Chapter 5

Imitative Innovation and International Joint Ventures: A Dynamic Analysis.
circumstance, we provide a justification for joint venture formation as opposed to licensing, which is different from the existing literature. We also analyze how this optimal contract changes in response to shift in government policy or imitative technological innovation undertaken by the host partner.

We show that under certain conditions, there might not be any transfer of technology in the first period from the MNC to the host firm. If the first period technology is transferred and the MNC and the host firm believe that there is absolutely no chance of full liberalisation in the second period then the MNC offers a joint venture contract. This joint venture contract is so designed that it remains stable (meaning the joint venture is continued with the same share distribution) in the second period provided that the host firm is successful in its imitative innovation. Otherwise, the relationship is unstable as the payoff is readjusted in favour of the MNC. On the other hand, when the MNC and the host firm believe with absolute certainty that the second period policy would be full liberalisation, the MNC is indifferent between a range of joint venture contracts and licensing in the first period. In the second period it would threaten to break up and thereby adjust the payoff in its favour, implying an unstable relationship. However when the second period liberalisation policy is uncertain, the optimal contract is always to offer a joint venture in the first period and in many cases this joint venture tends to be unstable.

Our objective is to show the instability in terms of payoff readjustment but not in terms of the breakdown of the joint venture. The payoffs can be readjusted either by redefining the shareholdings between the partners in the second period or by transfer of a lumpsum amount (as upfront payment) from one party to another. In our model this instability is shown to be a part of the subgame perfect equilibrium outcome. This implies that the instability is fully anticipated at the time of joint venture formation itself.

In the papers by Kabiraj (1997) and Roy Chowdhury and Roy Chowdhury (1999) joint venture instability is defined in terms of breakdowns. On the contrary, in our model, the breakdown of the joint venture never occurs in equilibrium. However, the threat of breaking up causes some necessary payoff readjustments. Thus, the threat of breaking up is a cause of instability of joint venture in our model.

The literature on innovation is quite vast. Even if there is no explicit treatment of imitative innovation per se, nevertheless, the theoretical literature on licensing has dealt with the issue of imitation (Kabiraj and Marjit (1993), Katz and Shapiro (1985), Rockett (1990) etc.) as well
as the incentive to innovate (Gallini (1984), Gallini and Winter (1985), Kabiraj and Yang (1996) etc.) at great length. Gallini (1984) examines the ex-ante incentive for licensing and shows that an incumbent firm might license its production technology to reduce the incentive of a potential entrant to develop a better technology on its own. Kabiraj and Yang (1996) have discussed the innovative incentives of a local firm when an advanced technology may be available through licensing from a foreign firm. In contrast to the existing literature, our focus is on imitative innovation in the context of joint venture and how equity distribution influences the incentive for imitative innovation undertaken by the host partner.

The rest of the chapter is organised as follows. In section 2, we describe the basic framework of our analysis. Section 3 presents the problem when both periods are characterised by the same partial liberalisation policy. In section 4, we discuss the same problem when the government pursues a policy of full liberalisation in the second period. Policy uncertainty is introduced in section 5. In Section 6 we analyse the impact of costly innovation of the MNC on the choice of optimal contract in the first period. Section 7 concludes the discussion.

2. The basic framework

As in earlier chapters we make the same assumption that there are two strategic agents: an MNC and a host firm and a non-strategic agent: the government. We consider a two period model with no discounting.

We begin by describing the actions of the non-strategic agent, the government. For simplicity we assume that there are two kinds of policies the government might undertake. One is the policy of partial liberalisation, when the government allows a joint venture between an MNC and a host firm with some foreign equity restriction (licensing is a special case of joint venture) and the other is the policy of full liberalisation, when the government allows the setting up of a wholly owned subsidiary by the MNC also.

We consider a scenario where the government is liberalising the economy in stages. The first period starts with the announcement of the partial liberalisation policy, such that a joint venture between an MNC and a host firm is allowed. In the second period, the government may either adopt the full liberalisation policy (allowing wholly owned subsidiaries), or continue the same policy of partial liberalisation.
first period. So the host firm can use Technology 1 (without depending on the MNC) in the second period if it so desires. Apart from this imitation of Technology 1 during the first period production, the host firm may, however, develop Technology 1 to Technology 2 with probability $q(e)$ at a cost $e$. That is when the host firm (workers and personnel) works with Technology 1 it can develop this to the level of Technology 2 by putting some extra effort or additional R&D expenditure. This is the assumption of imitative innovation. Essentially we are assuming that the "learning by doing" (costlessly) allows the host firm to learn (imitate) Technology 1, but to develop Technology 2 (which is superior to Technology 1) the host firm has to incur some cost in terms of extra effort or R&D expenditure. Since the first period technology of the host firm is inferior as compared to Technology 1 of the MNC, the host firm cannot catch up with the foreign innovation (Technology 2) through a process of independent R&D. However, the host firm may catch up with the MNC's second period technology through a process of imitative innovation. We allow only two possibilities about the outcome of the imitative innovation as: either the host firm would catch-up with the MNC's Technology 2 with probability $q(e)$, or the host firm would not catch-up with probability $1-q(e)$. In case of not catching-up, the host firm would have the knowledge of Technology 1. The outcome of this imitative innovation is common knowledge to both parties in the beginning of the second period. We assume that the parties can not write contract forbidding either imitation or imitative innovation. This can be justified on the ground that due to the deliberate omission of the government and the local court with nationalist feelings the MNC can not verify these behaviours of the host firm in the local court. This hypothesis is related to the empirical findings on patent protection in developing countries. In IFC's survey (Mansfield, 1994) of 16 countries it was reported that the countries perceived to have the weakest patent protections are India, Thailand, Brazil and Nigeria.

(iii) We assume that the contract cannot be written on future technology. That means, in the first period, no contract can be contingent either on the success or failure of imitative innovation, or on the MNC's second period technology (Technology 2), but a contract can be always written on present technology. Since contracts cannot be written on future technology, so in the first period the MNC cannot commit to provide Technology 2 in the second period. However, in the second period the MNC can write a contract to transfer Technology 2 if the host firm agrees on that.

\footnote{Our assumption of non-contractibility of future technology is in the same spirit of Aghion and Tirole (1994). They have studied the organisation aspects of R&D activities and their implications in terms of frequency and size of innovations. They have used the incomplete contract framework and their assumptions are that the exact nature of the innovation is "ill defined" \textit{ex-ante} and two parties cannot contract for delivery of a specific innovation.}
(iv) There is a fixed capital expenditure $F$, which needs to be incurred in order to set up a plant for production. We assume that this fixed capital does not depreciate physically but if it is to be sold in the market then its resale value declines to $\delta F$ after one period and to $\delta^2 F$ after two periods (where $0 \leq \delta < 1$) as second hand capital is usually valued less. If one partner of the joint venture wants to break up and set up a separate unit of its own it has to sell out its share of fixed capital in the joint venture unit. The partner willing to purchase the plant would be given preference by law (i.e., in case any partner wants to sell out his share of fixed capital, the offer has to be made to the other partner first). As a result the party willing to set up a plant by breaking up would get back its share of first period capital which is valued less by a $\delta$ factor (where $0 \leq \delta < 1$). This is one factor that makes the breaking up of the joint venture costly in the second period (ex-post). However, the same plant can be used for the production of two periods without any additional fixed cost. Because of the resale value of the plant, the net set up cost of a plant is $F(1-\delta)$, if it is used for one period only. We denote $F(1-\delta)$ by $F'$.

