelling of the situation (with one exception, described below) as a finite, extensive-form game. Also, contract terms such as profit share, input prices and so on boil down to the outcome in terms of the division of the surplus. Finally, the fixed surplus assumption rules out weighting of employment by the LDC, though this can be incorporated by allowing for variations or non-transferable components,
as noted. Additional simplifying assumptions will be presented in the course of specifying the model.

There are numerous models of entry and entry-deterrence in the industrial organization literature, but there is only one that we are aware of that deals with contracting as a means of entry prevention. This is the paper by Aghion and Bolton (1985), henceforth AB. Here we adapt their model\textsuperscript{4} to examine an issue they allude to, but do not analyze: how the LDC may favorably affect its contract terms with an incumbent multinational by offering incentives to a potential entrant. In AB's model, the situation is one of an incumbent monopolist (hence a Stackelberg leader) contracting with a downstream buyer. The potential entrant is another upstream firm. In our analysis, we replace the downstream firm by the LDC government. The other two firms are then multinationals. The interpretation of the LDC as a buyer fits with our previous model in section I of a joint venture producing a final good in the LDC, with an input provided by the multinational partner. This interpretation will be used for concreteness, but it is important to realize that the level of abstraction in AB's model (and ours) permits an interpretation of the LDC as the seller and the multinational as the buyer (and hence a monopsonist), which fits with our previous analysis in section II of a joint venture producing an intermediate good for the multinational.

\textsuperscript{4}We consider only the simplest version of their model. Their paper, and the revised version (Aghion and Bolton (1986)) also look at two-sided asymmetry of information, contract length and other issues. These complications do not affect the point we make here.
AB also assume that the incumbent is a Stackelberg leader, and therefore extracts all the additional surplus generated for the incumbent and the downstream firm through a contractual arrangement that deters entry. We follow this assumption initially, for the incumbent and the LDC, but then we show how the results do not depend on it. This is also pointed out by AB, but we demonstrate it explicitly for the maximization of a weighted sum of the incumbent and LDC payoffs, and for the generalized bargaining solution (see, e.g., Svejnar and Smith (1984)). We next describe our model, and identify the point at which it differs from that of AB. We will be brief, since much of the justification for assumptions can be found in AB.

We consider a two-period model, where a single multinational firm is operating in an LDC. Initially, we suppose this firm has monopoly power in selling one unit (appropriately scaled) of an intermediate good to a multinational–LDC joint venture or, alternatively, produces the good in the joint venture, and sells to an LDC firm, which we may think of as government-owned, for simplicity. We assume there is another multinational that may supply the intermediate good, if its profit from doing so is greater than pursuing alternatives. The profit from the best alternative is assumed to be a random variable, for simplicity uniformly distributed on $[-\theta, 1-\theta]$, $0 < \theta < 1$. The variables are scaled so that the unit cost of production for the LDC market is zero.

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5See also, Diamond and Maskin (1979).
Hence, in the absence of any LDC policies to affect the decision of the potential entrant, the latter's probability of entry is given by

$$\psi = \Pr(\pi > \pi^A)$$

where $\pi =$ profit in LDC market

$\pi^A =$ maximum profit in alternative market, $-\theta < \pi^A < 1-\theta$

Suppose that entry occurs. We assume that there is post-entry Bertrand competition between the multinationals; so that the resulting equilibrium price is equal to marginal cost, i.e., zero by assumption.

Hence $\pi = 0$. Then $\psi = \Pr(\pi^A < 0)$, and with the above uniform distribution, $\psi = \theta$.

Furthermore, we assume that the two multinationals and the LDC know the cost and demand functions, but the the incumbent and the LDC know only the distribution of the potential entrant's alternative profit opportunities. Thus, only the potential entrant observes the realization of $\pi^A$, and contracts cannot be contingent on $\pi^A$.

Next, we describe how the incumbent multinational can affect the probability of entry by signing a contract with the LDC. In period 1, it proposes a contract to the LDC government. The latter can either accept or reject this contract. If the contract is rejected, then in period 2 the incumbent charges the monopoly price $p = 1$ if entry does not occur, otherwise the entrant supplies the good at price $p = 0$. The probability of entry without a contract, and without any actions by the LDC, is $\theta$, as noted above.
If, on the other hand, the contract is accepted, we assume it cannot be renegotiated in period 2. A contract in this situation is fully described by a list of four prices \( \{p_0, p_0^e, p, p^e\} \) where

- \( p_0 \) = price LDC must pay to incumbent if it does not buy the good from the incumbent and there is no entry;
- \( p_0^e \) = price LDC must pay to incumbent if it does not buy the good from the incumbent and there is entry;
- \( p \) = price LDC must pay if it buys the good from the incumbent and there is no entry;
- \( p^e \) = price LDC must pay if it buys the good from the incumbent and there is entry.

