

Future technology, incomplete information and international joint venture[☆]

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Abstract

In this paper we describe a scenario where joint venture (JV) formation between a domestic firm and a foreign firm is absolutely motivated by the future expected gain. We show that incomplete information about the host-country policy and foreign technology along with the threat of entry can create an option value for setting a JV in the current period when the foreign firm is expected to invent a new technology in the future.

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1. Introduction

The topics of international joint venture (JV) and technology transfer have attracted a fair amount of attention in recent years. In this context one can broadly identify two sets of research. Researchers working on international business and related areas have provided

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us with many interesting case studies. This is more or less descriptive.¹ The other research mostly concentrates on economic modeling of the issues related to international JVs in developing countries. These works generally focus on the incentives behind formation of JVs between a foreign multinational (MNC) and a domestic firm (or the host government).

In this paper we draw attention to the formation of JVs where partners are absolutely concerned about future benefits as distinct from current benefits. This has not been addressed so far in the theoretical literature. The empirical literature points out that domestic business houses often opt for financial collaborations with the foreign firms with a view to get a regular flow of new technologies from the parent company. For instance, in the study on Indian business houses almost 60% of the respondents seem to attach high importance to this factor (Saqib, 1995). However, technologies transferred in future are not available as free lunch; it requires certain additional payments. In this paper we argue that, even if there is no immediate benefit from the JV, a domestic firm may still prefer to form a JV. This occurs if it anticipates some future benefits, particularly when the foreign firm is expected to bring a new technology in the near future and there is incomplete information about domestic policy and foreign technology. That is, such a JV formation creates an option value.

The developing countries are more or less adopting a process of gradual liberalization instead of a ‘big bang’ approach. Hence, in the early phase of the liberalization, these countries are more interested in collaborative ventures than allowing fully owned foreign subsidiaries. Then such a policy gives the MNCs an option for transferring their technologies to these countries either through technology licensing (TL) or through JVs. Even if the MNCs form a JV in an early period, whether they will transfer their future innovations to their existing JVs, or to an outsider, is theoretically an intriguing problem. Because if the parent company does have a new technology, *ceteris paribus*, it will choose the transferee in a way that will maximize the transferor’s payoff. Usually, the MNC is indifferent between selling the new technology to an outsider or to the JV if it can extract the same surplus from these channels. We show that policy uncertainty along with the possibility of an opportunistic behavior by the firms may be a reason for extracting higher surplus from the JV.

More specifically, we consider the following situation. Initially, there are one foreign-based MNC and a domestic firm. The MNC is capable of inventing a technology in the future period. There is potential entry in the future period, and the entry of a new firm in the market means two potential bidders for the MNC’s new technology. We show that without any relationship in the current period, the less-liberalized future policy (described later) of the domestic government coupled with the informational problem about the MNC’s technology and the threat of imitation prevents the MNC from extracting the entire surplus generated from its technology. Hence, the remaining surplus is left with the domestic firm. But, the possibility of entry implies that the entrant may win the bid for the MNC’s new technology and capture this surplus. The formation of a JV in the current period ensures that the incumbent will be able to outbid the entrant in the future period, and thus the incumbent can capture the relevant surplus created by the MNC’s technology. However, even if the new technology is given to

¹ For a descriptive literature see, for instance, Tomlinson (1970), Killing (1983), and Beamish (1988).

the domestic JV, it may involve additional payment on top of the additional dividend earned by the MNC from a more profitable venture. Hence, JV formation in the current period acts as an option. Thus, our paper falls in the class of the literature where policy uncertainty provides incentives for JV formation (see, e.g. Marjit, 1998; Marjit et al., 1995; Das, 1998, 1999).²

The remainder of the paper is organized as follows. Section 2 provides the basic model. We show the results of the paper in Sections 3 and 4. Section 5 discusses implications of some alternative assumptions. Section 6 concludes the paper. The proofs are relegated to Appendix A.

2. Model

To convey the message of the paper in the simplest way, we consider a two-period model to capture the dynamics of the decision-making behavior of the economic agents. Let $t = 0$ denotes the current period and $t = 1$ represents the future period.

2.1. Firms in the current period

We consider the scenario where so far foreign direct investment had been disallowed and also trade barriers and transportation costs had prevented import of goods into a country, called domestic country. So TL was the only means by which the foreign firms could penetrate the domestic economy.³

Now consider that there are two firms in the current period: one domestic firm and one foreign firm. We call these firms incumbent and MNC, respectively. Since our purpose is to focus on the future benefits as a reason for forming a JV, we assume that neither of these firms any technology in the current period.⁴ Hence, we assume away any production in the current period and assume that production starts in the future period.