(v) Two parties (in joint venture) share the fixed capital expenditure at pro-rata and we assume that this share of fixed capital is legally enforceable. Therefore, any partner willing to break up can claim his share of fixed capital, which is enforceable in court.

Note that $\Pi_1$ and $\Pi_2$ are per period monopoly profits associated with Technology 1 and 2 respectively. These are gross of net set up cost $F'$. Let $Z$ be the second period duopoly profit (gross of $F'$) of each firm if they compete under Cournot conjecture in the second period with Technology 2. We make the following additional assumptions:

(A1). $\Pi_2 - F' > 0$,

(A2). $\Pi_1 - F' > 0$,

(A3). $Z - F' > 0$,

(A4). $\Pi_2 > 2Z$,

(A5). $q(e)$ is increasing and strictly concave in $e$. $q(e) = 0$ and $q(e) < 1$ in the relevant range, along with $q'(0)$ being infinite;

(A6). $Z > \Pi_1^6$ and

$^5$ Net set up cost is same as "exogenous sunk cost" described by Sutton (1991).

$^6$ Consider the inverse demand function $P = A - bQ$ and the cost function $C = cQ$ (where $A, b, c > 0$ and $A > c$). Now $\Pi_2 = \frac{(A-c)^2}{4b}$ and $Z = \frac{(A-c)^2}{9b}$. The assumption of "drastic" technology implies that the marginal cost of the first period technology should not be lower than the monopoly price charged in the second period i.e., $(A+c)/2$. As a result $\Pi_1 \leq \frac{(A-c)^2}{16b}$. 
(A7). Both the firms are risk neutral.

Assumption (A3) indicates that breaking up to compete with Technology 2 is feasible. Assumption (A4) implies that total duopoly profits of the two firms are less than the monopoly profit under Technology 2 (in the second period). Assumption (A5) is required to guarantee interior solutions of the probability of success of the host firm's imitative innovation (for strictly positive incentives). Under linear demand and cost functions, (A6) simply follows from the assumption of 'drastic' technology.

We consider below the game played by the MNC and the host firm.

**First period:** The MNC decides whether to offer Technology 1 or not. The host firm either accepts or rejects the offer. If the offer is either rejected or the offer is not made in the first period, the MNC does not receive any payoff from this domestic market and the host firm would continue its business with its inferior technology and would obtain zero (by assumption). When the MNC offers Technology 1 it does so with a contract specifying an upfront fee to be paid to the MNC and a share \((1-\alpha)\) of the joint venture, leaving a share \(\alpha\) to the host firm (where \(\alpha \geq \alpha_m\) due to government restriction). If the host firm accepts the offer it produces with Technology 1 and chooses to do imitative innovation in the first period. Recall that the outcome of this imitative innovation is uncertain. At the end of first period, the profit is realised and the parties get their respective shares. Since we have assumed that contract can not be written on future technology (see feature (iii) of the model), so Technology 2 is not part of the first period contract offered by the MNC. Therefore, the MNC's shareholding \((1-\alpha)\) in the joint venture business does not involve any commitment of supplying Technology 2 in the second period. The basic structure of the first period game is represented by Figure 5.1.

![Figure 5.1](image-url)
Second period: If the first period offer of the MNC is accepted, the second period game can be described in the following stages.

Stage 1. The government announces the second period policy of either partial liberalisation (same policy continued) or full liberalisation (subsidiary allowed).

Stage 2. After this policy announcement the MNC makes a second period offer. Now depending on the success or failure of the imitative innovation, the host firm either has Technology 2 or Technology 1. If the host firm is already successful in its innovation this offer only specifies the payment to the MNC and in case of failure this offer involves the supply of Technology 2 as well.

Stage 3. The host firm can either accept or reject the offer. If the MNC’s offer is accepted, then production takes place and payoffs are achieved according to the provision of the second period offer. The game ends here in case of acceptance.

Stage 4. After rejection by the host firm in stage 3, the MNC can decide either to continue with the existing joint venture contract at the given share distribution (same as first period) or to break up. If the MNC breaks up, first it has to sell out its share of fixed capital. After this, in case of partial liberalisation, the MNC is not allowed to set up a subsidiary and in case of full liberalisation, the MNC is allowed to set up a subsidiary. The host firm may, however, either buy-out the joint venture plant and continue its business or sell its share of fixed capital in the market. The game ends here in case of break up by the MNC.

Stage 5. In case the MNC has decided to continue with the joint venture in stage 4, the host firm can decide whether to break up or continue the joint venture contract at the given share distribution (same as first period). If the host firm decides to break up (to set up a plant of its own), the MNC can either purchase the joint venture plant and carry on its own business in case of full liberalisation or sell its share of fixed capital in the market in case of partial liberalisation. Second period profit is realised at the end of this period.

If the first period offer has been either rejected or the offer has not been made, the MNC would make the offer of Technology 2 in the second period, which the host firm either accepts or rejects. If the offer is accepted, the production is carried out and the payoffs are realised. In case of rejection the host firm continues its business with its technology to get the payoff zero. In case of full liberalisation the MNC has an additional option of setting up a subsidiary of its own.
Figure 5.2 provides the brief sketch of the second period games.

(a) When Technology 1 is accepted.  

(b) When Technology 1 is not offered or rejected.

We assume that the host firm would accept any offer when it receives a payoff, which is weakly greater than what it gets by rejection from the subsequent equilibrium. The MNC breaks up the joint venture if by breaking off it receives at least the payoff that it gets from subsequent equilibrium after continuation.

Note that if the first period offer is accepted then some proportional sharing rule is agreed upon by the two parties in the joint venture business. Now if the joint venture is continued in the second period and the parties receive the same proportional payoffs in the second period then we call the joint venture relationship to be stable. However, any deviation from the first period share distribution in the payoffs obtained in the second period would be termed as unstable joint venture in our analysis.

Given the above specifications, it is easy to see that the MNC does not form a joint venture in the absence of government restriction on foreign equity holding, but it would serve the domestic market by setting up a wholly owned subsidiary in order to get the maximum possible payoff, $\Pi_1 + \Pi_2 - (1-\delta^2)F$ in two periods.
the model). Thus from the business of its new plant the host firm obtains $\Pi_2 - F'$ in the end of second period and by selling off its share of fixed capital of the existing joint venture (first period) plant the host firm gets $\alpha \delta F$ in the second period. Thus, the host firm's total payoff from setting up a new plant is $\Pi_2 - F' + \alpha \delta F$ in the second period. On the other hand, from the option of continuing the joint venture the host firm obtains the profit $\alpha \Pi_2$ by operating the joint venture plant. Recall that after the second period production (at the end of the second period) the fixed capital of the joint venture plant will be sold. Thus, the host firm's total payoff from the option of continuing the joint venture is $\alpha \Pi_2 + \alpha \delta^2 F$. So the host firm would break up with Technology 2 if and only if $\alpha < \alpha^*$ where $\alpha^* = \frac{\Pi_2 - F'}{\Pi_2 - \delta F'}$. And for $\alpha \geq \alpha^*$, it continues with the existing joint venture.

