

163  
23.12.05

International Joint Ventures and Technology Transfer in Developing  
Economies: Theoretical Analyses

Arijit Mukherjee

A thesis submitted to the **Indian Statistical Institute** in Partial Fulfillment of the  
Requirements for the award of the degree of **Doctor of Philosophy**

*Indian Statistical Institute*  
*Calcutta, 1998*

|                                 |                                |
|---------------------------------|--------------------------------|
| Foreword                        | 1                              |
| Introduction                    | 1                              |
| Literature Review               | 1                              |
| 1.1 International Joint Venture | 1                              |
| 1.2 Technology Lic              | 1                              |
| Outline of the Dissertation     | 1                              |
|                                 | <i>To My Mother And Father</i> |

## 1 Venture for Difference in Perception

|                   |   |
|-------------------|---|
| Introduction      | 1 |
| Model and Results | 1 |
| Conclusion        | 1 |

## 2 Technology Transfer and Joint Venture under Asymmetric Information

|                               |   |
|-------------------------------|---|
| Introduction                  | 1 |
| Problem with two technologies | 1 |
| Problem with one technology   | 1 |
| Conclusion                    | 1 |

## 3 Are Benefits One Motive for Joint Venture Formation

|              |   |
|--------------|---|
| Introduction | 1 |
| Model        | 1 |
| Conclusion   | 1 |

## 4 Country Policy: Commitment or No-Commitment

|              |   |
|--------------|---|
| Introduction | 1 |
| Discussion   | 1 |



# Contents

|                                                                             |           |
|-----------------------------------------------------------------------------|-----------|
| <b>Preface</b>                                                              | <b>3</b>  |
| <b>1 Introduction</b>                                                       | <b>5</b>  |
| 1.1 Literature Review                                                       | 7         |
| 1.1.1 International Joint Venture                                           | 7         |
| 1.1.2 Technology Licensing                                                  | 14        |
| 1.2 Outline of the Dissertation                                             | 15        |
| <b>2 Joint Venture for Difference in Perception</b>                         | <b>17</b> |
| 2.1 Introduction                                                            | 17        |
| 2.2 Model and Results                                                       | 19        |
| 2.3 Conclusion                                                              | 24        |
| <b>3 Technology Transfer and Joint Venture under Asymmetric Information</b> | <b>25</b> |
| 3.1 Introduction                                                            | 25        |
| 3.2 Problem with two technologies                                           | 27        |
| 3.3 Problem with one technology                                             | 33        |
| 3.4 Conclusion                                                              | 38        |
| <b>4 Future Benefit: One Motive for Joint Venture Formation</b>             | <b>39</b> |
| 4.1 Introduction                                                            | 39        |
| 4.2 Model                                                                   | 41        |
| 4.3 Conclusion                                                              | 48        |
| <b>5 Host-Country Policy: Commitment or No-Commitment</b>                   | <b>50</b> |
| 5.1 Introduction                                                            | 50        |
| 5.2 Bargaining power                                                        | 51        |
| 5.3 Technology choice                                                       | 56        |
| 5.3.1 Single technology                                                     | 56        |
| 5.3.2 Multiple technologies                                                 | 59        |
| 5.4 Conclusion                                                              | 61        |

|                   |                                                                 |            |
|-------------------|-----------------------------------------------------------------|------------|
| <b>6</b>          | <b>Pre-commitment and Technology Transfer</b>                   | <b>63</b>  |
| 6.1               | Introduction . . . . .                                          | 63         |
| 6.2               | Commitment by capacity installation . . . . .                   | 65         |
| 6.2.1             | Commitment by one firm . . . . .                                | 65         |
| 6.2.2             | Technologically efficient firm commits . . . . .                | 66         |
| 6.2.3             | Technologically inefficient firm commits . . . . .              | 68         |
| 6.2.4             | Commitment by both firms . . . . .                              | 69         |
| 6.3               | Commitment by incentive delegation . . . . .                    | 70         |
| 6.3.1             | Commitment by one firm . . . . .                                | 71         |
| 6.3.2             | Only technologically efficient firm hires a manager . . . . .   | 71         |
| 6.3.3             | Only technologically inefficient firm hires a manager . . . . . | 72         |
| 6.3.4             | Both firms hire a manager . . . . .                             | 72         |
| 6.3.5             | Zero cost of hiring a manager . . . . .                         | 72         |
| 6.3.6             | Positive cost of hiring a manager . . . . .                     | 73         |
| 6.4               | Conclusion . . . . .                                            | 76         |
| <b>7</b>          | <b>Bilateral Agreements in Oligopoly</b>                        | <b>78</b>  |
| 7.1               | Introduction . . . . .                                          | 78         |
| 7.2               | Model . . . . .                                                 | 79         |
| 7.3               | Conclusion . . . . .                                            | 84         |
| <b>8</b>          | <b>Summary and Future Extension</b>                             | <b>85</b>  |
| <b>Appendix A</b> |                                                                 | <b>87</b>  |
| A. 1              | Proof of Lemma 6.2.1 . . . . .                                  | 87         |
| A. 2              | Proof of Proposition 6.2.1 . . . . .                            | 87         |
| A. 3              | Proof of Proposition 6.2.2 . . . . .                            | 88         |
| A. 4              | Proof of Lemma 6.3.1 . . . . .                                  | 88         |
| A. 5              | Proof of Lemma 6.3.3 . . . . .                                  | 89         |
| A. 6              | Proof of Lemma 6.3.4 . . . . .                                  | 90         |
| <b>Appendix B</b> |                                                                 | <b>92</b>  |
| B.1               | Proof of Proposition 7.2.1 . . . . .                            | 92         |
| B.2               | Proof of Proposition 7.2.2 . . . . .                            | 92         |
| B.3               | Proof of Proposition 7.2.3 . . . . .                            | 92         |
| <b>Figures</b>    |                                                                 | <b>101</b> |
| <b>Table</b>      |                                                                 | <b>107</b> |

# Preface

Since the second half of the 80's, most of the developing countries have started liberalizing and opening up their economies. Such liberalization finds suitable expression in terms of gradual removal of tariff barriers, liberal inflow of foreign capital and technology, etc. Technological collaboration and international joint ventures are key forms of arrangements which characterize the liberalization process in the developing world. This dissertation "International Joint Ventures and Technology Transfer in Developing Economies: Theoretical Analyses" attempts to provide a systematic analysis of international joint ventures and deals with strategic aspects of technology transfer which usually accompanies such joint venture agreements. Both theoretical and empirical literature motivate us to look at these issues.

This project started when I joined the Indian Statistical Institute, Calcutta, as a research scholar. I consider myself extremely fortunate to have Professor Sugata Marjit as my thesis supervisor with whom I shared my thoughts from the very beginning. His advice and encouragement throughout the period of my research activity were always a big support to me. I never felt insecure under his kind supervision and it was a real pleasure to work with him.

I am also fortunate to have Dr. Tarun Kabiraj at Indian Statistical Institute, Calcutta, as one of my teachers and co-authors of some of my papers. I am grateful to him for his suggestions and insightful comments on my research. His friendship and guidance was a constant source of support and encouragement to me and my thesis.

During the period of my research I have greatly benefited from numerous stimulating discussions with Professor Abhirup Sarkar and Professor Mihir K. Rakshit of Indian Statistical Institute, Calcutta, Professor Amitava Bose of Indian Institute of Management, Calcutta, Dr. Sharmila Banerjee of University of Calcutta and Professor Sudipto Dasgupta, Professor Kunal Sengupta, Dr. Krishnendu Ghosh Dastidar and Dr. Prabal Ray Chaudhuri of Jawaharlal Nehru University. Their comments and suggestions on various aspects of this work have helped me to improve my understanding of the subject and give a concrete shape to my disjoint thoughts.

I would like to thank the conference participants of the 5th and the 6th Annual Conferences, Jadavpur University, Calcutta, the International Conference on Game Theory and Economic Applications, Bangalore, 1996 and the UGC sponsored National Conference on Contemporary Issues in Economic Theory and Policy, Burdwan University, 1997, for their helpful comments and suggestions during my presentations of the ongoing research works.

I would like to acknowledge the financial support that I received from Indian Statistical Institute, in the form of fellowship during the period of my stay at Indian Statistical Institute, Calcutta. I have benefited from the scientific and friendly atmosphere at Indian Statistical Institute, Calcutta. Thanks are also due to all my teachers and other scientific and non-scientific workers at Indian Statistical Institute.