2.2. Domestic policy in the current period

Assume that in the current period the domestic country has decided to liberalize the economy and allow TL. Foreign direct investment is also allowed but subject to a maximum level; hence, fully owned subsidiary of the foreign firm is not allowed under the present policy. Let $\alpha < 1$ be the fraction of the maximum foreign equity ownership that is allowed by the domestic country.

² Al-Saadon and Das (1996) describe the formation of JVs in the presence of uncertainty in the government tax policy. In different context, see Rodrik (1989), Aizenman (1992), and Buffie (1995) for analyses on the credibility of the host-country policies.

³ This fits well with the experience of many developing countries. For example, this was the scenario in India up to the end of 1980s.

⁴ Our main results hold even if we allow these firms to have production technology in the current period. Interested readers may look at our working paper (Marjit et al., 2001) for the analysis with production in the current period.

We define the licensing contract and the JV contract as follows:

1. Under TL agreement, the MNC licenses its technology against a price, which consists of an up-front fixed fee and a royalty payment, but the domestic firm owns the project completely.
2. Under the JV agreement the MNC and the domestic partner both have ownership in the domestic project. They share the costs and revenues according to their shareholdings. The output in the JV is chosen to maximize the profit of the JV.⁵

2.3. Firms' expectation about the future period

We assume that although the incumbent is a monopolist in the current period, both the MNC and the incumbent apprehend potential domestic entrants in the future period. To make the structure simple, we consider only a single entrant in the future period and that it will appear in the market with certainty. We also assume that the entrant has no production technology.

We assume that the identity of the future entrant is not known in the current period. Therefore, this creates a type of incompleteness in the market and prevents the possibility of an agreement between the MNC and the future entrant in the current period. Our results will, however, hold even if we relax this assumption, provided that the MNC cannot write JV contracts with more than one firm simultaneously.

We further assume that there is uncertainty about the domestic policy. By this we mean that the private sector is skeptical about the continuation of the present government policy.⁶ So assume that there is a positive probability that the domestic economy will backtrack from its declared liberalization policy in the future, and therefore, there is a chance that it will not allow any further equity ownership of the foreign firm in future. We here abstract the analysis from complete liberalization as well as from nationalization (i.e. when the host-government does not allow the previously formed JVs to operate in the market). Later we argue that these (simplifying) assumptions do not affect our qualitative result.

Let $r > 0$ be the probability that the government will backtrack in the future period, that is, the government will not approve any further foreign equity participation in the future period, although TL will be allowed as usual. So $(1 - r)$ is the probability that the present policy will be continued in future.

2.4. Innovation by the MNC

We assume that the MNC emerges in the future period with a production technology⁷ but neither of the domestic firms (i.e. the incumbent and the entrant) can generate

⁵ In this paper we restrict to the assumption that the JV will choose an output level so as to maximize the JV profit. We can, however, see that even if we allow the JV output to be decided by the domestic firm or by the MNC, our main results still hold. One may look at Marjit et al. (2001) for the details.

⁶ See Rodrik (1989), Marjit (1990), Thomas and Worrall (1994), Al-Saadon and Das (1996) and Mukherjee (2000) for analysis on different policy uncertainty.

⁷ This draws attention to the fact that the MNC does R&D and operates in the international market. So its R&D output and costs are independent of the consideration of the domestic market (Kabiraj and Yang, 2001).

a production technology. The production technology of the MNC corresponds to the constant marginal cost c . Hence, it creates the possibility of technology transfer in the future period.

We assume that the innovation is ill-defined ex-ante, and hence it creates a type of incompleteness in research contracts⁸ in the sense that in the current period ($t = 0$) the firms cannot write a contract on the future technology, although firms know the magnitude of potential benefits. The availability of the production technology at the beginning of the future period ($t = 1$) creates the possibility of technology transfer in future.

We further assume that there are no fixed costs of production. We shall discuss the implication of this assumption later. The nature of product market competition is characterized by Bertrand competition.