Note that we assume that the contract is not contingent on the entrant's price offer, because of verifiability problems. Also, note that the total payment of the LDC in the second case will include what it pays to purchase the good from the entrant. If this is \( \tilde{p} \), the total payment is \( \hat{p} = \tilde{p} + p_0^e \). The LDC's monetary gain is then \( 1 - \hat{p} \).

If a contract is signed and entry takes place, the LDC has the choice of trading with either the incumbent multinational or the entrant. If it trades with the latter, its payoff, as noted, is \( 1 - \hat{p} \), while trading with the former yields \( 1 - p^e \). Clearly, the entrant can

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\(^6\)Aghion and Bolton (1986) point out that one can relax this assumption, unless the entrant has all the bargaining power. Since there is no new information about the entrant in period 2, renegotiation does not change the character of the results.
only sell its output if $1 - \hat{p} > 1 - p^e$, or $\hat{p} < p^e - p^e_0$. We assume that in this case the entrant charges $p^e - p^e_0$, and the LDC, being indifferent, trades with the entrant. Hence the probability of entry if the contract is signed is given by

$$\psi' = \Pr(\pi^A < p^e - p^e_0).$$

With $\pi^A$ uniformly distributed on $[-\theta, 1 - \theta]$, $\psi' = p^e - p^e_0 + \theta$.

Until now, we have followed the (simplest version of) the AB model. Now we provide an extension that captures the idea that an LDC government may encourage multinational rivalry and benefit thereby. There are two possible ways the LDC can benefit by encouraging entry. If there is no contract, then entry results in Bertrand competition, and the LDC gets one unit of surplus instead of zero. If there is a contract, and if $p > p^e (= \hat{p})$, then the LDC pays a lower price if there is entry, and hence has a greater surplus. In either of these two cases, the LDC has an incentive to encourage the second multinational to enter. In reality, this can be through investment incentives, tax breaks or favorable contract terms. Such incentives can be publicly announced, making precommitment plausible. In our abstract model, the effect of such policies is a transfer of surplus from the LDC to the entrant. We assume that such expenditures occur only if entry actually occurs, i.e., there are no payments or facilities built unless the other MNC agrees to come in.

Let $b_n = \text{LDC payment to entrant if no contract with incumbent and entry occurs;}$
\[ b_c = \text{LDC payment to entrant if contract with incumbent and entry occurs.} \]

The effect of these sidepayments is to increase the probability of entry. Now we have:

\[
\psi = \Pr(\pi^A < b_n) = \theta + b_n;
\]

\[
\psi' = \Pr(\pi^A < p^e - p_0^e + b_c) = \theta + p^e - p_0^e + b_c.
\]

As long as \( b_n \) and \( b_c \) are nonnegative, then given \( \theta, p^e \) and \( p_0^e \), these expressions are no smaller than their earlier counterparts. Our analysis will focus on the optimal choice of \( b_n \) and \( b_c \) by the LDC. We assume that these choices are made through contingent contracts with the potential entrant, anticipating subsequent negotiations with the incumbent. Hence the choice of \( b_n \) and \( b_c \) is the first move of the game.

We now summarize the entire game in a game tree. This tree incorporates one more simplifying assumption that follows AB, namely that \( p < 1 \). In this case, if there is no entry, the LDC will always trade with the incumbent multinational, and \( p_0 \) need not be specified in the analysis of the optimal contract. In the game tree below, and in the subsequent analysis, we will use \( F \) for the LDC, \( I \) for the incumbent multinational and \( E \) for the potential entrant. The payoffs in the tree represent money amounts, not utilities, with the upper amount in each case being \( I \)'s profit, and the lower amount being \( F \)'s profit. We suppress \( E \)'s payoff for simplicity.

\[ \text{---7---} \]

They show, however, that this will hold in equilibrium in any case.
As noted, the above payoffs represent monetary amounts. If both I and F are risk neutral then, as AB show, there is some indeterminacy in the optimal contract. This indeterminacy disappears if either or both are risk averse. For concreteness, we assume that I is risk averse with utility function $V(\cdot)$, with $V' > 0$, $V'' < 0$, and $F$ is risk neutral. The results below do not change qualitatively if we assume any other combination of risk aversion and risk neutrality. As AB demonstrate, in the case we consider, if there are no sidepayments from F to E, the unique optimal contract is given by

\[ p_0^e = p = 1 - \theta + \theta^2/4 \]

\[ p = p^e + \theta/2. \]

Hence, $p > p^e$, and there is a case for $b_c > 0$ as well as $b_n > 0$. In the next Proposition, we show that the optimal $b_n$ for the LDC is indeed positive, but that—surprisingly—the choice of $b_c$ does not matter. This second aspect extends to other bargaining situations, as we show in subsequent Propositions. The proof is similar to that of Proposition 2.3 in AB but is instructive in providing intuition, so we present it in Appendix section F. Thus, we have,