I would like to thank all my friends, particularly, Sukanta Bhattacharya, Brati Sankar Chakraborty, Samarjit Das, Kaushik Bhattacharya, N. Balasubramanian, Atanu Sengupta, Diganta Mukherjee, Manisha Chakraborty, Suchismita Bose (Ghose), Rajlakshmi Mallick, Aniruddha Bagchi and Soumyananda Dinda for sharing many wonderful moments at the Indian Statistical Institute, Calcutta.

Finally, I express my deep gratitude and respect to my mother and father. Whatever I have achieved so far would not have been possible without their love, affection, encouragement and blessings. I owe everything to them.

Arijit Mukherjee  
Indian Statistical Institute, Calcutta, India  
May, 1998.

# Chapter 1

## Introduction

Economic development is a continuous process of improvement and upgradation of the existing technological knowledge and their applications. This can be done in more than one way. Countries can acquire superior knowledge through a risky process of self-financed indigenous innovation. This may, however, be proved to be an expensive and time consuming process.<sup>1</sup> Direct and indirect import of technologies are other ways of getting advanced knowledge. Technological change that has been taking place in most of the developing countries is partly the result of import of technologies from the industrially advanced economies. Multinational companies (MNCs) may potentially act as agents in transferring knowledge from the developed to developing countries. Generally they transfer their superior technologies through 'licensing' contracts, through 'joint venture's (JVs) with firms of developing countries or through fully owned foreign subsidiaries.

There is a vast literature dealing with foreign direct investment and multinationals (see, Ethier, 1986, Rugman, 1986, Horstmann and Markusen, 1987a, 1987b, Caves, 1996, etc.). While these works are mainly concerned with the problems of informational asymmetry and/or the existence of some firm-specific assets, some researchers have examined the incentives for foreign direct investment when there are transaction costs associated with arm's length arrangements such as licensing. Rugman (1981, 1986) provides specific discussions on this issue while Williamson (1981) gives a more general view. One can find a nice survey on this topic in Markusen (1995). Though these works focus on arm's length arrangements such as licensing and on the fully owned foreign subsidiaries, the analytical literature on foreign investment, surprisingly, pays relatively little attention to another important organizational form of foreign investment, known as international JV. International JV is a frequently observed form of foreign investment visible in the developing countries (see, Hladik, 1985, Beamish, 1988, Korbin, 1988, etc.). Often, due to local regulatory laws, the MNCs cannot operate fully owned subsidiaries but have to form a JV with domestic firms. Equity participation by both foreign and domestic firms in investment projects is evident in empirical studies (eg., see Tomlinson, 1970 and Killing, 1983). These studies have

---

<sup>1</sup>Myrdal (1981) has dealt with the problems and prospects of technology transfer to developing countries.

focused on wide range of issues, viz., reasons for forming JVs, attitude towards JV control, JV as means of technology transfer, effects of differences in parental size, reasons for selecting specific associates, nature of business involved, etc. Analytical literature on international JVs based on rigorous economic modeling is small but growing. Interesting applications of game theoretic models and principal-agent framework are being made to clarify and analyze certain stylized facts. Hence, we feel the need to have a fresh theoretical look at the issues related to international JVs.

Unlike the literature on international JVs, there already exists a vast literature on technology licensing. Under the technology licensing, technologically superior firm sells its technology to the technologically backward firm and charges an appropriate price for the transferred technology. The researchers are mainly concerned with the feasibility of technology transfer, quality of the licensed technology, optimal patent licensing contract, concentration effects of technology transfer, impact of the possibility of technology licensing on innovation, etc. (see, Gallini, 1984, Katz and Shapiro, 1985, Gallini and Winter, 1985, Rockett, 1990, Gallini and Wright, 1990, Marjit, 1990b, Kabiraj, 1993, 1994, Kabiraj and Marjit, 1992a, 1992b, 1993, Singh, 1992, Eswaran, 1993, Lin, 1996, etc.). Some of these studies focus on situations where the licensor and the licensee do not compete in the same market and others incorporate licensing in a market characterized by competition between the licensor and licensee. While this literature has focused on strategic aspects underlying technology licensing agreements, it has mostly concentrated on duopoly situation. However, the importance of number of firms in an industry may be also important to shape the strategic interaction of the players (see Salant et al., 1983, Perry and Porter, 1985, Kamien and Zang, 1990, etc.). Further, sometimes an action taken before the choice of output or price may give a firm strategic advantage in the product market against its competitor(s) (see Spence, 1977, Dixit, 1980, Fershtman and Judd, 1987, Basu, 1993, 1995, Basu and Singh, 1985, 1990, etc.). These factors have important implications for the payoffs of the competing firms. Their other activities, eg., the decision on technology licensing, too may be affected with the presence of these factors. But, to the best of our knowledge, no one has attempted to look at the effect of pre-commitment and the number of competitors in the product market while considering technology licensing in a market with strategic behavior. In our analysis we highlight the importance of these factors in the context of technology licensing and evaluate their implications. Though these problems may not have any special significance for the developing economies, the basic assumption of asymmetric technology is more likely to be valid for contrasting firms of developed and developing nations. Further, the particular licensing arrangements considered here may be more relevant in case of licensing to a firm of a developing country.

Rest of this chapter will be divided in two parts. First, we shall provide a brief literature review on international JV and technology licensing. In the second part, we shall provide an outline of the remaining chapters of this dissertation.

## 1.1 Literature Review

### 1.1.1 International Joint Venture<sup>2</sup>

Recently the importance of international JVs has increased dramatically. Hladik (1985) demonstrated that among U.S.-based multinationals, the percentage of JVs - as opposed to fully owned subsidiaries - increased from 48% in 1951-55 to 75% in 1973. While Beamish (1988) observed that international JVs grew by 59% between 1981 and 1983, Korbin (1988) showed that in some less developed countries, nearly 80% of total foreign capital enter through JVs. Since its economic reforms in July 1991, India too has experienced a sharp increase in financial collaboration between Indian and foreign firms (see, Gupta and Chawla, 1995).

Recently, researchers from different fields are taking more and more interest in analyzing the issues on international JVs. International JVs in developing countries inevitably lead to the discussions of technology transfer, patent protection, trade policies in the transition economies, trade related investment measures, etc. Often the uncertainty in the government policy making may be the driving force behind forming a JV between foreign and domestic firms. When the government of a country cannot commit to a particular policy, which is a predominant character of a developing economy (particularly in the transition phase of liberalization), a suitably made JV between foreign and domestic firms may reduce the risk of policy uncertainty. On the other hand, the government policy itself, can be affected by formation of JVs. Papers by Marjit (1990a), Abdalla (1992), Broll and Marjit (1995), Das (1995, 1996) and Al-Saadon and Das (1996) fall in this area. These papers except Al-Saadon and Das (1996) focus on the JVs that result from the threat of expropriation and tax uncertainty. The work by Al-Saadon and Das (1996) show how the government policy uncertainty and transfer pricing of inputs by the multinational firm influence equity distribution in a JV and the welfare of a domestic country.

Marjit (1990a) and Abdalla (1992) focus on the issue of expropriation threat faced by a foreign firm while investing in other countries. Employing an infinite period game, Marjit (1990a) shows that a host government by forming a JV with a foreign firm can attract foreign investment, otherwise foreign investment will not come due to the threat of expropriation. A suitably made public-private JV reduces the gain from expropriation to the local government and induces the foreign firm to invest. More specifically, if  $I^0 > \frac{T^*}{(1-\delta)}$ , where  $I^0$ ,  $T^*$  and  $\delta$ , are the optimal investment of the project, lump sum tax payment and discount factor respectively, then expropriation is profitable which in turn will deter investment. Here  $I^0$  shows the gain from expropriation which is greater than discounted tax payment. But a suitably made public-private JV with  $\theta$  as the investment and profit share of the foreign firm can change the above condition to  $\theta I^0 \leq \frac{T^*}{(1-\delta)}$ ; this JV makes expropriation less profitable than discounted tax receipts and encourages foreign firm to invest in the JV.

In a model with complementary inputs provided by both firms, Abdalla (1992) shows that

---

<sup>2</sup>This section is heavily based on Marjit, Mukherjee and Kábiraj (1997b).

threat of expropriation reduces the optimal input choice of the firm facing the threat. This in turn affects the optimal input choice of the other party. Further, this threat of expropriation increases lump sum payments to be made to the domestic firm (who does not face that threat) by the foreign firm (who faces that expropriation threat).