2.5. Problems under technology transfer in the future period

Two common problems in the context of international technology transfer are the threat of imitation from the licensee and the licensor's private information about the licensed technology. While it is often difficult for a licensee to get all information about the new technology from patent disclosures, it may not also be possible for the licensor to convey all the good things about the new technology. So, it forms an informational problem and creates the possibility of opportunism on the part of the licensor. On the other hand, technology transfer encourages imitation from the licensee, whereas a strong patent protection makes imitation more difficult and, in turn, raises the cost of imitation. Since it is almost impossible to eliminate the threat of imitation altogether, particularly under international technology transfer, the foreign technology seller generally prefers an agreement with more foreign ownership (Mansfield, 1994).

We assume that the domestic firms believe that the technology of the MNC has a marginal cost either c (low) or c' (high), where $c < c'$. This is a draw from a commonly known probability distribution. Let p and $(1 - p)$ be the probabilities of the low cost (c) and the high cost technology (c'), respectively.

We assume that while the domestic patent laws protect the property rights on the original innovation, imitation or 'inventing around' with a non-infringing innovation is always permissible.⁹ Assume that the domestic firm can imitate the MNC's technology immediately by incurring a cost $I > 0$.

The implication of the above assumption is that if the MNC's technology is available under TL agreement, the domestic firm imitates it immediately, if profitable, by spending I and stops royalty payments, if any. But, since the firms share profits under JV and the foreign firm may have sufficient decision making power in the JV, the domestic firm cannot stop paying the foreign firm's share of profit and contractually specified royalty

⁸ See Grossman and Hart (1986), Aghion and Tirole (1994), and Dasgupta and Tao (1998) for this literature.

⁹ As in Gallini and Wright (1990), we assume that an economically viable imitation requires the use of the technology. For example, imitation is facilitated by the possession of know-how that is not disclosed in the patent but is necessary for commercial production. It has been found empirically also that patent disclosure does not severely limit the effectiveness of patents (Levin et al., 1988).

payments in the JV. This eliminates the domestic firm's incentive to imitate foreign technology in the JV.¹⁰

We also assume that both domestic firms are symmetric with respect to their imitating capability.

2.6. Equilibrium concept for bidding in the future period

We consider Nash equilibrium of the bidding game of period 1. This has the property that neither firm gains by changing its bid unilaterally. The firm with the largest bid gets the technology and needs to pay according to its bid. If both firms give the same offer, we assume that each domestic firm gets the technology with a probability $1/2$.¹¹

Naturally, neither firm bids a price that makes it worse off compared to not having the technology. Each offer specifies the price for the technology and also the mode of technology transfer, i.e. technology transfer either through JV or through TL.

2.7. Verifiable outputs and risk-neutrality of the firms

We assume that the outputs of the domestic project are verifiable, but the marginal cost of production of the foreign technology is observable ex-post technology transfer by both the MNC and the domestic collaborator but are not verifiable by a third-party enforcer.¹²

Finally, we assume that all the agents are risk-neutral, and that any contract can be written only at the beginning of any period.

2.8. Moves of the game

We consider the following game. At the beginning of period 0, the incumbent and the MNC either write a JV contract or no contract (our specification does not allow TL in the current period). After that, at the beginning of period 1, the policy uncertainty of the domestic country is being resolved, the MNC comes up with its invented technology, and a potential entrant appears in the market. Then, the incumbent and the entrant simultaneously bid for the MNC's new technology. The MNC chooses the best offer, and the contract is made. Then production takes place and profit is realized. Fig. 1 describes the sequence of moves. We solve the game through backward induction.

¹⁰ We presume that economically it is not feasible for the domestic firm to open a new subsidiary and produce with the imitated technology. This may be due to higher costs of opening a new firm and the loss of profits from competition with the existing JV. It may also be possible that under the JV contract the foreign firm has sufficient decision-making power in the JV so that the local firm finds it difficult to imitate the JV technology and thereby stop royalty payment to the foreign firm. Such an issue is discussed in Marjit and Mukherjee (2001). The empirical study by Mansfield (1994) supports the view that threat of imitation is lower under JV than TL.

¹¹ We may assume that if both domestic firms give the same offer, the incumbent gets the technology with probability $z \in (0, 1)$ and the entrant gets the technology with probability $(1 - z)$, which may reflect the MNC's preference for a particular domestic firm. However, this modification does not affect our main result as long as $z < 1$.

¹² The reason may be that the third-party enforcer (e.g. the legal system) may have imperfect ability to assess the cost information (see, e.g. Gallini and Wright, 1990).