For $\alpha < \alpha^*$, the host firm's breaking up becomes a credible threat. In case of break up of the host firm, the MNC obtains $(1-\alpha)\delta F$ by selling out its share of fixed capital of the joint venture plant. And for $\alpha \geq \alpha^*$, the host firm would continue the joint venture and the payoffs are the respective shares of the second period returns $\Pi_2 + \delta^2 F$. Given this behaviour in stage 5, the MNC is weakly better off in stage 4 by continuing the joint venture as the break up option gives it the payoff $(1-\alpha)\delta F$. Now given this outcome followed by the rejection of the host firm, the host firm would accept any offer in stage 3, which gives at least the payoff it gets after rejection. So in stage 2, the MNC can make an offer to the host firm such that the host firm is indifferent between acceptance and rejection. Thus, for $\alpha < \alpha^*$, the MNC has to offer $\Pi_2 - F' + \alpha \delta F$ to the host firm and keep $\Pi_2 + \delta^2 F - [\Pi_2 - F' + \alpha \delta F] = F - \delta F' - \alpha \delta F$ for itself, which is better than selling off its own share of fixed capital after rejection in stage 5. Therefore, the MNC would make that offer and the host firm would accept that, since the latter is not better off by rejection. As a result the joint venture is continued such that the parties get these new payoffs. These payoffs can be implemented by a combination of suitable share adjustment and upfront payments. Note that in this second period outcome the payoff is adjusted in favour of the host firm. Now for $\alpha \leq \alpha^*$, the MNC offers to continue the existing joint venture and the host firm accepts that. Thus we find that for $\alpha \geq \alpha^*$, the joint venture is continued at the initial share holding and for $\alpha > \alpha^*$, the payoff is readjusted in favour of the host firm. Thus, the optimal payoffs to the parties in this second period subgame are given in the following proposition.
Proposition 1. Consider the case where the government pursues a policy of partial liberalisation in the second period and the host firm is already successful in its imitative innovation. Then
(a) for \( \alpha < \alpha^* \),
\[ H_{I_p}^p (\alpha) = \Pi_2 - F' + \alpha \delta F \]
\[ M_{I_p}^p (\alpha) = F - \delta F' - \alpha \delta F \]
and (b) for \( \alpha \geq \alpha^* \),
\[ H_{I_p}^p (\alpha) = \alpha \Pi_2 + \alpha \delta F \]
\[ M_{I_p}^p (\alpha) = (1-\alpha) \Pi_2 + (1-\alpha) \delta F. \]
Also if \( \alpha < \alpha^* \), the payoff is adjusted in favour of the host firm in the second period; otherwise they continue the earlier joint venture at the initial shareholdings.

Case (ii). The host firm is not successful in innovation

If the host firm is not successful in its imitative innovation then also it has two options: either to set up a plant of its own or to continue the existing joint venture in stage 5. If the host firm sets up a new plant with Technology 1, it would obtain the net profit \( \Pi_1 - F' \) and by selling off its share of fixed capital of the existing joint venture (first period) plant the host firm gets \( \alpha \delta F \) in the second period. Thus, the host firm’s total payoff from setting up a new plant is \( \Pi_1 - F' + \alpha \delta F \) in the second period. On the other hand, from the option of continuing the joint venture the host firm obtains the profit \( \alpha \Pi_1 \). Recall that after the second period production (at the end of the second period) the fixed capital of the joint venture plant will be sold. Thus, the host firm’s total payoff from the option of continuing the joint venture is \( \alpha \Pi_1 + \alpha \delta F \). So, in stage 5 the host firm would break up with Technology 1 provided that \( \alpha < \bar{\alpha} \) where \( \bar{\alpha} = \frac{\Pi_1 - F'}{\Pi_1 - \delta F'} \). And for \( \alpha \geq \bar{\alpha} \), the host firm continues the existing joint venture.

It is easy to see as in case (i) that the MNC is weakly better off by continuing the joint venture in stage 4 as the break up option gives it the payoff \( (1-\alpha) \delta F \). So after rejection of the offer in stage 3, the subsequent equilibrium sequence of actions would lead the game to stage 5 and thus the MNC would receive \( (1-\alpha) \delta F \) for \( \alpha < \bar{\alpha} \) and \( (1-\alpha) \Pi_1 + (1-\alpha) \delta F \) for \( \alpha \geq \bar{\alpha} \). Also note that the host firm would accept any offer which gives at least the payoffs that it gets by taking the optimal decision in stage 5. Therefore, the MNC can make the offer of Technology 2 and readjust the payoffs to give \( \Pi_1 - F' + \alpha \delta F \) to the host firm in order to keep for itself \( \Pi_2 + \delta F - \)
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On the other hand, for \( \alpha \geq \bar{\alpha} \), the host firm wants to continue the initial joint venture contract to obtain \( \alpha \Pi_1 + \alpha \delta \Pi \). So, the MNC can make the offer by supplying Technology 2 such that the host firm gets \( \alpha \Pi_1 + \alpha \delta \Pi \). As a result the MNC gets \( \Pi_2 - \alpha \Pi_1 + (1 - \alpha) \delta \Pi \). It is easy to see that the payoffs from this offer is better for the MNC as compared to the payoff obtained in stage 5 outcome. It is easy to see that due to the host firm’s failure in imitative innovation, the payoff is adjusted in favour of the MNC for all values of \( \alpha \). Thus, the outcome of the second period game in this case is summarised below.

\[ [\Pi_1 - \Pi' + \alpha \delta \Pi] \text{ for } \alpha < \bar{\alpha} \].

**Proposition 2.** Consider the case where the government pursues a policy of partial liberalisation in the second period and the host firm is not successful in its imitative innovation. Then in second period the MNC offers Technology 2. Moreover,

(a) for \( \alpha < \bar{\alpha} \),

\[
\begin{align*}
H_0^p (\alpha) &= \Pi_1 - \Pi' + \alpha \delta \Pi \\
M_0^p (\alpha) &= \Pi_2 + \delta \Pi - [\Pi_1 - \Pi' + \alpha \delta \Pi]
\end{align*}
\]

and (b) for \( \alpha \geq \bar{\alpha} \)

\[
\begin{align*}
H_0^p (\alpha) &= \alpha \Pi_1 + \alpha \delta \Pi \\
M_0^p (\alpha) &= \Pi_2 - \alpha \Pi_1 + (1 - \alpha) \delta \Pi.
\end{align*}
\]

And for all values of \( \alpha \), the payoff is adjusted in favour of the MNC.

Note that \( 1 > \alpha^* > \frac{1}{2} \) holds given the parameter restrictions (by A3 and A4). It is easy to see that \( \alpha^* > \bar{\alpha} \) as \( \Pi_2 > \Pi_1 \).

If the MNC decides not to offer Technology 1, or the offer is rejected by the host firm in the first period, then the MNC can offer Technology 2 to the host firm in the second period (see the game in figure 5.2b). Note that the net surplus that can be generated in the second period from Technology 2 is \( \Pi_2 - \Pi' \). The MNC can offer Technology 2 either in licensing or in joint venture such that it obtains the payoff \( \Pi_2 - \Pi' \). The host firm would accept the offer, thus obtaining its reservation payoff, which is zero.