Works by Broll and Marjit (1995) and Das (1995, 1996) show the importance of JV to eliminate the problem of tax policy uncertainty. The first paper shows that with or without uncertainty in the government's tax policy, a public-private JV is Pareto dominant to a 100% owned foreign subsidiary. An interesting feature of the analysis is that investment share and profit share are different. A lower share of profits of the government than its investment helps to reduce the burden of the distortive taxes. In particular, consider  $\theta_1 = \frac{\theta_2}{(1-t)}$ , where  $\theta_1, \theta_2$  and  $t$ , are foreign firm's profit share, foreign firm's investment share and tax rate (actual or expected). Then the JV generates a zero tax rate equivalent investment which is greater than the level of investment under 100% foreign subsidiary. While this JV makes foreign firm indifferent between JV and no JV, it increases government's payoff.

Das (1995) considers a situation where the project needs two inputs - one of them is specific to foreign firm (which cannot be contracted at arm's length) but the other input can be produced by the local firm more efficiently than the foreign firm. This paper considers a JV between two private firms with equal investment and profit sharing. With policy hazard (i.e., where the host government sets its (sales) tax rate after the entry decision of the foreign firm) the paper shows that JV reduces the tax rate charged by the government, which in turn generates more profit for the project. Hence, in the presence of policy moral hazard, JV is the preferred option. In a related work, Das (1996) has analyzed the importance of JV when the foreign firm has also licensing option along with JV and fully owned subsidiary. The paper assumes that the foreign firm is less risk averse compared to the local firm. Greater risk averseness of the local firm draws compensation to the local firm. Assuming zero bargaining power of the local firm and no moral hazard problem on the part of the foreign firm, Das (1996) shows that without any policy hazard licensing is always dominated by JV and also JV dominates the fully owned subsidiary if the risk associated with the project is not sufficiently high. For sufficiently high risk aversion, the local firm needs high risk premium. This reduces the surplus for the foreign firm. But for the lower degree of risk faced by the firm, the advantage of getting an input from the local firm more efficiently outweighs the compensation required by the local firm and makes the JV better option than the fully owned subsidiary. But in case of policy hazard, licensing will dominate JV if the riskiness is too low. When riskiness is too low, the local firm needs little risk premium but it will help to reduce policy hazard. This policy advantage effect makes licensing better option than JV.

In the above mentioned papers JV formation comes as strategic response to the policy uncertainty. Singh and Bardhan (1991), Qiu and Tao (1995) and Al-Saadon and Das (1996) show how the action of the parents in a JV affects or is affected by the government policy.



Singh and Bardhan (1991) paper has studied the effects of multinational rivalry on host country policies under the situations when the local-foreign JV produces an intermediate goods or when it produces a final goods. In case of JV in intermediate goods, the foreign partner of the JV uses the intermediate goods to produce its final output and in the final goods market the foreign partner of the JV competes with another foreign firm with differentiated products. In this situation, the host government prefers 'complete indigenization' (i.e., 100% local ownership) when JV sets price of the intermediate goods as an 'autonomous subsidiary' or local firm sets this price; but if the price of the intermediate goods are set by the foreign parent, the JV profit will be zero as the foreign firm sets marginal cost price for the intermediate goods. So, it does not matter what the foreign firm's share is. If the JV acts as an 'autonomous subsidiary' then the controlling firm will be interested with the JV's profit only rather than foreign firm's global profit. This induces the host government to set highest possible share of the JV for the local firm when JV acts as an 'autonomous subsidiary'. But if foreign partner sets the price for intermediate goods the foreign partner will be interested to maximize its global profit which in turn implies that it will set marginal cost price for the intermediate goods where this marginal cost of production (price of labor in the paper) set by the domestic government will be less as competition between foreign firms in the final goods increases. This implies that when JV firm is controlled by the foreign firm, the local government will set wage rate less under price competition than under quantity competition. With price competition, if the costs of foreign (JV) partner go up, both the firms in the final goods market increase price. On the other hand, with quantity competition, if the costs of the foreign (JV) partner increase, its output in the final goods market is reduced and the output of its competitor is increased. It turns out that this indirect negative effect is sufficiently smaller in magnitude for quantity competition than for price competition. This induces the host government to choose a lower wage rate in case of price competition between the two foreign firms in the final goods market than in quantity competition. In contrast to JV in intermediate goods, they have showed that if the JV produces final goods and the foreign partner competes (in prices) with another foreign firm in supplying an input in the JV, the host government may not prefer 'complete indigenization' when JV is concerned with its profit only, but the government will prefer (almost) 'complete indigenization' when JV maximizes global profit of the foreign firm. Thus they focus on the importance of the multinational rivalry as well as on the nature of production (intermediate or final goods) of JV on the host government's policy.

Qiu and Tao (1995) show the effect of international JV in the R&D stage on the government's subsidy/tax policy. They employ a duopoly model with two-firms of different countries competing in the final goods market, and show how the cooperation in the R&D stage which precedes the output stage of these firms affects government's policy of each country. They show that even with no spillover of R&D outcome the optimal R&D subsidy rate and the equilibrium R&D investment are higher under cooperative R&D than non-cooperative R&D but welfare is

higher under non-cooperative R&D than cooperative R&D. Under cooperative R&D, strategic benefit from subsidization weakens, but at the same time cooperative R&D makes the incentives of the government and firm divergent since the government is concerned with its country's welfare, whereas firms care their competitor's profit also. This type of cooperation increases the incentive of the firms to allocate their R&D investments in favor of more cost efficient firm. This induces the government to raise its subsidy. In equilibrium, the second motive, called 'asymmetric motive', dominates the first one, called 'strategic motive'. So, the equilibrium subsidy rate and R&D investments increase. This excessive subsidization reduces welfare. Further, consumers of the host country are not benefited as the firms, by assumption, compete in the third market. However, cooperation at the government level may change the optimal government policy from subsidization to taxation or laissez faire. When governments' of the two countries cooperate fully, the 'asymmetric motive' is to tax R&D. This dominates the 'strategic motive' of subsidization. But for full cooperation in both levels both these motives disappear and laissez faire comes as an optimal policy.

Al-Saadon and Das (1996) address the issue of equity distribution between the firms in a JV when there is a commitment problem on the government's part (for setting production or excise tax) or on the foreign firm's part (for setting transfer pricing). The main point of this paper is that the participating firms and the government of the host country would prefer no-commitment strategy to commitment strategy with respect to transfer pricing and tax policy respectively. No-commitment helps to attract more profit to the concerned partner and increases its utility.

Sometimes JVs are formed to eliminate the informational problem. Chan and Hoy (1991) and Choi and Maldoom (1992) fall in this group. The papers show the importance of buyback contracts when each firm provides complementary inputs whose quality levels are non-contractible. Chan and Hoy (1991) show that a buyback contract in conjunction with minimum standard requirements which can be verified at the beginning of production period reduces the moral hazard problem. Choi and Maldoom (1991) address the question of why buybacks occur at all. They have explained the dominance of buyback contracts over 'market allocated' contract. The 'market allocated' contract imposes more constraint on the problem as under this contract any shirking in quality levels will be adjusted through output allocation after the production takes place. But in case of the buyback contract the output allocation is fixed ex ante. Any shirking from the optimal quality level is more costly which in turn reduces the problem of shirking and makes the buyback a more useful arrangement.

In their paper, Marjit, Broll and Mallick (1995) show that a JV between a foreign firm and the domestic government can improve the situation when the foreign firm becomes skeptical about the project's return. Recently, Marjit and Broll (1997) have argued that when forward exchange markets are not well developed, JV may be preferred by the foreign investor to mitigate risks due to fluctuations in the exchange rate. This is important when the foreign investors serve the local market. In the absence of proper risk-sharing institutions, foreign firms may use JV

as the second best alternative.