**Proposition 10.** In the equilibrium of the game described above,

1. it is optimal for the incumbent multinational to sign a contract with the LDC government;
2. the optimal contract given $b_n$, $b_c$ has
\( p = p_0^e = p^e + \frac{3}{2} + b_c \), and

\[ p = 1 + \frac{3}{4} - (\theta + b_n)(1 - b_n); \]

(iii) the optimal contract given \( b_n, b_c \) results in a probability of entry \( \psi' = \theta/2 \), independent of \( b_n, b_c \);

(iv) given the optimal contract, the optimal \( b_n \) for the LDC government is \((1-\theta)/2\), resulting in a probability of entry with no contract of \( \psi = (1+\theta)/2 \), while the level of \( b_c \) is a matter of indifference.

Remarks.

(1) Clearly, one may substitute the optimal (for the LDC) \( b_n \) to get the final equilibrium contract,

\[ p_0^e = p = \frac{3}{4} - \frac{3}{2}, \]

\[ p^e = \frac{3}{4} - \theta - b_c. \]

(2) In the equilibrium of Proposition 10, the optimal contract involves \( p_0^e = p > p^e \). This means that the incumbent gets the same amount whether or not entry occurs, and, given our assumptions, whether or not the LDC trades with the incumbent. This is what we would expect, since the incumbent is risk averse and the LDC is risk neutral. If these risk preferences are interchanged, then the equilibrium involves \( p_0^e > p = p^e \), i.e., the risk averse LDC is perfectly insured. If both are risk averse, then in equilibrium \( p_0^e > p > p^e \), i.e., there is risk sharing.
(3) We motivated the sidepayment $b_c$ by arguing that if $p > p^e$, the LDC has an incentive to encourage entry to get a lower price. However, we see in Proposition 10 that this possibility does not work, which is quite an interesting result. The reason is that the incumbent is able to adjust the contract, in particular $p^e$, by the amount of the sidepayment. This forces down the entrant's receipts, $	ilde{p}$, by the same amount, so that $\tilde{p} + b_c$ is independent of $b_c$ in equilibrium. Similarly, $\hat{p} + b_c$ is also independent of $b_c$ in equilibrium, where $\hat{p} = \tilde{p} + p_0^e$. This is what we would expect, since the contract that maximizes expected surplus for the incumbent cannot be improved on by introducing the sidepayment $b_c$. On the other hand, clearly the LDC is able to benefit by the sidepayment $b_n$, since it prefers $b_n$ to be $(1-\theta)/2 > 0$. This benefit is at the expense of the incumbent multinational.

(4) While the LDC is better off with $b_n = (1-\theta)/2$ in the above equilibrium it still gains as much from the contract as it would with no contract. This is a consequence of assuming that the incumbent is a Stackelberg leader in choosing the contract. However, this fact does not drive the result that $b_c$ does not matter. We demonstrate this final assertion below, in Proposition 11.

(5) Finally, note that the result on the "irrelevance" of $b_c$ is for the case where the LDC can precommit. However, given the intuition for this result, we would expect it to hold also if the LDC chooses $b_c$ at a later stage in the game, for then the incumbent MNC would anticipate this in its contract choice resulting in exactly the same contract as in Proposition 10.
Proposition 11. The optimal contract if the incumbent multinational and LDC government jointly maximize a weighted sum of expected utilities is such that the probability of entry given the contract \((\psi')\), the incumbent's price if no entry occurs \((p)\), and the LDC's total payment if entry occurs \((p+b_c)\), are independent of \(b_c\).

For proof see Appendix, section G. The proof actually follows quite easily from Proposition 10, since the weighted sum of expected utilities has a mathematically similar form to the Lagrangian in that case. We see that what drives the result that \(b_c\) does not matter is that \(\psi' = \theta/2\) maximizes the joint welfare of the two parties in the contract (as noted in remark (3)). A special case of Proposition 11 is where \(V' = 1\), i.e., the incumbent is also risk neutral.

The structure of the model allows us to derive a further result on the irrelevance of \(b_c\). This is for the case where the incumbent and LDC bargain over the contract according to the generalized Nash bargaining solution. Let \(U_I\) and \(U_F\) be their expected utilities from the contract respectively measured from the origin of their noncontract payoffs. Then the generalized Nash bargaining solution involves maximizing \(U_I^{\gamma}U_F^{1-\gamma}\), where \(\gamma\) is a parameter measuring relative bargaining strength. We have,

Proposition 12. The optimal contract resulting from the generalized Nash bargaining solution is such that the probability of entry given the contract \((\psi')\), the incumbent's price if no entry
occurs \((p)\), and the LDC's total payment if entry occurs \((p + b_c)\) are independent of \(b_c\).