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7 Note that \( \alpha^* > 1/2 \) implies \( \frac{\Pi_2 - \Pi'}{\Pi_2 - \delta \Pi'} > 1/2 \). That is \( 2(\Pi_2 - \Pi') > \Pi_2 - \delta \Pi' \). So \( \Pi_2 - 2\Pi' > -\delta \Pi' \). Since \( \Pi_2 > 2Z \) by (A4) and \( Z - \Pi' > 0 \) by (A3), hence \( \Pi_2 - 2\Pi' > 0 > -\delta \Pi' \) holds. On the other hand, \( \alpha^* < 1 \) as \( \delta < 1 \).
Full game

With the above characterisation of the second period outcome we can now proceed to analyse the subgame perfect equilibrium for the two period game. First consider the outcome associated with the transfer of Technology 1. When the MNC offers Technology 1 in the first period, it specifies the contract of an upfront fee $t_1$, and a share $\alpha$ of the business. If the host firm accepts the offer it produces with Technology 1 and undertakes the imitative innovation at a cost $e$. Now depending on the outcome of imitative innovation, the host firm’s expected total payoff in two periods is given as

$$\alpha(\Pi_1 - F) - e + q(e)H_1^p + \{1-q(e)\} H_0^p - t_1 \quad (1)$$

Similarly, the MNC gets,

$$(1-\alpha)(\Pi_1 - F) + t_1 + q(e) M_1^p + \{1-q(e)\} M_0^p \quad (2)$$

The MNC would maximise the above payoff by choosing $\alpha$ and $t_1$ subject to the participation constraint of the host firm, which is assumed to be zero in two periods. So for any value of $\alpha$, the MNC chooses $t_1$ such that the host firm is left with zero expected payoff in two periods (i.e., the expression given in $(1) = 0$). Thus, by charging $t_1$ optimally and putting the values of second period payoffs (from Propositions 1 and 2), for any value of $\alpha$, the MNC gets

$$\Pi_1 - e^* + \Pi_2 - (1-\delta^2)F \quad (2')$$

where $e^*$ solves the following first order condition of the host firm’s profit maximisation with respect to $e$.

$$q'(e)[H_1^p - H_0^p] = 1^8 \quad (3)$$

An interior solution is guaranteed by the restriction imposed on the function $q(e)$ (by A5). Note that the term $[H_1^p - H_0^p]$, can be interpreted as the incentive for imitative innovation. As the value of this term increases, $q'(e)$ has to be lower leading to the choice of higher $e^*$ given the RHS of (3). Thus, $e^*$ is a positive function of the term $[H_1^p - H_0^p]$. This term represents the premium that the host firm obtains if it is successful in its imitative innovation. The host firm spends more money on imitative innovation when the premium is more. An interesting point to note here is that if the joint venture contract is offered in the first period, then the host firm would get some strictly positive payoffs at the end of both periods. However, the MNC charges the upfront payment such that the host firm is left with zero expected payoff in two periods (i.e., the expression given in $(1) = 0$). Since we have assumed that the participation

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8 Unless we specify a specific functional form of $q(e)$ we can not determine $e^*$ as a real number. Thus, the payoff to the MNC (given by (2')) would remain a function in our analysis. However, to maximise this function, $e^*$ needs to be minimised given the relationship (3).
constraint is zero in two periods, the host firm still accepts the offer in the beginning of the first period game.

Once Technology 1 is transferred, the host firm would have the incentive for imitative innovation (from (3) since \([H_1^p - H_0^p] > 0\) for any given first period \(\alpha\) from propositions 1 and 2), so the host firm would always incur some expenditure \(e^*\). Recall the discussion before Proposition 1 and note that for \(\alpha < \alpha^*\), the incentive for imitative innovation stems from the fact that Technology 2 may potentially be used by the host firm outside the joint venture business and for \(\alpha \geq \alpha^*\), Technology 2 is to be used in the joint venture business. One might wonder why the host firm undertakes imitative innovation when it would use the innovated technology (Technology 2) in the joint venture business. The reason is that if it does not undertake imitative innovation then it has to depend on the MNC for Technology 2 in the second period. The MNC would offer Technology 2 with the contract such that the host firm obtains the share of profit under Technology 1. Thus, to reduce the probability of dependence, the host firm would undertake imitative innovation even though it would be utilised in the joint venture business in case of success. The essential purpose behind this imitative innovation is to receive some extra rent in case it is successful in developing Technology 2.

Recall that the MNC develops Technology 2 at no cost, the MNC does not want this imitative innovation to be undertaken by the host firm as the expenditure \(e^*\) is a wastage of total surplus obtained by the MNC (see \((2')\)). Since Technology 2 is not contractible in period 1 the host firm would always invest on imitative innovation. If Technology 2 could have been contracted so as to be provided by the MNC in the second period then a contract can be designed where the host firm would have no incentive to innovate it for its second period use. For example, a simple contract which would ensure this is to charge the upfront payment \(\Pi_1 + \Pi_2 - (1- \delta^2)F\) by supplying Technology 1 in the first period and commit to provide Technology 2 in the second period. In the absence of that contract about future technology as assumed in the model, to maximise its payoff, the MNC would try to minimise \(e^*\). Since there is no direct way to minimise \(e^*\), the MNC would choose a contract of joint venture (choose \(\alpha\)) so as to minimise the incentive for imitative innovation (implying \(e^*\) is minimised from (3)) subject to the additional constraint \(\alpha \geq \alpha_m\) in the first period.

Let us characterise the incentive for imitative innovation of the host firm for the ranges of \(\alpha\). Recall the payoffs of the host firm for different ranges of \(\alpha\) from Proposition 1 and 2. For \(\alpha \geq \)
\( \alpha^* \), \( e^* \) is the solution of this equation (by putting the values of \( H_1^p \) and \( H_0^p \) from Propositions 1 and 2 in (3))

\[
q'(e) [\alpha (\Pi_2 - \Pi_1)] = 1. \tag{4}
\]

So \( e^* \) decreases as \( \alpha \) decreases to \( \alpha^* \). Similarly for \( \alpha < \bar{\alpha} \), \( e^* \) is given by

\[
q'(e) (\Pi_2 - \Pi_1) = 1; \tag{5}
\]

so, the incentive is constant in this range of \( \alpha \). And for \( \bar{\alpha} \leq \alpha < \alpha^* \), \( e^* \) is given by

\[
q'(e) [\Pi_2 - F' + \alpha \delta F - \alpha \Pi_1 - \alpha \delta^2 F] = 1,
\]

i.e.,

\[
q'(e) [\Pi_2 - F' - \alpha (\Pi_1 - \delta F')] = 1. \tag{6}
\]

(Since \( F' = F(1-\delta) \) by definition)

Now since \( \Pi_2 - F' > \alpha (\Pi_1 - \delta F') \), as \( \alpha \) increases to \( \alpha^* \), the premium decreases. As a result \( e^* \) decreases as well. Therefore, by comparing (4), (5) and (6) we find that \( e^* \) is minimum at \( \alpha^* \).

Thus, we obtain the following lemma on incentives for imitative innovation.

**Lemma 1.** The incentives for imitative innovation and the corresponding choices of \( e^* \) in the partial liberalisation case are given by the equations below.

For \( \alpha \geq \alpha^* \),

\[
q'(e) [\alpha (\Pi_2 - \Pi_1)] = 1,
\]

for \( \alpha < \bar{\alpha} \),

\[
q'(e) (\Pi_2 - \Pi_1) = 1,
\]

and for \( \bar{\alpha} \leq \alpha < \alpha^* \),

\[
q'(e) [\Pi_2 - F' - \alpha (\Pi_1 - \delta F')] = 1.
\]

And the incentive is minimum at \( \alpha^* \).

The incentive for imitative innovation, which is the premium received by the host firm, can be presented as in Figure 5.3.

![Figure 5.3](image)

(if \( \bar{\alpha} \geq 1/2 \), otherwise the premium is decreasing function for \( \alpha \in [1/2, \alpha^*] \))

Figure 5.3.

\[9\] Note that by (A4), \( \Pi_2 > 2Z \). So, \( \Pi_2 - F' > 2Z - F' \). Since \( Z > \Pi_1 \) by (A6), so \( Z > \alpha (\Pi_1 - \delta F') \). Now by (A3), \( Z - F' > 0 \). Hence \( 2Z - F' = Z + Z - F' > \alpha (\Pi_1 - \delta F') + positive. Therefore, \( \Pi_2 - F' > \alpha (\Pi_1 - \delta F') \)
Proposition 3. The sequence of actions that constitutes the subgame perfect equilibrium is given below.