One important issue in the literature of JV is transfer pricing. Using a Nash bargaining approach Svejnar and Smith (1984) have addressed the issue of transfer pricing and distribution of JV profit between the parents in detail. They also examine the passive and active role of the domestic government. If the government acts as a passive agent, the parents can minimize the burden of taxes on foreign firm's share of profit by making the foreign firm's declared share zero, or, more likely, by adjusting the transfer prices so that the declared profit is zero. But the parents use the actual cost of inputs, rather than transfer prices, in their criterion for factor allocation. However, the introduction of a tax on the input supplied by the foreign parent affects the input allocation in the JV. In contrast, when government acts as an active agent, parents allocate resources in such a way that even for input(s) on which the government collects the tax, the value of marginal product is equated to the actual cost of input. Here the JV maximizes the (weighted) product of the utilities of all three parents. So the JV takes care of the interest of an income-maximizing government and acts in such a way that it generates the largest possible total profit. However, each agent gets its profit share according to their bargaining power rather than the specified equity share. As long as the agent's objective function includes share of profit, JV's criterion for resource allocation will be independent of the bargaining power of the agents. But as an active agent if the government cares only for resource allocation of the JV and gives no weightage on its share of profit, the government's bargaining power will affect JV's criterion for resource allocation. Falvey and Fried (1986) examine the interaction between national ownership requirements and transfer pricing. Indigenization or national ownership requirement is shown as a policy to combat transfer pricing. When indigenization implies managerial control by domestic owners, this indigenization will change the input combination in favor of indigenous inputs and increase the government's revenue and domestic partner's profit. Later Gangopadhyay and Gang (1993) have extended the literature on transfer pricing. Using a principle-agent framework they have shown that transfer price will be less under foreign control than under domestic control of the JV. If the domestic firm controls the JV, the input choice will be distorted as it takes transfer price as cost per unit of input. When the foreign firm has control over the JV firm, such distortion disappears because input choice will be based on the actual cost of input. This increases consumer surplus while providing the domestic firm its reservation payoff which is the 'market arrangement' profit of the domestic firm. Thus, higher output and lower transfer price under foreign firm control makes the domestic government interested in choosing a policy with foreign controlled JV.

Tang and Yu (1990) paper addresses to the question of optimal mode of entry in a foreign market. It considers five possible entry strategies, viz., foreign direct investment (FDI), exclusive licensing (EL), multiple licensing (ML), JV and joint venture and licensing (JVL). Using a linear output royalty (which may be thought of as a transfer price on output) they have showed that

from the foreign firm's point of view the ranking is as follows:

$$\Pi_{FDI} = \Pi_{ML} > \Pi_{JVL} > \Pi_{JV} > \Pi_{EL}.$$

In case of ML, the foreign firm chooses the number of local firms and unit royalty rate in such a way that with Cournot competition, industry output converges to monopoly output. Since JVL consists of both income from equity share and royalty payment, it helps to reduce the incentive for distortionary unit royalty rate which in turn generates more surplus than JV and EL. With a possibility of two-part tariff under licensing, EL and JVL generate same profit that of FDI and ML. In this situation it is optimal for the firm to charge a zero royalty rate and positive fixed fee under two-part tariff. However, the interest of the firm and that of the domestic government may not match. With linear output royalty under licensing they have shown that social welfare (sum of consumer surplus and domestic firm's profit) ranking is given by

$$W_{JV} > W_{FDI} = W_{ML} > W_{JVL} > W_{EL}.$$

Profits from various entry strategies may be equal without other costs like entry cost, governance cost, the possibility of imitation by the local firm, etc. However, presence of these factors may create difference in profits between different entry strategies.

In a model with firm specific advantages, Purkayastha (1993) has examined the host country tariff policy. With a constant elasticity demand function the paper shows that an increase in foreign ownership increases total profit of the JV. This result stems from the fact that higher foreign ownership leads to lower transfer price and this increases profit of the JV firm. Thus the lower transfer price with higher foreign ownership has a similar flavor to that of Gangopadhyay and Gang (1993). However, unlike Gangopadhyay and Gang (1993), Purkayastha (1993) has not addressed the issue of control. The paper assumes that the local firm takes decision on the output level of the JV whereas the foreign firm in the first stage decides the JV ownership and transfer price of its input. Further, it shows that an increase in unit tax differential between imports of final goods and intermediate goods increases multinational's ownership in the JV. So, this result reflects the idea similar to that of tariff jumping as a reason for foreign investment.

Marjit and Beladi (1996) take a fresh look at the issue of tariff jumping as a reason for foreign investment. In a world with two firms competing in quantities they have argued that high tariff does not necessarily induce a firm to open a fully owned subsidiary when setting up a new subsidiary involves sunk investments. Foreign investment in the form of JV will take place between competing firms. However, as JV also needs to incur a sunk investment, for a very high tariff rate, a non-cooperative situation (where foreign firm exports its goods to the domestic country and competes with the local firm) dominates JV arrangement. For sufficiently high sunk investment, non-cooperative situation dominates for low tariff also. If the firms have asymmetric cost then the range of tariffs that implement JV, expands relative to symmetric cost situation. To show the results, this paper considers that if the firms make JV then neither of the

partners would compete with the JV firm through their independent production. In absence of this assumption the likelihood of JV will, however, be reduced. Hence the JV makes the market less competitive and this may lead to difference in incentives for JV between firms and domestic government (like Tang and Yu, 1990). Marjit and Beladi (1996) exploit a result available in the literature on technology transfer from Marjit (1990b).

There is not much work in the literature on the formation of JVs for the production of intermediate goods (input). The earlier literature mostly considers formation of output JV where inputs are supplied by either of firms at an appropriate price. This we have already discussed in the context of transfer pricing. However, with the possibility of input JV, given that the parents compete independently in the downstream product market<sup>3</sup>, some conventional results might undergo a drastic change. Recently, Kabiraj and Chaudhuri (1996) have constructed a model of input JV between two firms with asymmetric technology in input production. The paper considers a situation where downstream firms form an input JV for upstream input production, but the input JV is allowed to work independently without any direct influence by the parents. The input JV decides its pricing and input supply decision on the basis of the profit maximization principles for the JV firm. Given that the control issue is difficult to settle, it is often suggested that the venture firm should be controlled and operated by an independent professional management (see Tomlinson, 1970 and Killing, 1983, for study showing the attitudes towards control of a JV firm). Under this situation a profitable input JV to occur requires restrictions on the equity shareholding of the parents, fixed costs and on the degree of asymmetry in input production technologies. Since input JV acts independently regarding its production and pricing decision, industry output, input and output prices become independent of the individual firm's equity share in the venture. Hence there is no incentive for claiming a larger equity share. The market determined payoff (from two sources - JV profit share and product market profit) of each firm becomes inversely related to its equity share. While larger equity share means larger profit share of the venture firm, the firm suffers a net loss in the product market. The paper also shows that such JV contract must be associated with a fixed fee (which can be thought of as a lump sum transfer price) contract. So the technologically superior firm can settle at any equity share within the restrictions on equity holding, and then can extract profits according to its bargaining power by means of fixed fee.

On input JV there is another interesting paper provided by Spencer and Raubitschek (1996). It shows that in an oligopolistic set up with both domestic and foreign firms competing in the product market, when imports of inputs are available at price at lower than the domestic cost of input production, a formation of an input JV by the domestic firms which produce inputs domestically at a higher cost may be sometimes profitable to them. This happens because the constituent firms commit to purchase inputs, at least a portion, from the JV at a higher price

<sup>3</sup>When parents control the (input) JV firm fully, either it falls in the area of vertical integration or there is no such point of input JV because it is reduced to output JV.

(given that the remaining portion is imported). This reduces aggregate (derived) demand for imported inputs. Under some elasticity conditions the resulting fall in imported input price may lead to higher profits to the domestic competitors.

### 1.1.2 Technology Licensing

Now we look at the literature on technology licensing which is another topic addressed in this dissertation. The issues of technology licensing has been extensively discussed by the researchers working on industrial organization and international economics. One can find a nice survey of this literature in Kabiraj (1993) and Markusen (1995).<sup>4</sup> In this subsection, however, we shall devote our attention only to those works relevant for this dissertation.<sup>5</sup>

Rockett (1990), Kabiraj and Marjit (1992a, 1993) have addressed the issue of quality of the transferred technology. Rockett (1990) has shown the importance of imitation cost in designing patent licensing contract as well as on the quality of the licensed technology. It has considered licensing under different degrees of imitation (or, patent protection). Depending on the degree of patent protection and cost of imitation, it might be profitable for the licensee to license an inferior quality technology as it reduced the incentive for imitation to the licensee. Further, it has been shown that for any particular technology to be licensed, fixed fee and per unit output royalty rate are sensitive to the cost of imitation. Kabiraj and Marjit (1992a, 1993) discuss the problem of technology transfer from a foreign MNC to a domestic firm when the domestic market has been protected from foreign competition but the licensor faces the threat of competition from the licensee in its other market. This induces the MNC to internalize the entry threat by the domestic licensee and this in turn may result in the transfer of an inferior technology. Further, Kabiraj and Marjit (1992a, 1993) reveal the importance of the nature of competition on such quality choice. Kabiraj (1990) has also addressed the possibility of transfer of inferior quality technology. It focuses on the role of adoption cost needed for the licensed technology and the size of the final goods market. In a paper Kabiraj and Marjit (1992b) have explained the possibility of welfare loss due to technology transfer. They have considered technology licensing to one firm in a duopoly market. However, after technology transfer, it may be a monopoly of the licensee. If other reason like fixed cost of production is mainly responsible for this change in market structure rather than the cost efficiency of the licensee, this type of technology licensing may be welfare reducing. In infinitely repeated duopoly game, Eswaran (1993) and Lin (1996) have also addressed the role of cross-licensing and licensing, respectively, to facilitate the collusive outcome. Therefore, these papers also focus on the welfare reducing role of technology licensing.