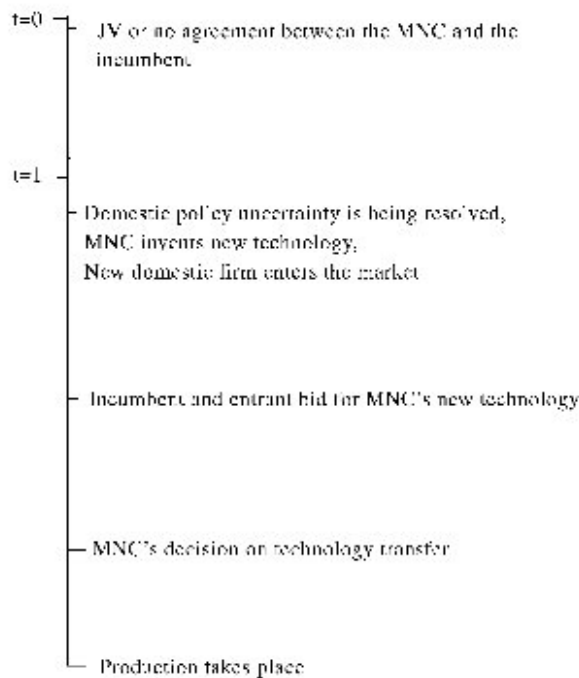


Fig. 1. Sequence of moves of the game.

3. Analysis of the future period

The game in the future period is conditional on what has happened in the current period. The MNC and the incumbent have signed a JV agreement in the current period, or there is no agreement at all. The domestic government at the beginning of the future period ($t = 1$) will either backtrack from the first period's policy and allow only TL and no further JV, or it continues the first period policy, thus allows both TL and new JV formation. Hence, there are four possible scenarios at the beginning of period 1: (1) no JV in period 0 and the domestic government allows only TL in period 1, (2) no JV in period 0 and the domestic government allows both TL and JV in period 1, (3) JV agreement between the MNC and the incumbent in period 0 but the domestic government does not allow further JV in period 1, and (4) JV agreement in period 0 and the domestic government allows both JV and TL in period 1.

When the firms bid for the MNC's technology, neither of the domestic firms knows the exact type of the MNC's technology. So, we consider a screening game where the uninformed domestic firms give offer in such a way that the types of the MNC are revealed. Appealing to Myerson (1979), we consider the contracts that distinguish a MNC with a low-cost technology from the MNC with a high-cost technology. We focus on the separating equilibrium contracts.¹³

¹³ We assume that the MNC with a particular type of technology will opt for the offer intended for the MNC having a different type of technology only when this strategy gives the MNC a positive benefit.

Let $\pi(\hat{c})$ denote the monopoly profit of the project using the technology of the MNC with the marginal cost \hat{c} , $\hat{c} = \{c, c'\}$. To make the threat of imitation credible, we assume that $\pi(c') + I < \pi(c)$, where I is the cost of imitation. This means that under licensing agreement the licensor cannot extract more than a payoff $\pi(c') + I$.

Now we are in a position to solve the game of period 1. First, consider the game under no JV in period 0. We have the following result.

Proposition 1. *Assume that the MNC and the incumbent do not have a JV agreement in period 0. The following outcomes represent the equilibrium offers in the bidding game.*

- (a) *If in period 1 the domestic government does not allow any further JV agreement, each of the incumbent and the entrant will offer two contracts: (i) the payment of only a fixed fee, $\pi(c')$, and (ii) the payment of a fixed fee, $\pi(c')$, and an output based royalty, I , which will be paid if and only if the output exceeds some critical level.*
- (b) *If in period 1 the domestic government allows both TL and new JV agreement, both the incumbent and the entrant will offer two contracts: (i) the TL agreement consists of a fixed fee $\pi(c')$, and (ii) the JV agreement consists of a share α for the MNC and $(1 - \alpha)$ for the domestic firm, and an output based royalty $(1 - \alpha)\pi(c)$, which will be paid if and only if the output of the JV exceeds some critical level.*

Proof. See Appendix A. \square

The above result shows that if there is no JV in period 0, each of the incumbent and the entrant has payoff equal to 0 if the MNC has high-cost technology, c' . Due to the competitive bidding, the entire surplus goes to the MNC when the firms target the high-cost MNC. This occurs irrespective of the policy choice of the domestic government in period 1. Since the low-cost technology can always generate a profit like the high-cost technology, each firm offers the maximum profit corresponding to the high-cost technology, because otherwise, the competitor wins the bid.