(a) Suppose that $\Pi_1 - e^* + \Pi_2 - (1 - \delta_2)F > \Pi_2 - F'$. Then in the first period the MNC makes an offer such that $\alpha = \max \{\alpha^*, \alpha_m\}$ and the host firm accepts the offer in the first period. In the second period the MNC makes an offer to continue the joint venture, provided that the host firm is successful in imitative innovation. Otherwise, the MNC offers Technology 2 and readjusts the payoff in its favour. In any case, the host firm accepts those offers.

(b) If, however, $\Pi_1 - e^* + \Pi_2 - (1 - \delta_2)F < \Pi_2 - F'$, the MNC makes no offer in the first period. In the second period the MNC makes an offer of Technology 2 and it is accepted by the host firm.

The second period outcomes associated with the transfer of Technology 1 in the first period described in the above proposition are discussed in Propositions 1 and 2 before.

First note that $e^*$ is the cost of imitative innovation that is incurred under optimal contract when the first period technology is transferred to the host firm. This is a pure wastage from the MNC’s point of view. If $e^* \leq \Pi_1 - \delta F'$ (from the given condition in the above proposition), the MNC supplies the first period technology (under joint venture contract only); otherwise, the MNC does better by simply transferring Technology 2 in the second period in order to avoid the cost of imitative innovation incurred by the host firm.

The significance of this proposition is that if the MNC chooses to offer Technology 1 in the first period, it offers the joint venture contract as opposed to licensing. This joint venture agreement remains stable in the second period provided that the host firm is successful in its innovation (see Proposition 1). Otherwise, the payoffs are readjusted in favour of the MNC along with the offer of the second period technology (see Proposition 2). It is also interesting to note that the first period joint venture contract offered by the MNC is not necessarily at the foreign equity restriction limit, $\alpha_m$.

4. Full liberalisation in second period

Consider the case when the government liberalises the economy fully in the second period (stage 1). Under this policy the MNC is allowed to set up a wholly owned subsidiary. Recall the structure of the game described in section 2. The MNC would have an additional option of
its own. So there will be duopoly competition when the host firm chooses to break up. Thus, after being successful in its imitative innovation, if the host firm breaks up it obtains \( Z - F' \) from its new plant as it has to compete with the MNC and \( \alpha \delta F \) by selling off its share of fixed capital of the first period joint venture. Thus, the host firm obtains total payoff by breaking up \( Z - F' + \alpha \delta F \). On the other hand, by continuing the existing joint venture its payoff is \( \alpha \Pi_2 + \alpha \delta^2 F \). So the host firm never breaks up the joint venture given that its share holding is at least \( \alpha_m (> 1/2) \) (as \( \Pi_2 > 2Z \) by A4). If the MNC chooses to break up in stage 4, it gets the payoff \( Z - F' + (1-\alpha)\delta F \) (due to duopoly competition), whereas by continuing the joint venture its payoff is \( (1-\alpha)\Pi_2 + (1-\alpha)\delta^2 F \). Hence the MNC wants to break up if and only if \( \alpha \geq \hat{\alpha} \) where

\[
\hat{\alpha} = \frac{\Pi_2 - Z + F'(1-\delta)}{\Pi_2 - \delta F'}. \]

It is easy to check that \( 1 > \hat{\alpha} > 1/2 \) given the parameter restrictions (by A3 and A4).

For \( \alpha \geq \hat{\alpha} \), the MNC would choose to break up in stage 4. If the MNC breaks up, the host firm can purchase the plant at the market value to continue the business on its own. So the host firm needs to pay only \((1-\alpha)\delta F\) to buy the plant. However, since the host firm has to compete in this case, its payoff would be \( Z + \delta^2 F - (1-\alpha)\delta F = Z - \delta F' + \alpha \delta F \). On the other hand for \( \alpha < \hat{\alpha} \), the MNC chooses to continue the joint venture in stage 4 and the game reaches to stage 5 where the host firm also chooses to continue. Thus, after rejection in stage 3 from subsequent equilibrium of the game the host firm would receive the payoffs: \( Z - \delta F' + \alpha \delta F \) for \( \alpha \geq \hat{\alpha} \) and \( \alpha \Pi_2 + \alpha \delta^2 F \) for \( \alpha < \hat{\alpha} \). Now in stage 2 the MNC can make an acceptable offer such that the host firm gets what it expects to get from rejection. By that offer the MNC receives \( \Pi_2 + \delta^2 F - (Z - \delta F' + \alpha \delta F) \) for \( \alpha \geq \hat{\alpha} \) and \( (1-\alpha)\Pi_2 + (1-\alpha)\delta^2 F \) for \( \alpha < \hat{\alpha} \). It is easy to see that these payoffs weakly dominate the payoffs from making an unacceptable offer which gets rejected and equilibrium is reached at later stages of the game after rejection (for \( \alpha \geq \hat{\alpha} \) the MNC is strictly better off and for \( \alpha < \hat{\alpha} \), the MNC is indifferent). Thus,

**Proposition 4.** Consider the case where the government pursues a policy of full liberalisation in the second period and the host firm is successful in its imitative innovation. Then
(a) for \( \alpha \geq \hat{\alpha} \),

\[
H_1^T(\alpha) = Z - \delta F' + \alpha \delta F
\]

\[
M_1^T(\alpha) = \Pi_2 + \delta^2 F - (Z - \delta F' + \alpha \delta F)
\]

and (b) for \( \alpha < \hat{\alpha} \),

\[
H_1^T(\alpha) = \alpha \Pi_2 + \alpha \delta^2 F
\]
Proposition 5. Consider the case where the government pursues a policy of full liberalisation in the second period and the host firm is not successful in its imitative innovation. Then in the second period the MNC offers Technology 2. Moreover,
\[
H_o^f (\alpha) = \alpha \delta F \\
M_o^f (\alpha) = \Pi_2 - \alpha \delta F + \delta^2 F.
\]
And the payoff is always adjusted in favour of the MNC.

If the MNC decides not to offer the technology or the offer is rejected by the host firm in the first period then the MNC can set up a subsidiary with Technology 2, or transfer (in licensing or joint venture) Technology 2 to the host firm to obtain \( \Pi_2 - F' \) and the host firm would get zero in any case. Without loss of generality we assume that the MNC sets up a subsidiary in the second period.

Full game

With the above characterisation of the second period outcome we can now proceed to determine the payoffs of the two parties in two periods. Given the contract of an upfront fee, \( t_2 \), and a share \( \alpha \), by accepting the offer of the first period technology, the host firm obtains
\[
\alpha (\Pi_1 - F) - e + q(e)H_1^f + \{1-q(e)\} H_0^f - t_2.
\]
Similarly, the MNC gets,
\[
(1-\alpha)(\Pi_1 - F) + t_2 + q(e) M_1^f + \{1-q(e)\} M_0^f.
\]
The MNC would maximise the above payoff by choosing \( \alpha \) and \( t_2 \) subject to the participation constraint of the host firm, which is assumed to be zero in two periods. So for any value of \( \alpha \), the MNC chooses \( t_2 \) such that the host firm is left with zero expected payoff in two periods (i.e., the expression given in (7) = 0). Thus, by charging \( t_2 \) optimally and putting the values of second period payoffs (from propositions 4 and 5), for any value of \( \alpha \), the MNC obtains \( \Pi_1 - e^* + \Pi_2 - (1- \delta^2)F \); where \( e^* \) is given by the following first order condition of the host firm's profit maximisation with respect to \( e \).
\[
q'(e)[H_1^f - H_0^f] = 1
\]
To maximize its payoff, the MNC would minimise \( e^* \) by giving a contract of joint venture such that \( \alpha \geq \alpha_m \). Let us characterise the incentive for imitative innovation of the host firm for the permissible ranges of \( \alpha \). Recall the payoffs of the host firm \( (H_1^f, H_0^f) \) for different ranges of \( \alpha \) from Propositions 4 and 5 respectively. Now depending on the values of \( \alpha \), \( e^* \) is the solution of the equations (from (9)):
For \( \alpha < \alpha^* \), \( \quad q'(e)[\alpha (\Pi_2 - \delta F')] = 1; \quad \)
Proposition 6. In case of full liberalisation the following sequence of actions constitutes the subgame perfect equilibrium.