For proof see Appendix, section H.

The proof is similar to that of Propositions 10 and 11. This similarity has also been utilized by Svejnar and Smith (1984) in their two-party model of LDC-multinational joint ventures.

The implication of Propositions 10-12 is that the ability of the LDC government to supplement a contract with an incumbent multinational by inducements to another multinational to enter is usefully limited to inducements conditional on no contract being signed. This allows the LDC to extract surplus from the incumbent. However, under general conditions the ability to offer post-contract inducements (announced prior to signing) has no effect—the optimal contract with several different bargaining rules washes out this sidepayment. We conclude this section with a further discussion of the role of \(b_n\).

It is especially interesting that \(b_n\) matters even if the LDC has bargaining power in the absence of entry. This is because entry still benefits the LDC. To illustrate, suppose that there is a division of the surplus in the absence of entry and a contract, so that the LDC gets \(\alpha\). Then the LDC's objective function is

\[
(\psi + b_n)(1 - b_n) + (1 - \psi - b_n)\alpha
\]

where \(\psi = \theta + b_n\) is the probability of entry. This becomes

\[
\alpha + (1 - \alpha)\theta + (1 - \theta - \alpha)b_n - b_n^2.
\]
This is maximized at $b_n = (1 - \theta - \alpha)/2$, assuming $\alpha$ is such that this is positive. Hence the role of $b_n$ does not depend on the incumbent having all the bargaining power. Note, however, that if $\alpha = 1 - \theta$, $b_n = 0$, i.e., the LDC does not need the sidepayment if it has enough bargaining power. Similarly, if $\alpha$ is not too large, $b_n$ will, for example, affect $U_1$ and $U_F$ in the generalized Nash bargaining case, since it affects their origins.

In this paper we have concentrated on the consequences of oligopolistic competition among MNCs for LDC policies in a very limited framework. Our purpose is more to be illustrative than exhaustive in a relatively unexplored area of research. Our results are likely to be qualified if we introduce some realistic factors we have abstracted from: for example, (a) if we have competition among LDCs, (b) if we increase the number of domestic firms within an LDC, or (c) if we take into account important scale economies and market size considerations (it is reported, for example, that such considerations recently persuaded the government of South Korea to reject a proposed Samsung-Chrysler joint venture for automobile manufacturing in a domestic market where GM is already involved).
References


Appendix

A.

Totally differentiating (3') and (4) and writing in matrix form,

\[
A \begin{bmatrix}
\frac{\delta p_A}{\delta \lambda} \\
\frac{\delta p_B}{\delta \lambda}
\end{bmatrix} = \begin{bmatrix}
f_A \\
0
\end{bmatrix}
\]

(6)

where

\[
A = \begin{bmatrix}
\alpha_{11} & \alpha_{12} \\
\alpha_{21} & \alpha_{22}
\end{bmatrix}
\]

(7)

and

\[
\alpha_{11} = (2-\lambda)f_1^A + (p_A - m_A)f_{11}^A
\]

(8a)

\[
\alpha_{12} = (1-\lambda)f_2^A + (p_A - m_A)f_{12}^A
\]

(8b)

\[
\alpha_{21} = f_1^B + (p_B - m_B)f_{21}^B
\]

(8c)

\[
\alpha_{22} = 2f_2^B + (p_B - m_B)f_{22}^B
\]

(8d)

By stability of Bertrand equilibrium, \(|A| > 0\)

\[
\frac{\delta p_A}{\delta \lambda} = \frac{1}{|A|} \begin{bmatrix}
f_A & \alpha_{12} \\
0 & \alpha_{22}
\end{bmatrix} \begin{bmatrix}
\alpha_{11} \\
\alpha_{21}
\end{bmatrix} = \frac{f_A}{|A|} < 0
\]

(9)

Since \(\alpha_{22} < 0\) by second order condition

\[
\frac{\delta p_B}{\delta \lambda} = \frac{1}{|A|} \begin{bmatrix}
\alpha_{11} & f_A \\
\alpha_{21} & 0
\end{bmatrix} \begin{bmatrix}
\frac{\alpha_{21}}{|A|}
\end{bmatrix} = -\frac{f_A}{|A|} \frac{\alpha_{21}}{|A|} < 0
\]

(10)

if \(\alpha_{21} \equiv \pi_{21} > 0\) i.e., strategic complements.
B.