Now consider offers to be made by the domestic firms targeting the MNC with a low-cost technology, c . If the domestic government does not allow new JV in period 1, the technology of the MNC can be transferred through TL only, which creates the threat of imitation from the licensee. Therefore, the licensor cannot get any output royalty that exceeds the cost of imitation, I . Hence, neither domestic firm can offer a credible contract consisting of an output royalty more than the cost of imitation. Further, the separating constraint requires that the up-front fixed-fee cannot exceed the maximum payoff generated by the high-cost technology, because otherwise the MNC having the high-cost technology accepts the offer targeting the low-cost MNC. Therefore, in this situation, the winner of the technology is left with a positive profit, $\pi(c) - \pi(c') - I$, that the MNC cannot extract under TL. However, if the domestic government allows new JV in period 1, the domestic firms can invite the MNC for making a JV and transferring the technology through JV. Since JV eliminates the threat of imitation, it eliminates the constraint on the ex-post payment

to the MNC. Therefore, under competitive bidding, the MNC having the low-cost technology extracts the entire surplus generated from its technology, and the domestic firms get zero profit under JV.

So, given that there is no JV in period 0, the payoffs of the incumbent and the MNC in period 1 are as follows. If the government does not allow new JV in period 1, then

$$\pi_i^1 = \pi(c) - \pi(c') - I, \quad (1)$$

$$\pi_m^1 = \pi(c') + I, \quad (2)$$

and if the government continues its policy of period 0, then

$$\pi_i^1 = 0, \quad (3)$$

$$\pi_m^1 = \pi(c), \quad (4)$$

where the superscript denotes the period and the subscript stands for the firm (i implies incumbent and m implies MNC).

Next, consider the scenario where the MNC and the incumbent have signed a JV contract in period 0.¹⁴ The following proposition characterizes the equilibrium of the bidding game when the MNC and the incumbent have formed a JV in period 0 and the domestic government does not allow new JV agreement in period 1.¹⁵

Proposition 2. *Suppose the MNC and the incumbent have formed a JV in period 0, and the domestic government stops approving new JV agreement in period 1. The equilibrium offer of the incumbent and the entrant, targeting the MNC with the high-cost technology (c'), provides the same payoff, $\pi(c')$, to the MNC with the high-cost technology. But, while targeting the MNC with the low-cost technology (c), the incumbent's equilibrium offer always outbids the entrant's equilibrium offer, and the MNC with the low-cost technology gets more than $\pi(c') + I$.*

Proof. See Appendix B. \square

The intuition of the above result is simple. Given that the incumbent and the MNC have formed a JV in period 0, the MNC can eliminate the threat of imitation by transferring the technology to the existing JV. So, when the domestic government does not allow a new JV agreement in period 1, transfer of technology to the entrant can be possible only through TL. In that case if the MNC transfers the technology to the entrant, this creates the threat of imitation and the MNC cannot extract more than $\pi(c') + I$ from the entrant for the technology c , whereas the incumbent can make

¹⁴ Here, we assume that the breakdown of a JV involves negligible cost. Hence, the MNC always has the option to make a new JV with another firm even if it has already formed a JV with the incumbent. See Kabinaj (1999) for the analysis on the breakdown of JVs.

¹⁵ If the government allows new JV agreement in period 1 then, like Proposition 1(b), both firms' offer will be such that the MNC with the low-cost technology gets $\pi(c)$. The difference is that, in this situation, the incumbent offers a fixed fee $\pi(c') - \alpha\pi(c')$ for the MNC with c' technology.

a credible offer which pays the MNC more than the entrant's offer. Since the threat of imitation is eliminated under JV, the contract also eliminates the constraint on the ex-post payment to the MNC. Hence, the incumbent always outbids the entrant while giving an offer targeting the MNC having the low-cost technology. However, if the domestic government allows a new JV agreement in period 1, the entrant can also give an offer to form a new JV with the MNC. This possibility eliminates the incumbency advantage of having a JV with the MNC in period 0 and getting the new technology in period 1, because the competitive bidding, targeting the low-cost MNC, pushes both the domestic firms to their reservation payoffs, and the MNC extracts the entire surplus generated from its technology.