(a) Suppose that $\Pi_1 - e^* + \Pi_2 - (1 - \delta)F \geq \Pi_2 - F$. Then the MNC makes a first period offer such that $1 \geq \alpha \geq \text{Max} (\hat{\alpha}, \alpha_m)$, which the host firm accepts. In the second period, depending on success or failure of imitative innovation the MNC makes an offer revising the earlier terms of the joint venture. The host firm accepts this offer.

(b) If, however, $\Pi_1 - e^* + \Pi_2 - (1 - \delta)F < \Pi_2 - F^*$, the MNC makes no offer in the first period. In the second period the MNC sets up a subsidiary with Technology 2.

The second period outcomes associated with the transfer of Technology 1 described in the above proposition have been discussed in Propositions 4 and 5 before. In this case if the MNC decides to make an offer in the first period it may optimally license out Technology 1 as it is indifferent to any contract with $\alpha$ such that $1 \geq \alpha \geq \text{Max} (\hat{\alpha}, \alpha_m)$. Here the MNC offers the licensing or joint venture contract with the full anticipation that it can enter in the second period. And the MNC by using a threat of entry in the second period makes the second period offer. The interesting feature of this case is that if the MNC commits to the joint venture in the first period it would revise the contract terms in its favour in the second period depending on success or failure of imitative innovation. Thus, we get an inherent instability in the joint venture, which is commonly observed in many developing countries when these economies have allowed foreign firms to set up wholly owned subsidiaries.

It should be noted that the joint venture does not break down in our model. However, the threat of breaking up by one of the partners determines the fallback (reservation) payoff of the host firm in the second period. The MNC makes the second period offer after taking into consideration the threat of breaking up and maximises its own payoff by giving the fallback payoff to the host firm. Hence the threat of breaking up is a source of instability of the joint venture, which leads to payoff readjustments between the partners in the second period. Another source of instability in our model is the failure of the host firm in its imitative innovation. This results in the fact that Technology 2 is supplied by the MNC in the second period leading to payoff readjustment in favour of the MNC.
5. Uncertain government policy in second period

Let us consider the possibility of uncertainty about the government's policy in the second period. To justify this uncertainty we argue that the government can credibly commit to its policy only for the current period and in the first period the announcement of policy about the second period cannot be credible. This credibility problem is noted, among others, in Buffie (1995), Rodrik (1989). Rodrik (1989) noted that one source of credibility problem is incomplete and asymmetric information. Private investors may not know the true objective function of the government in power, or may confuse it with the alternative government whose objectives differ. Imperfect information is particularly likely to be prevalent in many developing countries where governments rotate frequently. We propose another source of uncertainty about the future government policy. It is often argued that most of the developing countries have started the process of liberalisation due to international pressure in terms of conditional lending by the international financial institutions (IMF-World Bank package of stabilisation and structural adjustment). Depending on the performances of their economies during the initial phases they might not succumb to the same pressure in future and continue with the policy so far adopted. We are ruling out the reversion of policy to the protectionist regime, as that could be very costly because certain decisions like investments etc. are irreversible/sunk in nature. We consider that the government can either continue the first period policy of joint venture (partial liberalisation) or it can allow the wholly owned subsidiary of the MNC (full liberalisation) in the second period. Let p be the probability that the government would liberalise the economy fully and (1-p) be the probability that it would continue the same first period policy. p is common knowledge to both players.

Note that if either the MNC decides not to offer Technology 1 or the offer is rejected by the host firm in the first period then the second period outcomes are similar. In the second period the MNC would either set up a subsidiary with Technology 2 in case of full liberalisation, or transfer (in licensing or joint venture) Technology 2 to the host firm in case of partial liberalisation. In both situations the MNC would obtain $\Pi_2 - F'$ and the host firm would get zero in any case. So, when the policy is uncertain the expected payoff of the MNC remains same. The expected payoff of the host firm is zero here.

If the MNC decides to offer the first period technology and the offer is accepted, the second period outcomes depending on the policy realisation (partial liberalisation or full liberalisation) and the outcome of imitative innovation (success or failure) has already been characterised in Propositions 1, 2 and 4, 5. So we directly get into the analysis of the full
game. Now given a contract of an upfront fee, $t$, and a share, $\alpha$, we can write the expected payoffs of both parties when Technology 1 is offered and accepted in the first period. The host firm's total payoff in two periods when it accepts Technology 1, is

$$\alpha(\Pi_1 - F) - e + p[q(e) H^f_t + \{1-q(e)\} H^r_t] + (1-p)[q(e) H^p_t + \{1-q(e)\} H^r_t] - t,$$

and the MNC's payoff is

$$(1 - \alpha)(\Pi_1 - F) + t + p[q(e) M^f_t + \{1-q(e)\} M^r_t] + (1-p)[q(e) M^p_t + \{1-q(e)\} M^r_t].$$

(13)

The MNC would maximise the above payoff by choosing $\alpha$ and $t$, subject to the constraint that the host firm obtains its reservation payoff, which is assumed to be zero for both periods. So for any value of $\alpha$, the MNC chooses $t$ such that the host firm is left with zero expected payoff in two periods (i.e., the expression given in (12) = 0). Thus, by charging $t$ optimally and putting the values of second period payoffs (from Propositions 1, 2, 4 and 5), for any value of $\alpha$, the MNC obtains $\Pi_1 - e^* + \Pi_2 - (1 - \delta^3)F$, where $e^*$ is given by the following first order condition of the host firm's profit maximisation with respect to $e$.

$$q'(e)[p(H^f_t - H^r_t) + (1-p)(H^p_t - H^r_t)] = 0$$

(14)

Note that the premium on imitative innovation associated with any $\alpha$ in this discussion of uncertain policy is the convex combination of the premia received under full liberalisation and partial liberalisation (given by (9) and (3) respectively). To maximize its payoff the MNC would try to minimise $e^*$ by giving a contract of joint venture such that $\alpha \geq \alpha_m$. To find out the optimal share for which the incentive for imitative innovation is minimum, we proceed by identifying the following two possibilities: case 1, $\alpha^* \geq \hat{\alpha}$ and case 2, $\alpha^* < \hat{\alpha}$. Note that $\alpha^* < \hat{\alpha}$ if and only if $Z < (2-\delta)F^\prime$.  