In their paper Gallini and Winter (1985) and Katz and Shapiro (1985) deal with technology licensing in a duopoly game of R&D rivalry. While in Gallini and Winter (1985) licensing always

---

<sup>4</sup>One can find discussions on technology transfer in Reinganum (1989), Kamien (1992) and Pack and Saggi (1997).

<sup>5</sup>While some of the works mentioned in this subsection have relevance to the international context, others do not have special significance to international economics. However, due to the important findings and/or the similar type of licensing contract used in this dissertation, we pay attention to those contributions also.

occurs in equilibrium, Katz and Shapiro (1985) have shown that under fixed-fee licensing of the innovation, licensing may not occur in equilibrium at all. In a different context, Marjit (1990b) too has shown that licensing may not occur in equilibrium when the licensor and licensee compete in the same market like Cournot duopolists with homogeneous goods; in particular, licensing will occur iff the firms are close enough in terms of their initial technologies. In a paper Gallini (1984) has shown the incentive of a firm to license its technology in order to forestall innovation by the licensee. Thus, sharing the market through technology licensing makes further innovation less attractive to the licensee.

The above mentioned papers, except Kabiraj (1990) and Kabiraj and Marjit (1992b), assume that the licensor and licensee compete in the same market. Gallini and Wright (1990) and Singh (1992) have addressed the issue of technology licensing when the licensor and licensee do not compete in the same market. Gallini and Wright (1990) examine the case where the quality of the technology is private information to the licensor and the licensor faces imitation threat from the licensee. The paper considers licensing for both the cases of drastic and non-drastic innovations. It explains reasons for having fixed fee and linear or non-linear royalty provision in the patent licensing contract. Further, this paper has focused on both exclusive and multiple licensing. Singh (1992) also has considered the problem of technology licensing both under complete and asymmetric information. It studies how the regulatory laws on the provision of royalty or fixed fee affect the patent licensing contract.

## 1.2 Outline of the Dissertation

This dissertation will consist of seven more chapters. On chapters 2, 3, 4 and 5 we identify some additional grounds for forming international JVs between technologically advanced foreign firms and technologically backward domestic firms. Chapters 6 and 7 devote attention to some aspects of technology licensing when the licensor and licensee compete in the same market. Chapter 8 will provide some future research agenda after summarizing the results of this dissertation.

**Chapter 2.** Empirical findings show rising trend of international JVs (see, Hladik, 1983, Korbin, 1988, Beamish, 1988, etc.). This chapter shows that difference in perception about the project's return and/or difference in opportunity cost of investment makes the JV a better option than technology licensing. This work also demonstrates the possibility of dominance of complete buy out over JV.

**Chapter 3.** In this chapter we show that if there is an asymmetric information problem coupled with the threat of imitation by the licensee, then a JV agreement may help a foreign firm to extract more surplus generated from its technology. Further, this JV formation helps to attract relatively better quality technology than 'technology licensing' deal. This again supports an empirical finding which shows that in an economy with relatively weak patent protection, foreign firms prefer JV than licensing and better technology comes under JV than licensing (see Mansfield, 1994 and Saqib, 1995).

**Chapter 4.** We find in the empirical study that often domestic firms are more concerned about the future technological upgradation as a reason for forming a JV with a foreign firm (see Saqib, 1995). In a two period game we provide a theoretical justification of the above finding. We show that in an economy with weak patent protection, government policy uncertainty coupled with the threat of entry may be the reason for this type of behavior.

**Chapter 5.** Here we consider a model of foreign investment and show that the government policy uncertainty may be a reason for technology licensing or formation of JV by a foreign firm even if it is allowed to operate a fully owned subsidiary. Thus, it focuses on the role of government policy uncertainty on the entry decision of a foreign firm. We examine whether domestic welfare is greater under committed or non-committed government policy and focus on the importance of bargaining power and technology choice.

**Chapter 6.** This chapter contributes to the literature on technology licensing and considers the problem of technology licensing in a market with Cournot duopolists. In a model of pre-commitment by the firm(s), we examine the profitability of technology licensing and focus on the nature of the commitment - (i) commitment by capacity installation and (ii) commitment by incentive delegation. We consider the possibility of commitment by one firm as well as by both the firms. This work shows that who commits and also the form of commitment have an important implication on the profitability of technology licensing.

**Chapter 7.** In this chapter we concentrate on a bilateral technology licensing deal in an oligopoly market where the firms compete in Cournot fashion. We have compared the result with the bilateral horizontal merger. This work focuses on the role of the number of firms in the industry and degree of cost asymmetry on the profitability of licensing and horizontal merger between a technologically advanced and a technologically backward firms.

**Chapter 8.** This chapter summarizes the findings of this dissertation and suggests a possible future research agenda.



## Chapter 2

# Joint Venture for Difference in Perception<sup>1</sup>

### 2.1 Introduction

The purpose of this chapter is to show theoretically how foreign equity participation facilitates technology collaboration between a foreign firm and a local firm. The term "technology collaboration" is used to imply an arrangement where the MNC supplies its technology without getting involved in investment. Pure technology collaboration (defined later) and ex post pure technology collaboration (defined later) explain technology supply under a fixed fee contract. Under equity participating technology collaboration (defined later) the MNC supplies its technology without any fee and gets a share of the project's profit according to its share in investment.

"Technology collaboration" as a term has been used extensively in the discussions on the Indian economy. The theoretical construct to be developed is based on the current Indian experience. India, like many other less developed countries, followed protectionary policies with strict regulations on foreign equity participation in domestic investments. In early eighties doors were opened to the rest of the world for seeking new technologies through technology collaborations. The number of such collaborations grew since then. But foreign equity control continued to be under strict watch and most of the collaborations were pure technology sharing arrangements with the entire investment cost borne by the local partners. A detailed description of the contemporary Indian scenario can be found in EPW (1985), Bagchi (1987), Marjit and Singh (1995) and Gupta and Chawla (1995).

Since 1991 the situation has changed as India has liberalized foreign investment laws and regulations. Right after these changes joint-ventures are increasingly characterized by foreign firms' participation with equity stake. There are many studies which show the rising trend of international JVs in the world economy (see, Hladik, 1985, Beamish, 1988, Korbin, 1988, etc.).

---

<sup>1</sup>This chapter is based on Marjit and Mukherjee (1998).

We build up our analytical model based on the following scenario. Consider a local firm which contemplates to buy a new technology, blue print, plant or machineries, etc., from a MNC. Since the technology is new, the local firm may be apprehensive about the actual outcome of the technology transferred. In a way the MNC, the hitherto user of the technology, may not convince the new purchaser about all the nice things the technology would yield and the local firm may worry about local conditions which may influence the return from the new technology.<sup>2</sup>

We consider following four arrangements.

1. Pure technology collaboration (PTC) - Under this arrangement MNC transfers its technology to the local firm at a negotiated price to be paid ex ante technology transfer.

2. Equity participating technology collaboration (EPTC) - Under this arrangement both parties share the project's profit according to their share in investment, and the MNC supplies its technology without any charge.

3. Ex post pure technology collaboration (EPPTC) - Under this arrangement the MNC supplies its technology to the local firm and makes an enforceable contract that specifies a negotiated price to be paid ex post the realization of the profit.

4. Complete buy out (CBO) - This arrangement considers a situation where the MNC cannot get the license of this project from the domestic government but can buy it from the local firm.

From this four possibilities we determine the dominant contract. In other words, we find that arrangement which is preferred at least by one party while the other getting at least its Nash-bargained profit share of the project's profit generated by the foreign technology. Alternatively, one can think of a situation where the MNC gives an offer to the local firm while the MNC has to choose one offer from the four possibilities - PTC, EPTC, EPPTC and CBO. However, while giving the offer, the MNC has to ensure that the local partner gets at least Nash-bargained profit share of the project's profit.