So, given that there is a JV between the MNC and the incumbent in period 0, we have the following payoffs for the incumbent and the MNC. Define

$$e = \alpha\pi(c) - \pi(c') - I.$$

Then, if the domestic government does not allow new JV in period 1

$$\pi_i^1 = \pi(c) - \pi(c') - I - s, \quad (5)$$

$$\pi_m^1 = \pi(c') + I + s, \quad (6)$$

and if the domestic government continues the policy of period 0

$$\pi_i^1 = 0, \quad (7)$$

$$\pi_m^1 = \pi(c), \quad (8)$$

where

$$s = \begin{cases} d, & \text{if } e \leq 0, \\ e, & \text{if } e > 0, \end{cases} \quad (9)$$

and d is a very small positive quantity that the incumbent offers to the MNC to outbid the entrant.

4. Current period decision

Now estimate the expected payoffs of the incumbent and the MNC from their first period decision under no-collaboration (NC) and JV. Recall that r is the probability that the domestic government backtracks in the future from the present policy and both the incumbent and the entrant believes with probability p that the technology of the MNC is a low-cost technology.

So, when the MNC and the incumbent do not make a JV in period 0, the payoffs of the MNC having the low-cost technology and the incumbent are, respectively

$$\pi_m(\text{NC}) = \delta[r(\pi(c') + I) + (1 - r)\pi(c)], \quad (10)$$

$$\pi_i(\text{NC}) = \delta\frac{1}{2}pr(\pi(c) - \pi(c') - I), \quad (11)$$

where $\delta \in (0, 1]$ is the discount factor.

Similarly, the payoffs of the MNC having the low-cost technology and the incumbent when they form a JV in period 0 are, respectively

$$\pi_m(\text{JV}) = \delta[r(\pi(c') + I + s) + (1 - r)\pi(c)], \quad (12)$$

$$\pi_i(\text{JV}) = \delta pr(\pi(c) - \pi(c') - I - s), \quad (13)$$

where s has been defined in Eq. (9).

The following proposition gives our basic result.

Proposition 3. *Assume $p > 0$, $r > 0$ and $\pi(c) > \pi(c') + I$. Then the MNC and the domestic incumbent can always find it mutually profitable to form a JV in the first period.*

Proof. See Appendix C. \square

First of all, note that if $\pi(c) \leq \pi(c') + I$, imitation is not a credible threat. So, the MNC is always successful to extract the entire surplus from its technology irrespective of the domestic policy, leaving no incentive for the incumbent to go for a JV in the first period. But, when $\pi(c) > \pi(c') + I$, the MNC cannot extract the entire surplus from its technology under TL. The existence of a potential entrant in the future period means that the incumbent may not necessarily get the MNC's technology in the future. But if the incumbent forms a JV with the MNC in the current period, the incumbent gets the strategic advantage over the entrant while bidding for the MNC's technology in the future. However, without the threat of entry, the incumbent always gets the MNC's technology and, therefore, has no incentive for a JV in the current period.

The possibility of a domestic policy reversal is also important for the incumbent's decision. If $r = 0$, that is, if the government could credibly commit that it would continue the present policy, the incumbent does not get the strategic advantage from JV. Hence, the incumbent has no incentive for forming a JV in the current period.

Incomplete information about the MNC's technology (i.e. $p \neq 1$) means that the MNC has to sacrifice some profits under licensing. Hence, JV formation helps the incumbent to commit that the MNC can extract higher surplus from the JV for its technology if it is allowed to make only the licensing contract with the entrant. This ensures that, in this situation, the incumbent certainly gets the technology in the future period, which provides the incentive for a JV in the current period.

Therefore, policy uncertainty along with the opportunistic behavior of the firms can create an option value for setting up a JV in the current period when the firms expect entry in the future period. However, if the government continues the policy of the present period, this option from setting a JV does not create a value in the future.

5. Alternative assumptions

In this section we review our results under alternative assumptions. First, consider the form of the demand function. We have developed our analysis with the reduced form profit

expressions. Hence our results do not depend on the particular form of the demand function.

Let us now relax the assumption of zero fixed cost. If the project involves a fixed cost to be spent once-for-all, the incumbent incurs the cost at $t = 0$, whereas the entrant will have to incur the cost at $t = 1$. Since at $t = 1$ the fixed cost is already sunk to the incumbent, the incumbent can always outbid the entrant by giving a better offer. So, the existence of a fixed cost gives the incumbent an additional advantage while bidding at $t = 1$. This in turn eliminates its incentive for forming a JV at $t = 0$. But, if the fixed cost is fixed per period, or is (foreign) technology specific, then such a cost has to be incurred by both the incumbent and the entrant in the future period, and they become symmetric in the future period without any JV in the current period. Hence, our results hold under these types of fixed costs of production.