Diminishing returns to scale in the $F$ function imply $\pi > 0$ in equilibrium. Hence, at $\lambda = 1$, $\frac{\delta W}{\delta \lambda} < 0$

With linear demands, $f_{12}^B = f_{22}^B = 0$

Hence $\alpha_{21} = f_1^B$ and $\alpha_{22} = 2f_2^B$

With symmetry, $f_1^B = f_2^A$

Hence $\frac{\delta \pi}{\delta \lambda} = \frac{\delta p_A}{\delta \lambda} f_A - \frac{\delta p_B}{\delta \lambda} f_B$

\[= -\frac{f^A}{|A|} [\alpha_{22} f^A - \alpha_{21} f^B] \]

\[= -\frac{f^A}{|A|} (2f_2^B f^A - f_2^A f^B) \]

\[= -\frac{f^A}{|A|} (2f_1^f A f^A - f_2^f A f^B) \]

Also, by linearity and symmetry,

$|A| = 2(2-\lambda)f_1^A f_2^B - (1-\lambda)f_1^B f_2^A$

\[= 2(2-\lambda)f_1^A f_2^B - (1-\lambda)(f_2^A)^2 \]

\[= 2(2-\lambda)(f_1^A)^2 - (f_2^A)^2 (1-\lambda) \]
For linear demands, $F$ must be quadratic, say

$$F = \alpha(q_A + q_B) - \frac{1}{2}(\beta q_A^2 + \beta q_B^2 + 2\gamma q_A q_B),$$

with $\gamma > 0$ with substitutes.

Using (1) and (2), in equilibrium

$$\pi = (p-c)F - p_A q_A - p_B q_B$$

$$= (p-c)[F - q_A F_1 - q_B F_2]$$

$$= (p-c)\frac{1}{2}[\beta f^A_1^2 + \beta f^B_2^2 + 2\gamma f^A_1 f^B_2]$$

Now, at $\lambda = 0$, $\dot{f}^A = \dot{f}^B$.

Hence

$$\frac{\delta \pi}{\delta \lambda} = -\frac{(f^A_1)^2}{|A|} (2f^A_1 - f^A_2)$$

and

$$|A| = 4(f^A_1)^2 - (f^A_2)^2$$

Hence

$$\frac{\delta \pi}{\delta \lambda} = -\frac{(f^A_1)^2}{2f^A_1 + f^A_2}$$

Also, at $\lambda = 0$, $\pi = (p-c)[\beta(f^A)^2 + \gamma(f^A)^2]$

$$= (p-c)(\beta + \gamma)(f^A)^2$$

From (1) and (2),

$$f^A_1 = \frac{-\beta}{\beta^2 - \gamma^2} \cdot \frac{1}{p-c}, \quad f^A_2 = \frac{\gamma}{\beta^2 - \gamma^2} \cdot \frac{1}{p-c}$$

Hence, at $\lambda = 0$, \ldots
\[
\frac{\delta W}{\delta \lambda} = -\pi + \frac{\delta \pi}{\delta \lambda} \\
= -(p-c)(\beta+\gamma)(f^A)^2 - \frac{(f^A)^2}{2f_1 f_2} \\
= -(p-c)(f^A)^2 \left[ (\beta+\gamma) + \frac{4\beta^2-2}{(-2\beta+\gamma)} \right] \\
= -(p-c)(f^A)^2 \left[ (\beta+\gamma) - (2\beta+\gamma) \right] > 0
\]

Hence the maximum in the interval [0,1] lies strictly between 0 and 1.

C.

If an interior solution exists for the choice of \( q_A \), then it is given by

\[
(p-c)F_1 = p_A - \frac{(p_A-m_A)}{\lambda}
\]

(1)''

where the right hand side must be positive.

But then (3) reduces to \((1-\lambda)\gamma^A = 0\), which cannot hold.

Since the left hand side is always positive, if (1)'' holds, the MNC will always want to raise \( p_A \). But for \( p_A \) sufficiently high, the right hand side of (1)'' is negative, i.e., the first-order condition for \( q_A \) is given by \( F_1 = 0 \).

Using Proposition 6, we can show \( \frac{\delta p_A}{\delta \lambda} > 0 \) and \( \frac{\delta p_B}{\delta \lambda} > 0 \).

(Note that \( \frac{\delta p_A}{\delta \lambda} > 0 \) represents transfer-pricing of profits to the
parent MNC since raising \( p_A \) does not reduce usage of the input. \( \frac{\delta p_B}{\delta \lambda} > 0 \) follows from strategic complements.)

Hence \[ \frac{\delta W}{\delta \lambda} = -\pi + (1-\lambda) \frac{\delta \pi}{\delta \lambda} < 0 \]

since \[ \frac{\delta \pi}{\delta \lambda} = -\frac{\delta p_A}{\delta \lambda} q_A - \frac{\delta p_B}{\delta \lambda} q_B < 0 \]

Hence \( \lambda = 0 \).

D.