In this work we have assumed away the possibility of setting up a subsidiary by the MNC. Hence, at this stage, it is worthwhile to spend some time on the contractual arrangements specified above. One can think this as an analysis of the second stage of a two-stage game. The first stage involves the decision of the domestic government regarding whether to give permission for setting up the project. We can then show that the local firm will win the the license. Otherwise, local firm's profit will be zero and it will imply less welfare to the domestic country. In case the local firm gets the license for this project, it will give the local firm some bargaining power, which will help it to retain some surplus.<sup>3</sup> Assume that the local firm and domestic government have the same perception about the outcome of the project.<sup>4</sup>

<sup>2</sup>Another problem may emerge when there are technologies of varying qualities which are private information to the MNC but not to the local firm and a signaling equilibrium might be used to eliminate the adverse selection problem. Next chapter will discuss this issue.

<sup>3</sup>Another possibility may be to think of sufficiently higher costs (may not be physical) of getting the license by the MNC relative to local firm that makes it unattractive to the MNC.

<sup>4</sup>One can think of an alternative interpretation of the scenario. Suppose that 100% foreign ownership is not allowed in the domestic country but the domestic government allows either JV or technology collaboration. This

If the local firm is not allowed to raise capital from a cheaper source in the international capital market due to government regulation, which has been very much the case in India, just financial participation by a foreign firm without any technology involvement may be the optimal choice for the venture partners. This will be the case when firms face different opportunity costs of raising funds.

This chapter is divided into three sections. The second section describes the analytical model and derives the main results. The last section provides a conclusion.

## 2.2 Model and Results

Let us begin by assuming that a local firm is trying to buy a new technology from a MNC. Also assume that the investment requirement of the project is one unit. The MNC suggests that the new technology would yield  $\bar{\Pi}$  as the net payoff (net of investment costs) to the local firm which is skeptical about the true outcome and believes that the payoff would be some  $\Pi < \bar{\Pi}$ . The perception about the outcome of the project differs due to some country specific factors. We assume that the perception about the profit levels, i.e.,  $\Pi$  and  $\bar{\Pi}$ , are independent of the ownership status of the parties engaged in the contract. The local firm's opportunity cost of raising one unit of investible fund is  $r$  and the reservation price of such a technology to the MNC is  $\Pi^* < \Pi$ . It is assumed that  $\Pi^*$ ,  $\Pi$  and  $r$  all are common knowledge. Patent protection implies that only the MNC has the right to sell its technology. The price of the technology is determined by Nash bargaining, from

$$\max_v (\Pi - r - v)(v - \Pi^*) \quad (2.1)$$

where  $v$  is the price of the technology and (1) yields  $\hat{v}$  as the equilibrium price,

$$\hat{v} = \frac{(\Pi - r + \Pi^*)}{2} \quad (2.2)$$

The following Proposition is immediate.

**Proposition 2.2.1** *A PTC contract is feasible provided  $\Pi - r > \Pi^*$ .*

**Proof:** Note that the net payoff to the local firm and the MNC under a PTC are respectively,

$$\Pi - r - \frac{(\Pi - r + \Pi^*)}{2} = \frac{(\Pi - r - \Pi^*)}{2}$$

and

$$\frac{(\Pi - r + \Pi^*)}{2} - \Pi^* = \frac{(\Pi - r - \Pi^*)}{2}$$

is, in fact, a feature of many developing countries. In this structure, one can think CBO as an arrangement where the local firm acts as a local agent of the MNC and the MNC becomes the residual claimant over the specified amount payable to the local firm. Hence, of course, the MNC's share cannot exceed that stipulated by the domestic government. In our stylized framework we, however, follow the interpretation as given in the text.

Therefore, PTC is feasible iff  $\Pi - r > \Pi^*$ .

Assume that PTC is feasible. However, note that if the MNC could somehow convince the local firm about  $\bar{\Pi} > \Pi$ , both of them would have earned more. This precisely can be achieved through equity participation by the MNC.

Under EPTC the MNC makes an alternative offer to the local firm saying that it would like to hold ' $\alpha$ ' fraction of the one unit investment as equity in the venture and share the resultant profits accordingly. An enforceable contract would be written specifying the arrangement and if it yields greater payoff to at least one while making other indifferent, such an EPTC would be adopted instead of a PTC.

The participation constraint for the local firm is

$$(1 - \alpha)\bar{\Pi} + \alpha r - r \geq (\Pi - r) - \frac{(\Pi - r + \Pi^*)}{2} \quad (2.3)$$

and for the MNC is

$$\alpha \bar{\Pi} + (1 - \alpha)r^* - (\Pi^* + r^*) \geq \frac{(\Pi - r + \Pi^*)}{2} + r^* - (\Pi^* + r^*) \quad (2.4)$$

Left hand side of (2.3) denotes the net payoff to the local firm which now holds a share  $(1 - \alpha)$  of the equities, investing  $\alpha$  in the alternative asset. The right hand side represents the return from PTC. Condition (2.4) now involves investment by the MNC with an opportunity cost of  $r^*$ . Since the MNC values the ex post payoff from the project as  $\bar{\Pi}$ , the left hand side of (2.4) has a term like  $\alpha \bar{\Pi}$ . In case the EPTC does not mature, the MNC gets back  $\Pi^*$  and earn  $r^*$  on the investment. If PTC does not mature, it gets back  $\Pi^*$  only because under PTC no investment by the MNC was called for and it gets  $r^*$  any way. That is why  $r^*$  cancels in the right hand side. Again the right hand side in (2.4) represents net payoff to the MNC under PTC. Hence (2.3) and (2.4) leads to

$$\frac{(\Pi - r + \Pi^*)}{2} \geq \alpha(\Pi - r) \quad (2.5)$$

and

$$\alpha(\bar{\Pi} - r^*) \geq \frac{(\Pi - r + \Pi^*)}{2} \quad (2.6)$$

Casual empiricism suggests that with a highly protected capital market  $r > r^*$ . One can assume it at least in the context of India where real interest rate tends to outsmart the prevailing ones in the rest of the world. Another point to note about (2.6) is that the foreign firm uses  $\bar{\Pi}$  as the resultant payoff from the project because once it matures, the venture partners would gain from the premium  $(\bar{\Pi} - \Pi)$ . An EPTC is adopted if there exists a set of  $\alpha \in [0, 1]$  such that (2.5) and (2.6) are satisfied with strict inequality. It is easy to prove the following:

**Proposition 2.2.2** *There exists  $\alpha \in [0, 1]$  such that an EPTC is adopted.*

**Proof:**

Define

$$\alpha^{max} \equiv \frac{(\Pi - r + \Pi^*)}{2(\Pi - r)} = \bar{\alpha} \quad (2.7)$$

and

$$\alpha^{min} \equiv \frac{(\Pi - r + \Pi^*)}{2(\bar{\Pi} - r^*)} = \underline{\alpha} \quad (2.8)$$

$\bar{\alpha}$  is the maximum that the local firm can afford to give to the MNC and  $\underline{\alpha}$  is the minimum desired by the MNC. Note that  $\bar{\alpha} > \underline{\alpha}$ . Therefore, there exists  $\alpha \in (\underline{\alpha}, \bar{\alpha})$  such that EPTC would be adopted.

**Figure 1**

Figure 1 captures the set of ' $\alpha$ 's for which an EPTC would dominate PTC.

A corollary of the above result is straightforward. Suppose  $\Pi = \bar{\Pi}$ , even then EPTC would dominate PTC as long as  $r > r^*$ . Only the range of ' $\alpha$ 's would shrink as (2.6) would be flatter now. However, if  $(r - r^*)$  just captures the risk premium then such a motivation behind the equity participation is absent and the deal is struck only when perceived payoff between the agents are different. It is intuitive to see why  $\alpha = 0$  cannot be a solution to the problem simply because EPTC allows the parties to share the risk. A reallocation of investment from the local firm to the MNC opens the avenue for gains from trade. While the marginal loss to the local firm is  $(\Pi - r)$ , the gain becomes  $(\bar{\Pi} - r^*)$  and, therefore, trade takes place. However, on the surface it is not clear why  $\alpha = 1$  cannot feature as a solution. After all the MNC can reap the entire profit  $(\bar{\Pi} - r^*)$ . In that case the local firm earns  $r$  which is less than its payoff from PTC. In fact, the local firm would not go beyond  $\bar{\alpha}$  at which it is indifferent between PTC and EPTC.