We have done our analysis under the assumption that there is no possibility of complete liberalization or nationalization in the future period. If the domestic government allows complete liberalization in the future period, the MNC opens its own subsidiary in the future period and becomes a monopoly in the market. So, in this situation, a JV formation in the current period does not give the incumbent any benefit. Similarly, if the domestic country does not allow continuing the previously formed JV in the future, the MNC can transfer its technology through licensing only. Again, in this situation, the incumbent does not get any benefit in the future period from a JV formed currently. Hence, both these possibilities reduce the incentive for JV. But, as long as there is a possibility that the domestic government does not allow a *new* JV agreement in the future, the JV in the current period creates an option value and provides the incentive for forming a JV in the current period. The possibility of complete liberalization and nationalization reduce the value from creating a JV in the current period, but do not eliminate the incentive for a JV completely.

6. Conclusion

The literature on international JVs discusses various aspects behind the formation of a JV between two firms across borders. However, sometimes the firms of developing countries seek to form JVs with the foreign MNCs in anticipation of future benefits has not been properly addressed so far in the literature. Recent surveys support the view that many Indian firms give high importance on getting the MNC's superior technologies in the future as a reason for forming JVs today. The present paper is an attempt to theorize this empirical observation.

Although the purpose of getting a better technology is necessary for such a contract, it may not provide sufficient incentives for the formation of a JV in the current period. This paper identifies the factors that lead to the formation of a JV in anticipation of receiving a top-of-the-line technology in the future. We have shown that if the domestic government cannot fully commit to the future policy and there is a possibility of new entry in the future period, the existing firm finds it strategic advantage to form a JV with the MNC, which is expected to bring a superior technology in the future. The informational problem about the MNC's technology, along with the possibility of imitation by the domestic firms, prevents

the MNC to extract the entire surplus under TL. Given the positive probability that the domestic government may not allow a new JV in the future, the incumbent strikes a JV deal in the current period with the hope that it will outbid the potential entrant in the future period and get the surplus that the MNC cannot extract.

Appendix A. Proof of Proposition 1

(a) Assume that there is no JV in period 0, and in period 1 the host government does not allow new JV. Then licensing is the only option in period 1. Since the high-cost technology of the MNC generates a maximum profit, $\pi(c')$, no host-country firm is willing to pay more than this amount to the technology supplier. Again, no firm will offer less, because otherwise the other firm will give a better offer and win the bid. Hence, offering an up-front fixed fee of the amount $\pi(c')$ to target the MNC with high-cost technology is the unique Nash equilibrium of the bidding game.

Now we show that a separating contract provides the MNC with low-cost technology a maximum payoff, $\pi(c') + I$, where $\pi(c')$ is the up-front fixed fee and I is output based lump-sum royalty which is paid to the MNC if and only if the output produced exceeds a certain critical level. Such an offer satisfies the rationality constraint, separation constraint and the no-imitation constraint.

The separating contract implies that the up-front fixed fee cannot exceed the maximum payoff generated by the high-cost technology, i.e. $\pi(c')$, since otherwise, the high-cost MNC will have an incentive to pretend as low-cost MNC.

If the royalty payment exceeds I , the licensee will have the incentive to imitate the MNC's low-cost technology. Hence, no imitation constraint implies that the amount of the output royalty cannot be more than I . The corresponding royalty payment must satisfy

$$\int_{\bar{q}}^{q^*} (mr(q) - c) dq = I, \quad (A1)$$

where $mr(q)$ is marginal revenue, \bar{q} is the critical output level and q^* is the monopoly output with marginal cost of production c . If $\bar{q} = 0$, the left-hand side (LHS) of Eq. (A1) exceeds the right-hand side (RHS) of Eq. (A1), and if $\bar{q} = q^*$, then the LHS of Eq. (A1) is less than the RHS of Eq. (A1). Therefore, the continuity property ensures the existence of \bar{q} . Then if the MNC having a high-cost technology mimics the offer, the licensee produces up to \bar{q} , because if a licensee having low-cost technology is indifferent between producing \bar{q} and q^* , then a licensee having high-cost technology strictly prefers to produce at \bar{q} . Therefore, the MNC having high-cost technology does not get any royalty payment. Note that the participation constraint of each domestic firm requires that $I \leq \pi(c) - \pi(c')$. Therefore, imitation is a credible threat under assumption $\pi(c') + I < \pi(c)$.