Let the demand curves be

\[ q_A = a - bp_A + dp_B \]  \hspace{1cm} (11)

\[ q_B = a + dp_A - bp_B \]  \hspace{1cm} (12)

with inverse demands

\[ p_A = a - \beta q_A - \gamma q_B \]  \hspace{1cm} (13)

\[ p_B = a - \gamma q_A - \beta q_B \]  \hspace{1cm} (14)

where \( \alpha = \frac{a}{b-d}, \beta = \frac{b}{b^2-d^2}, \gamma = \frac{d}{b^2-d^2} \)

With price competition, the first-order conditions, \( \frac{\delta \pi_A}{\delta p_A} = 0, \frac{\delta \pi_B}{\delta p_B} = 0 \),

may be solved using (11) and (12) to yield

\[ p_A = \frac{1}{4b^2-d^2} [a(2b+d) + 2b^2c] \]  \hspace{1cm} (15)
and \[ p_B = \frac{a + dp_A}{2b}. \] (16)

The first-order condition for the LDC is
\[ f_A + c \left[ f_1^{A} \cdot \frac{\delta p^A}{\delta c} + f_2^{A} \cdot \frac{\delta p^B}{\delta c} \right] = 0 \] (17)

Substituting in the expressions for the linear, symmetric case, using (11), (12), (15), and (16), we have,
\[ c_p = \frac{a(2b+d)}{2(2b^2-d^2)} \] (18)

With quantity competition, the MNC first-order conditions are
\[ \frac{\delta p^A}{\delta q_A} = 0, \quad \frac{\delta p^A}{\delta q_B} = 0, \] which may be solved, using (13) and (14) to yield
\[ q_A = \frac{2\beta(\alpha - c) - \alpha \gamma}{4\beta^2 - \gamma^2} \] (19)
\[ q_B = \frac{\alpha - \gamma q_A}{2\beta} \] (20)

The first-order condition for the LDC is
\[ q^A + c \cdot \frac{\delta q^A}{\delta c} = 0 \] (21)

Substituting using (19), we have
\[ c = \frac{\alpha}{2} - \frac{\alpha \gamma}{4\beta} \] (22)

In terms of \( a, b \) and \( d \), this becomes, after simplification
\[ c_q = \frac{a(2b-d)}{4b(b-d)} \] (23)

It is easy to check that \( c_p < c_q \).
\[ \pi^A = (p^A - t)f^A + \lambda(t-c)f^A \]
\[ = [p^A - \{c(1-\lambda) + \lambda c\}]f^A \]
\[ = [p^A - c(\lambda,t)]f^A \]

Using the price competition case \( p^A \) is as before, with \( c \) replaced by \( \hat{c} \),

and
\[ f^A = q_A = \frac{1}{2b} \left[ a(2b+d) - \frac{(2b^2 - d^2)}{(4b^2 - d^2)} \right] \]
\[ = \frac{ab(2b+d)}{4b^2 - d^2} - \frac{(2b^2 - d^2)}{(4b^2 - d^2)} \frac{bc}{b^2 - d^2} \] \( \hat{c} \) (24)

The joint venture maximizes \( (t-c)f^A \) with respect to \( t \), giving the first-order condition
\[ f^A + (t-c)f_t = 0, \] \( f_t^A = f^A_t = \frac{\delta p_A}{\delta t} + f^A_t = \frac{\delta p_B}{\delta t} \)

Using (24), and solving, this yields the optimal
\[ t = \frac{c(1-2\lambda)}{2(1-\lambda)} + \frac{a(2b+d)}{2b^2 - d^2} \cdot \frac{1}{2(1-\lambda)} \] \( \hat{c} \) (26)

Now
\[ \frac{\delta W}{\delta \lambda} = -(t-c)f^A + \phi cf^A t^\lambda \] using (25), which determines \( t \).

But \( f^A_t < 0 \) and \( t^\lambda = \frac{t - c}{1-\lambda} > 0 \), from (26).
Hence \( \frac{\delta W}{\delta \lambda} < 0 \), i.e., the optimal \( \lambda = 0 \).

(If \( t \) is institutionally set, \( t_\lambda = 0 \), with the same result.)

\[
\frac{1}{(1-\lambda)} \frac{\delta W}{\delta c} = (t_c - 1) f^A + (t-c)[f^A t_c + f^A]
\]

From (28), \( t_c - 1 = \frac{1-2\lambda}{2(1-\lambda)} - 1 = \frac{-1}{2(1-\lambda)} < 0 \)

From (26) and (24),

\[
f^A t_c + f^A = \frac{-\left(2b^2-d^2\right)b}{\left(4b^2-d^2\right)} \left[ \frac{1-2\lambda}{2} + \lambda \right]
\]

\[
= \frac{-\left(2b^2-d^2\right)b}{\left(4b^2-d^2\right)} < 0
\]

Hence \( \frac{\delta W}{\delta c} < 0 \) and \( c = 0 \) is optimal.