First we determine the outcome in case 1. The MNC chooses $\alpha$ in the first period so that $e^*$ is minimum. The premium associated with the full liberalisation case is minimum at any $\alpha \geq \hat{\alpha}$ (by lemma 2). The premium associated with the partial liberalisation case is minimum at $\alpha^*$ (by lemma 1). Therefore, their convex combination also attains minimum at $\alpha^*$. Thus, if $\alpha_m \leq \alpha^*$ so that $\alpha^*$ is feasible then the MNC would offer $\alpha^*$ to minimise the incentive for imitative innovation. Now for any $\alpha > \alpha^*$ the incentive in the partial liberalisation case is a positive function of $\alpha$ (from lemma 1). So if $\alpha_m > \alpha^*$, the incentive is minimum at $\alpha_m$ reflecting the

$10$ Recall the values of $\alpha^*$ and $\hat{\alpha}$. By comparing we get $\alpha^* < \hat{\alpha} \iff \frac{\Pi_2 - F^\prime}{\Pi_2 - \delta F^\prime} < \frac{\Pi_2 - Z + F^\prime(1-\delta)}{\Pi_2 - \delta F^\prime}$. So, $\alpha^* < \hat{\alpha} \iff Z < (2-\delta)F^\prime$. 


corresponding $e^*$ to be minimum. Hence, the optimal contract involves $\alpha = \text{Max}(\alpha^*, \alpha_m)$. By this optimal contract the MNC gets $\Pi_1 - e^* + \Pi_2 - (1-\delta^2)F$; where $e^*$ is the expenditure incurred for undertaking imitative innovation corresponding to the optimal contract. Thus we get the following proposition which characterises the subgame perfect equilibrium in this case.

**Proposition 7.** If $\alpha^* \geq \hat{\alpha}$, the following sequence of action constitutes the subgame perfect equilibrium.

(a) Suppose that $\Pi_1 - e^* + \Pi_2 - (1-\delta^2)F \geq \Pi_2 - F'$. Then the MNC offers Technology 1 in the first period such that $\alpha = \text{Max}(\alpha^*, \alpha_m)$ and the host firm accepts it. In the second period the MNC offers to continue the joint venture if the host firm is successful in its imitative innovation and partial liberalisation is the realised policy. Otherwise, the MNC revises the terms of the joint venture in its favour.

(b) If, however, $\Pi_1 - e^* + \Pi_2 - (1-\delta^2)F < \Pi_2 - F'$, the MNC makes no offer in the first period.

In the second period, the MNC either enters with a subsidiary in full liberalisation or transfers Technology 2 in partial liberalisation.

The significance of the above proposition is that if the MNC chooses to offer Technology 1 in the first period, it offers the joint venture contract as opposed to licensing. However, the second period outcome depends on both the realisation of the government policy and the outcome of imitative innovation undertaken by the host firm. The first period joint venture remains stable if and only if the host firm is successful in imitative innovation and partial liberalisation is the realised policy in the second period (see Proposition 1). In all other possibilities the joint venture becomes unstable and the payoffs are readjusted in favour of the MNC (see Propositions 2, 4 and 5).

To determine the outcome in case 2 ($\alpha^* < \hat{\alpha}$), we proceed in following steps.

**Step 1.** If $\alpha_m \geq \hat{\alpha} > \alpha^*$, the optimal contract is to give $\alpha = \alpha_m$. This is because for any $\alpha \geq \hat{\alpha}$, from lemma 1 and 2, the premium received by the host firm is given by $p[Z - \delta F'] + (1-p)\alpha (\Pi_2 - \Pi_1)$, which is an increasing function of $\alpha$. So the premium is minimum at $\alpha_m$.

**Step 2.** Consider the possibility $\hat{\alpha} > \alpha_m \geq \alpha^*$. For $\alpha \geq \hat{\alpha}$, the incentive for imitative innovation is minimum at $\hat{\alpha}$, which is obvious from step 1. Note that there is a discontinuity in incentive to innovate at $\hat{\alpha}$ in case of full liberalisation. Now for $\hat{\alpha} > \alpha \geq \alpha_m \geq \alpha^*$, the
incentive for imitative innovation is given by \[ p \alpha (\Pi_2 - \delta F') + (1-p) \alpha (\Pi_2 - \Pi_1) \] (from Lemma 1 and 2). So to minimise the premium, \( \alpha \) should be brought down to \( \alpha_m \). Now by comparing the incentives for imitative innovation at \( \alpha_m \) and \( \hat{\alpha} \), we find that there exists a critical probability \( \beta \) such that for \( p \leq \beta \), \( \alpha_m \) is optimal and for \( p > \beta \), \( \hat{\alpha} \) is optimal; where \( \beta \) is defined below.

\[
\beta = \frac{1}{\alpha_m ((\Pi_2 - \delta F') - (Z - \delta F')) - (\hat{\alpha} - \alpha_m) (\Pi_2 - \Pi_1)} \]

The restriction on \( \Pi_1 \) and \( Z \) (from A6) implies \( \alpha < 1/2 \). Hence we are left with only one possibility, which is discussed below.

**Step 3.** Consider the possibility \( \hat{\alpha} > \alpha^* \geq 1/2 \). First, note from step 1 that for \( \alpha \geq \hat{\alpha} \), the minimum incentive for imitative innovation is reached at \( \hat{\alpha} \). Also note from step 2 that for \( \alpha^* \leq \alpha < \hat{\alpha} \), the incentive for imitative innovation is a decreasing function of \( \alpha \). What happens to the incentive for \( \alpha < \alpha^* \) is given by the expression, \( p \alpha (\Pi_2 - \delta F') + (1-p) (\Pi_2 - \Pi_1) \). The incentive is an increasing function of \( \alpha \) for the range \([\alpha_m, \alpha^*] \), if and only if \( p (\Pi_2 - \delta F') - (1-p) (\Pi_1 - \delta F') > 0 \),

\[ \text{i.e., iff } p > \frac{1}{\Pi_2 - \delta F') - (Z - \delta F') + 1} = \bar{p} \text{ (say)} \]

So, for \( p > \bar{p} \) the incentive for imitative innovation is lower at \( \alpha_m \) as compared \( \alpha^* \). For \( p \leq \bar{p} \), the incentive associated with \( \alpha^* \) would be lower as compared to \( \alpha_m \). Hence, the point of comparison with \( \hat{\alpha} \) will depend on the critical probability \( \bar{p} \). For \( p > \bar{p} \), by comparing the incentives for imitative innovation at \( \hat{\alpha} \) and \( \alpha_m \), we find that there exists a critical probability \( p_i \) such that for \( p < p_i \), the incentive for imitative innovation associated with the contract \( \hat{\alpha} \) is greater than \( \alpha_m \) and for \( p \geq p_i \), \( \hat{\alpha} \) involves lower incentive than \( \alpha_m \), where the probability \( p_i \) is defined as

\[ p \equiv \frac{1}{\alpha_m ((\Pi_2 - \delta F') - (Z - \delta F')) - (\hat{\alpha} - \alpha_m) (\Pi_2 - \Pi_1)} \]

\[ \Leftrightarrow p \leq \frac{1}{\alpha_m ((\Pi_2 - \delta F') - (Z - \delta F')) - (\hat{\alpha} - \alpha_m) (\Pi_2 - \Pi_1)} + 1 = \beta. \]
\[ p_i = \frac{1}{\alpha_m (\Pi_2 - \delta F') - (Z - \delta F')} \frac{\alpha_m (\Pi_2 - \Pi_1) - (\Pi_2 - F') + \alpha_m (\Pi_1 - \delta F')} {\hat{\alpha} (\Pi_2 - \Pi_1) - (\Pi_2 - F')} + 1 \]

Now if \( p_1 > \bar{p} \), only then the MNC would prefer to offer the contract \( \alpha_m \) for the range \((\bar{p}, \ p_1)\) and \( \hat{\alpha} \) for the remaining range, \([p_1, 1]\). However, if \( p_1 \leq \bar{p} \), then \( \hat{\alpha} \) would always be the optimal contract to offer for any \( p > \bar{p} \).