Then in the Nash equilibrium of the bidding game each host-country firm must offer $\pi(c') + I$ while targeting the low-cost MNC, otherwise, the competitor can outbid the other firm by giving a slightly better offer. So, in equilibrium each firm has two offers: (i) the one with an up-front fixed fee $\pi(c')$, and (ii) the other with an up-front fixed fee $\pi(c')$ and an

output based royalty I . The MNC accepts either the fixed fee offer if it has c' technology or accepts the other offer.

(b) Now, consider the case of no JV between the MNC and the incumbent in period 0, but the host government allows both JV formation and TL in period 1. Then in case of TL, following the argument of the case (a) above, both the domestic firms will offer an up-front fixed fee $\pi(c')$ for the high-cost MNC, and $\pi(c') + I$ for the low-cost MNC.

In contrary, since there is no threat of imitation under JV, the domestic firms can now push the offer up to $\pi(c)$, where a part will be paid as equity income (i.e. $\alpha\pi(c)$) subject to the government restriction on the equity holding, and the remaining part $(1 - \alpha)\pi(c)$ as output royalty when output exceeds a critical level. If the MNC having the high-cost technology accepts the JV contract, then the output of the JV firm will be up to this critical level, and the MNC will not receive any royalty payment. Further, due to the MNC's shareholding up to α , the MNC having the high-cost technology can get $\alpha\pi(c')$ as the maximum amount under JV, whereas it gets $\pi(c')$ from the licensing contract. Since, this type of JV contract will be accepted only by the MNC having the low-cost technology, this contract also satisfies the rationality constraint for the host-country firms.

Hence, in equilibrium both the host-country firms will offer $\pi(c)$ under JV, and since $\pi(c) > \pi(c') + I$, the JV agreement will strictly dominate the licensing contract.

Therefore, the host-country firms will give a TL offer with an up-front fixed-fee targeting the high-cost MNC and a JV offer with equity sharing and output royalty targeting the low-cost MNC. \square

Appendix B. Proof of Proposition 2

Here, the host government does not allow any new JV agreement in period 1, and the MNC and the incumbent have formed a JV in period 0. Then the entrant has the option of TL agreement only. Under competitive bidding the entrant will offer two contracts for the licensed technology: one contract targeting the high-cost MNC consists of an up-front fixed fee, $\pi(c')$, and the other contract targeting the low-cost MNC consists of an up-front fixed fee, $\pi(c')$, and an output based royalty, I . Any other contract targeting the MNC with low-cost technology does not satisfy the condition for separating equilibrium and no-imitation by the entrant.

Now, consider the incumbent targeting the MNC with high-cost technology. It will give the offer with an output-based royalty $\pi(c') - \alpha\pi(c')$, where the royalty will be paid if the output of the JV does not exceed the optimal output corresponding to the high-cost technology of the MNC. (Note that this type of contract makes sense since the management of the JV chooses output to maximize profit of the JV.) The MNC having the high-cost technology will choose the buyer randomly.

Given that JV is formed in period 0 and the technology is transferred to the JV, there is no threat of imitation. If the incumbent targets the MNC with low-cost technology, its equilibrium offer will be the following: the incumbent can credibly offer an output based royalty of the amount $\pi(c') + I + d - \alpha\pi(c)$, where $d > 0$ (and very small) is paid to

outbid the entrant whenever $\alpha\pi(c) \leq \pi(c') + I$. This royalty will be paid if the output of the JV exceeds the optimal output corresponding to the high-cost of technology of the MNC. When $\alpha\pi(c) > \pi(c') + I$, the incumbent does not need to offer any royalty payment, and the incumbent outbids the entrant. Therefore, the incumbent gets the technology, and the MNC gets more than $\pi(c') + I$. \square

Appendix C. Proof of Proposition 3

Comparing Eqs. (10) and (12), we have $\pi_m(\text{JV}) > \pi_m(\text{NC})$. Hence the MNC strictly prefers JV to NC in the first period. So, there will be JV in the first period if and only if the incumbent also prefers JV to NC. Now comparing Eqs. (11) and (13), we have $\pi_i(\text{JV}) > \pi_i(\text{NC})$ if and only if

$$\text{pr}[(\pi(c) - \pi(c') - I - s) - \frac{1}{2}(\pi(c) - \pi(c') - I)] > 0,$$

since $\delta > 0$. Given s as defined in Eq. (9), there always exists some $s > 0$ (and hence $\alpha < \bar{\alpha}$) such that the above condition holds. \square

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