(If \( t \) is institutionally set, \( t_c = 0 \), with the same result.)

Note that we would not expect this to come about, because the welfare function would probably be

\[
W = (1-\lambda)(t-c)f^A + \phi f^A
\]

This can, of course, be rewritten as

\[
W = (1-\lambda)[t - (1 - \frac{\phi}{1-\lambda})c] f^A
\]

The second term in \( \frac{1}{(1-\lambda)} \frac{\delta W}{\delta c} \) is still negative, but the first term is now

\[
t_c - 1 + \frac{\phi}{1-\lambda} = \frac{1}{1-\lambda} (\phi - \frac{1}{2})
\]
Hence, for \( \phi < \frac{1}{2} \), the result of Proposition 9 continues to hold. On the other hand, clearly, for \( \phi \) large enough there will be an interior solution, i.e., an optimal minimum wage to set for the joint venture. The critical value of \( \phi \) will depend on the demand parameters, \( a, b \) and \( d \).

\[ F. \]

We first describe how the optimal contract for \( I \) is determined. For such a contract to be acceptable to \( F \), it must provide the latter with at least as much as it could get in expected terms without a contract. This is

\[
\psi \cdot (1-b_n) + (1-\psi) \cdot 0 ,
\]

or substituting \( \psi = \theta + b_n \),

\[
(\theta + b_n)(1-b_n) .
\]

\( F \)'s expected gain from the contract is

\[
\psi'(1-p^e - b_c) + (1-\psi')(1-p) ,
\]

using \( \hat{p} = p^e \), and where \( \psi' = \theta + p^e - p_0^e + b_c \).

Hence, I will choose a contract \( \{ p, p^e, p_0^e \} \) to

\[
\max \psi' \nu(p_0^e) + (1-\psi') \nu(p)
\]

subject to

\[
\psi'(1-p^e - b_c) + (1-\psi')(1-p) > (\theta + b_n)(1-b_n) .
\]
Using \( p^e_0 = p \) in (b), we have

\[
p = 2p^e + p^e_0 - \theta - 2b_c = 0
\]
or

\[
p = p^e_0 = p^e + \frac{\theta}{2} + b_c
\]

Hence

\[
\psi' = p^e - p^e_0 + \theta + b_c
\]

\[
= p^e + \theta + b_c - (p^e - \frac{\theta}{2} - b_c) = \frac{\theta}{2}.
\]

From the constraint,

\[
\psi'(p - p^e - b_c) + 1 - p = (\theta + b_n)(1 - b_n),
\]
or

\[
\frac{\theta}{2} + \frac{\theta}{2} + 1 - p = (\theta + b_n)(1 - b_n)
\]
or

\[
p = 1 + \frac{\theta^2}{4} - (\theta + b_n)(1 - b_n) > 1 - (\theta + b_n)(1 - b_n)
\]

Hence I's price, \( p \), and its payoff, \( V(p) \) is higher if \( \psi' > 0 \).

Thus, the optimal contract given \( b_n \), \( b_c \) has

\[
p = p^e_0 = p^e + \frac{\theta}{2} + b_c, \quad \text{and}
\]

\[
p = 1 + \frac{\theta^2}{4} - (\theta + b_n)(1 - b_n)
\]

(part (ii) of the Proposition), and results in a probability of entry

\[
\psi' = \frac{\theta}{2} \quad \text{(part (iii) of the Proposition)}.
\]

Given this contract, \( F \) gets

\[
(\theta + b_n)(1 - b_n) = \theta + (1 - \theta)b_n - b_n^2,
\]

since the constraint is binding.
Let \( \lambda \) be the multiplier associated with the constraint. Then the first order necessary conditions, by substituting for \( \psi' \) and differentiating the Lagrangian respectively with respect to \( p \), \( p^e \), and \( p_0^e \), are

\[(a) \quad V'(p) = \lambda \; ; \]
\[(b) \quad V(p_0^e) - V(p) + \lambda(p-2p^e+p_0^e-\theta-2b_c) = 0 \; ; \]
\[(c) \quad V(p) - V(p_0^e) + (p^e-p_0^e+\theta+b_c)V'(p_0^e) + \lambda(p^e+b_c-p) = 0 \; . \]

Since the objective function is concave in \( p \), \( p^e \) and \( p_0^e \), and the constraint is linear, (a) - (c) are also sufficient conditions.