We shall now look into other possible contracts that might improve upon EPTC. We would see that EPTC, as a contractual arrangement is quite robust to the alterations of institutional arrangements increasing the set of feasible contracts. Consider EPPTC arrangement. Here the MNC in anticipation of a gain asks the local firm to postpone the payment for technology and since the outcome is observable, charges ex post  $\frac{(\bar{\Pi} - r + \Pi^*)}{2}$  as the price for the technology. Once the profits are realized, the local firm does not mind paying the fee because it is the Nash bargained outcome when the actual payoff is  $\bar{\Pi}$ . As usual we are assuming that this contract is also enforceable. The question is whether the MNC is going to make such an offer. Note that this increases the reservation payoff to the MNC as represented in (2.4). To the local firm it does not make any difference ex ante. This implies that  $\bar{\alpha}$  does not change but  $\underline{\alpha}$  increases upto  $\frac{(\bar{\Pi} - r + \Pi^*)}{2(\bar{\Pi} - r)}$ , call this  $\alpha'$ .

**Proposition 2.2.3** For  $\alpha \in (\alpha', \bar{\alpha})$ , EPTC dominates EPPTC.

**Proof:**

$$\bar{\alpha} = \frac{(\Pi - r + \Pi^*)}{2(\Pi - r)}$$

and

$$\underline{\alpha}' = \frac{(\bar{\Pi} - r + \Pi^*)}{2(\bar{\Pi} - r^*)}$$

Therefore,

$$\bar{\alpha} - \underline{\alpha}' = \frac{(r - r^*)}{2(\bar{\Pi} - r^*)} + \frac{\Pi^*}{2(\Pi - r)} - \frac{\Pi^*}{2(\bar{\Pi} - r^*)} > 0 \quad (2.9)$$

as  $(\Pi - r) < (\bar{\Pi} - r^*)$  and  $r > r^*$ .

One way of explaining the dominance of EPTC over EPPTC is to note that under EPTC, the opportunity cost of the project is partially reduced from  $r$  to  $r^*$  to the extent it is financed by the foreign firm. Under EPPTC the cost-sharing is absent. But there is a more fundamental point. We see that even if  $r = r^*$ , then also EPTC dominates EPPTC provided  $\Pi^* > 0$ . In this case, we get (with  $r = r^* = 0$ )

$$\bar{\alpha} - \underline{\alpha}' = \frac{\Pi^*}{2\Pi} - \frac{\Pi^*}{2\bar{\Pi}} > 0 \quad (2.10)$$

The reason is as follows. Suppose that the reservation price for its technology is 0 rather than  $\Pi^* > 0$ . In that case under EPPTC, the MNC gets  $\frac{\bar{\Pi}}{2}$  but ex ante the local firm believes that it will get  $\frac{\bar{\Pi}}{2}$ . So under EPTC, the local firm allows the MNC to invest in the project until  $\alpha = \frac{1}{2}$ . And this is the amount the MNC also wants, since it gives the MNC  $\frac{\bar{\Pi}}{2}$  under EPTC. Now consider a situation where the reservation price for the technology is  $\Pi^* > 0$ . In this situation, under EPPTC, the MNC gets  $\frac{(\bar{\Pi} + \Pi^*)}{2}$  but ex ante the local firm believes that it will get  $\frac{(\bar{\Pi} - \Pi^*)}{2}$  which is less than  $\frac{\bar{\Pi}}{2}$ . Therefore, the existence of a positive reservation price for the MNC's technology gives the MNC a bargaining power over the local firm. Due to this reduced payoff from the EPPTC, the local firm allows the MNC to invest more and due to the higher reservation payoff (in gross terms) to the MNC, the MNC also needs to increase its share in the project under EPTC. However, since the marginal loss to the local firm due to a higher  $\alpha$  is  $\Pi$  and the marginal gain to the MNC due to a higher  $\alpha$  is  $\bar{\Pi}$ , the local firm allows the MNC to invest much more than the amount is needed for the MNC to be indifferent between these two contracts. Thus we get a range of  $\alpha$  over which both firms are better off under EPTC and, therefore, EPTC dominates EPPTC.

We now introduce the possibility of CBO. Here we assume that the MNC cannot get the license for setting up this project from the domestic government directly. The local firm gets the license which is transferable and under CBO, the MNC pays for the license. From the previous contracts - PTC, EPTC and EPPTC - we see that EPTC dominates other contracts. We assume that under CBO, the MNC agrees to pay  $(1 - \alpha)(\Pi - r)$ , where  $\alpha \in (\underline{\alpha}', \bar{\alpha})$ , i.e., the MNC agrees to pay the amount that the local firm gets under EPTC. So, the local firm is indifferent between EPTC and CBO. We check whether the MNC is better off under CBO. The MNC does not sell its technology to the local firm, since it wants to avoid competition from the local firm. Therefore, the net payoff to the MNC under CBO is given by,  $(\bar{\Pi} - r^*) - (1 - \alpha)(\Pi - r) - \Pi^*$ .

**Proposition 2.2.4** *CBO dominates EPTC for MNC.*

**Proof:** We have for MNC,  $EPTC - CBO = -(1 - \alpha)[(\hat{\Pi} - r^*) - (\Pi - r)] < 0$ , since  $\alpha < 1$ .

So for all  $\alpha \in (\underline{\alpha}', \bar{\alpha})$ , CBO dominates EPTC for MNC. ■

The intuition is as follows. Under EPTC, the two firms share the actual profit and, therefore, under this contract the MNC gets,  $\alpha(\hat{\Pi} - r^*)$  which implies the MNC gives the local firm  $(1 - \alpha)(\hat{\Pi} - r^*)$ . But under CBO, the MNC gives the local firm  $(1 - \alpha)(\Pi - r)$  which is less than  $(1 - \alpha)(\hat{\Pi} - r^*)$ . This is because the payment under CBO is made before the realization of the profit and, besides that, the difference between  $r$  and  $r^*$  gives an advantage to the MNC.

The institutional arrangement of CBO implies that whatever the local firm achieves is attainable by the MNC also. If the technology needs some local inputs which the local firm can provide more efficiently than the MNC, the payoff under CBO reduces for the MNC. In that situation the case for offering EPTC would be stronger. Suppose that if the local firm does not participate in the venture,  $\hat{\Pi}$  drops to  $\hat{\Pi}$ . Then the following Proposition is immediate.

**Proposition 2.2.5** *EPTC dominates CBO for MNC provided profit under CBO,  $\hat{\Pi}$ , is less than  $\Pi'$  where*

$$\Pi' = \alpha\hat{\Pi} + (1 - \alpha)(\Pi - r + r^*), \text{ for } \alpha \in (\underline{\alpha}', \bar{\alpha}).$$

**Proof:** Let the profit under CBO is given by  $\hat{\Pi}$  rather than  $\hat{\Pi}$ . So, for  $EPTC - CBO > 0$ , we need

$$\hat{\Pi} < \alpha\hat{\Pi} + (1 - \alpha)(\Pi - r + r^*).$$

Proposition 2.2.5 shows that the case for the dominance of EPTC over CBO increases as  $\hat{\Pi}$  tends to  $\hat{\Pi}$ , ceteris paribus. Given,  $r = r^*$ , we see that if the perception of both firms about the profit level is same then any decrease in profit from  $\hat{\Pi}$  means EPTC dominates CBO. Also, given the values of  $\hat{\Pi}$ ,  $\Pi$ ,  $r$  and  $r^*$ , we see that as  $\alpha$  increases the case for EPTC becomes stronger. This implies that if under EPTC the MNC has a higher proportion in the total investment then the payoff from both EPTC and CBO increases but the former dominates the latter and as a result the case for EPTC becomes stronger. From this we can say that the necessary condition for EPTC to dominate CBO for some  $\alpha \in (\underline{\alpha}', \bar{\alpha})$  requires  $\hat{\Pi} < \Pi'$  when  $\Pi'$  is evaluated at  $\bar{\alpha}$ .

Proposition 2.2.5 assumes that under CBO, the MNC is managing the production and so it is losing the critical input that can be provided by the local firm only. However, one possible alternative arrangement is to make an arrangement with the local firm so that the local firm acts as a local agent of the MNC and the MNC becomes the residual claimant over the amount payable to the local firm. In this situation, with no other problems, this leads to a similar conclusion to Proposition 2.2.4. But with the possibility of imperfect monitoring by the MNC, opportunism on the part of the local firm (see next chapter on this issue) or government regulation on the royalty payment under technology collaboration may act as constraint on the profit extraction by the MNC under CBO with local firm's participation. On the other hand, with the allowed foreign ownership, EPTC gives the MNC an ownership benefit in the project that may help to

eliminate or at least reduce the level of opportunism on the part of the local firm and makes the monitoring more perfect. This may make the choice biased towards EPTC relative to CBO with the local firm's participation and may lead to the conclusion similar to Proposition 2.2.5.