On the other hand for \( p \leq \bar{p} \), by comparing the incentives for imitative innovation at \( \alpha^* \) and \( \hat{\alpha} \) we find that there exists a critical probability \( \hat{p} \) such that for \( p \leq \hat{p} \), the incentive is lower at \( \alpha^* \), and for \( p > \hat{p} \), the incentive is lower at \( \hat{\alpha} \); where \( \hat{p} \) is defined below

\[ \hat{p} = \frac{1}{\Pi_2 - F' - Z + \delta F'} + \Pi_2 - \Pi_1 (\hat{\alpha} - \alpha^*) + 1 \]

Thus, if \( \hat{p} < \bar{p} \), only then the MNC prefers to offer the contract \( \hat{\alpha} \) for the range \((\hat{p}, \bar{p})\) and \( \alpha^* \) for \( p \leq \hat{p} \). When \( \hat{p} \geq \bar{p} \), \( \alpha^* \) would be optimal contract to offer for all \( p \leq \bar{p} \). Therefore, \( \alpha^* \) would be optimal contract to offer for any \( p \leq \min(\hat{p}, \bar{p}) \).

Hence, the optimal contract that would be offered by the MNC can be summarised as follows:

- \( \alpha_m \) for \( p \in (\bar{p}, \ p_1) \), if this range exists,
- \( \alpha^* \) for \( p \leq \min(\hat{p}, \bar{p}) \), and
- \( \hat{\alpha} \) for all other possible values of \( p \).

Proposition 8 below provides the characterisation of the \textit{ex-ante} optimal share offered by the MNC in the first period in case 2.

**Proposition 8.** If \( \hat{\alpha} > \alpha^* \), the optimal contract of joint venture is given below:

(a) If \( \alpha_m \geq \hat{\alpha} > \alpha^* \) then the optimal contract is to offer \( \alpha = \alpha_m \).

(b) If \( \hat{\alpha} > \alpha_m \geq \alpha^* \) then the optimal contract is to offer \( \alpha_m \) for \( p \leq \beta \) and \( \hat{\alpha} \) for \( p > \beta \).

(c) If \( \hat{\alpha} > \alpha^* > \alpha_m \geq 1/2 \), then the optimal contract is to offer as:
   - \( \alpha_m \) for \( p \in (\bar{p}, \ p_1) \), if this range exists,
   - \( \alpha^* \) for \( p \leq \min(\hat{p}, \bar{p}) \), and
   - \( \hat{\alpha} \) for all other possible values of \( p \).
6. Costly innovation of the MNC

The purpose of this section is illustrative. For the sake of simplicity, we make the assumption that $\alpha < 1/2$. So far our analysis was based on the assumption that the MNC does not incur any additional cost to innovate Technology 2. In this section, we extend the analysis to allow for the possibility that the MNC incurs an additional cost for innovation, which is specific to the given host country. Suppose the MNC incurs a fixed cost $r$ to develop Technology 2 from its first period level for this particular host country. We now analyse how the nature of the optimal contract changes because of the innovation cost incurred by the MNC.

Partial liberalisation case:

If the MNC transfers Technology 1 in the first period then the MNC would get the returns on its innovation provided that the host firm fails to develop Technology 2. So the expected payoff to the MNC in undertaking this innovation is $(1-q(e^*))(\Pi_2 - \Pi_1) - r$, where the $e^*$ is given by the incentive minimisation condition at the optimal contract given in Proposition 3 (a). So long as the expected payoff of the MNC from undertaking innovation is non-negative, Proposition 3 characterises the equilibrium.

Consider the possibility $(1-q(e^*))(\Pi_2 - \Pi_1) - r < 0 < \Pi_2 - \Pi_1 - r$. If the MNC offers Technology 1 in the first period, it does not innovate Technology 2 but if it makes only the second period offer then it undertakes innovation of Technology 2. If the MNC does not undertake innovation but supplies Technology 1 in the first period, then the MNC would offer the contract in the first period such that the probability of the success of the host firm to develop Technology 2 is the maximum. This is because, the MNC can extract the total surplus from the relationship by suitably charging an upfront payment. Thus, by supplying Technology 1, the MNC would expect to obtain $\Pi_1 - e + q(e) \Pi_2 + (1-q(e))\Pi_1 - (1-\delta^2)F$, where the first period contract is such that $e$ is maximum (which is discussed below). If the MNC does not offer Technology 1, it innovates Technology 2 and transfers that in the second period to obtain $\Pi_2 - F(1-\delta) - r$. Now if $\Pi_1 - e + q(e) \Pi_2 + (1-q(e))\Pi_1 - (1-\delta^2)F \geq \Pi_2 - F(1-\delta) - r$, the MNC chooses to offer Technology 1 in the first period; otherwise it chooses to transfer Technology 2 in the second period.
The last possibility is that $\Pi_2 - \Pi_1 - r < 0$. In this situation the MNC never undertakes innovation of Technology 2. Since $\Pi_1 - e + q(e) \Pi_2 + (1-q(e)\Pi_1 - (1-\delta)F \geq \Pi_1 - F(1-\delta)$ always holds, the MNC always offers Technology 1 in the first period.

In the case where the MNC does not undertake innovation of Technology 2 after offering the first period technology, it would offer the first period contract such that the success probability of the host firm is maximum. The reason is that the MNC can extract the total surplus from the relationship by suitably charging an upfront payment. Therefore the optimal contract will be licensing contract only (from Lemma 1) (see Figure 5.3 also).

One can carry out similar analyses for the case of full liberalisation and for the case of uncertain policy in the second period.

7. Conclusion

In this chapter we have established the possibility of both the formation of international joint venture and its subsequent instability. In the first period the joint venture is formed in response to government restrictions on foreign equity holding. However, its subsequent instability is caused both by the uncertainty in the continuity of the process of opening up the economy in the second period and by the likelihood of the success of imitative innovation undertaken by the host partner. We have demonstrated that uncertainty about the government policy in the second period plays an important role in determining the exact share distribution in the first period joint venture formation.

We have identified two sources of instability in joint venture: shift in government policy and the failure of the host firm to innovate in order to catch up with the foreign technology. The shift in government policy towards full liberalisation results in the availability of an additional option of a wholly owned subsidiary for the MNC. The host firm’s failure to innovate the updated technology implies that the second period technology must come from the MNC. Both phenomena lead to payoff readjustment in favour of the MNC in equilibrium.

We have shown that under certain conditions, there might not be any transfer of technology in the first period from the MNC to the host firm. If the first period technology is transferred and the MNC and the host firm believe that there is absolutely no possibility of full liberalisation
in the second period then the MNC offers a joint venture contract. This joint venture contract is so designed that it remains stable (meaning the joint venture is continued with the same share distribution) in the second period provided that the host firm is successful in its imitative innovation. Otherwise, the relationship is unstable as the payoff is readjusted in favour of the MNC. On the other hand, when the MNC and the host firm believe with absolute certainty that the second period policy would be full liberalisation, the MNC is indifferent between a range of joint venture contracts and licensing in the first period. In the second period it would threaten to break up and thereby adjust the payoff in its favour, implying an unstable relationship. However when the second period liberalisation policy is uncertain, the optimal contract is always to offer a joint venture in the first period and in many cases this joint venture tends to be unstable.