Substituting (a) in (b) and (c), we have

\[(b)' \quad V(p_0^e) - V(p) + V'(p)(p-2p^e+p_0^e-\theta-2b_c) = 0 \; ; \]
\[(c)' \quad V(p) - V(p_0^e) + (p^e-p_0^e+\theta+b_c)V'(p_0^e)+V'(p)(p^e-p+b_c) = 0 \; . \]

Adding (b)' and (c)', we have

\[ [V'(p_0^e) - V'(p)](p^e-p_0^e+\theta+b_c) = 0 \]

or

\[ [V'(p_0^e) - V'(p)]\psi' = 0 \; . \]

Since \( V' > 0 \), from (a), the constraint is always binding \( (\lambda > 0) \). Hence, if \( \psi' = 0 \), then from the constraint,

\[ 1 - p = (\theta+b_c)(1-b_c), \]

and I's payoff is \( V(p) \).

If, on the other hand, \( \psi' > 0 \), then \( V'(p_0^e) = V'(p) \), i.e., \( p_0^e = p \). Thus I's payoff is still \( V(p) \).
The first-order conditions are

(a) \[ V'(p) = \mu ; \]

(b) \[ V(p_0^e) - V(p) + \mu(p-2p^e+p_0^e+\theta-2b_c) = 0 ; \]

(c) \[ V(p) - V(p_0^e) + (p^e-p_0^e+\theta+b_c)V'(p_0^e) + \mu(p^e+b_c-p) = 0 . \]

These may be seen to be identical to (a)-(c) in the proof of Proposition 11, except that \( \mu \) here is exogenous. Hence (a) determines \( p \). As before, (a)-(c) are also sufficient. Following similar steps, we obtain

\[
[V'(p_0^e) - V'(p)]\psi' = 0
\]

If \( \psi' = 0 \), the objective function is

\[ V(p) + \mu(1-p) . \]

If \( \psi' > 0 \), then \( V'(p_0^e) = V'(p) \), i.e., \( p_0^e = p \).

From (b), \( p = p_0^e = p^e + \frac{\theta}{2} + b_c \)

Hence \( \psi' = \frac{\theta}{2} \) as before.

Substituting these in the objective function, we have

\[ V(p) + \mu(1 + \frac{2}{4} - p) > V(p) + \mu(1-p) . \]

Hence \( \psi' = \frac{\theta}{2} \) is optimal, and \( \psi' \), \( p \) and \( p^e + b_c (= \hat{p}b_c) \) are independent of \( b_c \).
Maximizing this with respect to $b_n$ gives

$$(1-\theta) \frac{1}{2} - 2b_n = 0,$$

or

$$b_n = \frac{(1-\theta)}{2},$$

(again the second-order conditions are clearly satisfied).

Hence $F$ gets

$$\left(\frac{1+\theta}{2}\right)\left(\frac{1+\theta}{2}\right) = \frac{(1+\theta)^2}{4} > 0.$$

In this case, $p$ becomes

$$1 + \frac{\theta^2}{4} - \frac{1}{4} - \frac{\theta}{2} - \frac{\theta^2}{4} = \frac{3}{4} - \frac{\theta}{2}.$$

Now, with no contract, $b_n = \frac{1+\theta}{2}$ as before. I gets $V(0)$ with probability $\frac{1+\theta}{2}$ and $V(1)$ with probability $\frac{1-\theta}{2}$.

We may scale the von Neumann-Morgenstern utility function $V$ for simplicity such that $V(0) = 0$ and $V(1) = 1$. Then I's expected utility without the contract is $(1-\theta)/2$.

But $V\left(\frac{3}{4} - \frac{\theta}{2}\right) > \frac{3}{4} - \frac{\theta}{2}$ by concavity, and hence $V\left(\frac{3}{4} - \frac{\theta}{2}\right) > (1-\theta)/2$.

This establishes part (iv) of the Proposition.

The objective function is

$$\psi'V(p_0^e) + (1-\psi')V(p) + u[\psi'(1-p^e - b_c) + (1-\psi')(1-p)]$$

where $\psi' = \theta + p^e - p_0^e + b_c$. 

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The natural logarithm of the objective function is 

\[ \gamma \ln u_I + (1-\gamma) \ln u_F \]. The first-order conditions are

(a) \[ \frac{\gamma v'(p)}{u_I} \cdot \frac{(1-\gamma)}{u_F} = 0 \]

(b) \[ \frac{\gamma}{u_I} [v(p_0^e) - v(p)] + \frac{\gamma}{u_F} (p - 2p^e + p_0^e - \theta - 2b_c) = 0 \]

(c) \[ \frac{\gamma}{u_I} \left[ [v(p) - v(p_0^e)] + (p^e - p_0^e + \theta + b_c)v'(p_0^e) \right] \]

\[ + \frac{\gamma}{u_F} (p^e + b_c - p) = 0 \].

Rearranging, we see that these are the same as in the proof of Proposition 11, with \( u \) replaced by \( \frac{(1-\gamma)}{\gamma} \cdot \frac{u_I}{u_F} \). The remainder of the proof proceeds along identical lines.
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