Coming back to the issue of investment cost differential as reflected in the difference between  $r$  and  $r^*$  and its effect on EPTC, one may refer to a recent paper by Harvey (1995). Harvey (1995) discusses the negative correlation between  $r$  and  $r^*$  as a major factor behind the equity investment in developing countries. This correlation has been estimated to be declining. If  $r - r^*$  reflects the risk adjusted premium, then portfolio diversification would explain equity investment across borders provided  $r$  and  $r^*$  are negatively correlated. Due to severe restriction on capital market in India the entire differential in  $r$  and  $r^*$  may not have reflected only risk premium. To the extent there were some "pure profits" to be made, EPTC can be designed suitably. Naturally this avenue would be closed once the local firms are allowed to raise capital in the international market.

## 2.3 Conclusion

This chapter has been an attempt to relate the issue of technology collaboration to the financial participation of the MNC which provides technology to a joint venture. We have tried to argue that when the MNC believes that the new technology transferred to a local firm would yield a higher payoff than what is perceived by the local firm, equity participation by the MNC leads to a better contractual form than PTC. Propositions 2.2.3 and 2.2.5 show that this equity participating technology collaboration is also better than EPPTC and CBO. Only in Proposition 2.2.4 we see that CBO dominates other arrangements. Therefore, in most of the cases EPTC is preferred than other contractual arrangements. It is shown that if the MNC perceives higher return from its technology and/or the MNC has lower opportunity cost of investment, an equity participation may be needed. Our analysis also explains why the equity participation rule must have an interior solution.



## Chapter 3

# Technology Transfer and Joint Venture under Asymmetric Information<sup>1</sup>

### 3.1 Introduction

In this chapter we have considered both technology transfer agreement as well as JV agreement under asymmetric information. The technology supplier, the foreign firm, has private information regarding the quality of its technologies. We have shown that the foreign firm will supply relatively better technology under JV agreement than under technology licensing agreement.

A recent report published by the Indian Council of Research in International Economic Relations (see, Gupta and Chawla, 1995), shows that Indian business partners generally believe that by offering shares to their foreign counterpart, they possibly invite updated technologies. Saqib (1995) has conducted detailed interviews with the local businessmen about their possible strategic alliance with the U.S. firms. Often technology suppliers with valuable technology will only supply their valuable technology to a joint venture in which they won 50% and/or have a significant voice in its management (see, Killing, 1983). A somewhat close empirical support of the hypothesis also comes from Bhandari (1996) who has studied a sample of 3,000 affiliates of U.S. multinationals firms and found that there is a positive relationship between the importance of non-contractible technical know-how as measured by the (Product Patents/Total Employees), or (Skilled Employees/Total Employees) and U.S. equity share.<sup>2</sup> In this chapter we relate the quality issue to the equity participation by the foreign firm. Mansfield (1994) also discusses some of the related issues. He has conducted a survey based on U.S. firms and showed how the perceived strength or weakness of intellectual property protection influences technology transfer

<sup>1</sup>This chapter is based on Marjit and Mukherjee (1995).

<sup>2</sup>In this chapter we have a stylized framework dealing with process technologies. However, it would be evident that most of our analysis remains unaltered if one denotes 'better technology' as a 'better or new product'.

decision and foreign investment decision. This survey shows that in most cases foreign firms (in percentage) prefer to transfer their advanced technologies to joint ventures than to license to unrelated firms. Similar results can also be found in the survey report conducted by Miller et al. (1996).

Gallini and Wright (1990) and Marin and Schnitzer (1995) have addressed the problem of asymmetric information in case of a technology transfer. Gallini and Wright (1990) have analyzed how the patent licensing contract helps the licensor to extract maximum surplus generated from its technology when the licensor has private information about the quality of its technology and technology transfer facilitates imitation. We have showed that for sufficiently small imitation cost equity joint venture will be better than technology licensing agreement as suggested by Gallini and Wright (1990). But a combination of equity sharing and royalty payment is likely to dominate the technology licensing agreement always. Recently, Marin and Schnitzer (1995) have also addressed the problem of asymmetric information in a technology transfer deal when the licensor has multiple technologies to offer and showed that countertrade agreement may be a solution to this problem. Our result, however, implies that in a world where countertrade is not effective, equity participation by both the licensor and the licensee can be an answer to the problem. We consider the problem under following two situations - (1) when licensor has multiple technologies and (2) when licensor has one technology. These cases are analyzed in the second and third section respectively. In each case we have shown that equity participation between the licensor and licensee may be a better arrangement than technology licensing deal.<sup>3</sup>

Under Technology Licensing Arrangement (TLA), the foreign firm sales its technology and charges a price for its technology. This licensing agreement may consist of up-front fixed fee and royalty payment. In the EPA or JV arrangement the foreign firm brings its technology in the JV firm without any charge and the two firms share the profits of the JV firm according to their share in investment, while investment takes place before the technology transfer and investment is sunk. We also discuss the case when under EPA, foreign firm can charge an output based royalty and/or up-front fixed fee with the profit sharing arrangement, i.e., a contract like joint venture and licensing (see Tang and Yu, 1990). The main point of this chapter is that when the technology buyer is not certain about the quality of the technology to be transferred, equity participation may be an effective means of striking a deal with the best available technology.

The plan of this chapter is as follows. The second section describes the asymmetric information problem in case of technology transfer when the technology seller has two different technologies and the transfer of the technology facilitates imitation. The third section describes the asymmetric information problem while the technology seller has only one technology, rather than two, like that of Gallini and Wright (1990), and this technology sale facilitates imitation. Fourth section concludes the chapter.

<sup>3</sup>One related contribution is by Lee and Shy (1992). But they have not considered the double-sided problem as addressed here. Also they have ignored the possibility of licensing arrangement.

### 3.2 Problem with two technologies

We consider a local monopolist insulated from external competition by a prohibitive tariff and has a relatively outmoded technology  $t_0$  which can yield a profit  $\Pi_0$  and assume that the domestic monopolist has the option of purchasing a superior technology from abroad. There is only one potential technology supplier, we call him MNC, in the rest of the world with two types of technologies  $t_1$  and  $t_2$  and these technologies, if put to use, yield  $\Pi_1$  and  $\Pi_2$  respectively and we assume that  $0 < \Pi_0 < \Pi_1 < \Pi_2$ . These profits are net of investment costs, i.e.,  $\Pi_i = R_i - F$ ,  $i = 0, 1, 2$ , where  $R_i$  is the operating profit from  $i$ th technology and  $F$  is the fixed investment cost. We assume that there is a resource cost of technology transfer (viz., to codify information) that is borne by the MNC and different for two technologies (may be due to different complexities of these technologies).<sup>4</sup> We assume that  $v_1$  and  $v_2$  are costs for  $t_1$  and  $t_2$  respectively and  $v_2 > v_1$ .<sup>5</sup> Consider that these costs are same in two arrangements - TLA and EPA.<sup>6</sup> Also assume that these costs are known to both firms but buyer cannot observe and these costs are not verifiable.<sup>7</sup> Further we assume that 100% foreign ownership in the domestic market is not allowed. Though many developing countries are now liberalizing their rules in the sphere of foreign investment, still they are very much interested in the collaborative ventures rather than full foreign ownership.

We assume that technology transfer facilitates imitation or 'inventing around'.<sup>8</sup> But only patent disclosure is not enough for imitation. For successful imitation, the technology buyer requires a license to use the technology. However, for successful imitation the local firm needs to incur a cost  $I$  and assume same for both technologies.

So far we have not considered the information problem. Now we introduce the problem that arises from private information of the MNC. We consider that at the beginning of the game, the MNC has the private information about  $t_1$  and  $t_2$  but the local firm cannot distinguish between  $t_1$  and  $t_2$  from the available information (eg., information gained from the patent disclosure). Also the MNC cannot convince the local firm about the quality of the technology. One way to do this is through direct inspection. But for the imitation cost less than  $(\Pi_2 - \Pi_0)$ , it is not in the interest of the MNC to allow the local firm to make a direct inspection.<sup>9</sup> Further, the involvement of third-party expert may not resolve this information problem since in this situation there is a possibility of collusion between the outsider expert and the MNC (see Tirole,

<sup>4</sup>See Teece (1977, 1981) for resource cost of technology transfer.

<sup>5</sup>Alternatively, one can think these as costs to produce different qualities of technologies (see Marin and Schnitzer, 1996).

<sup>6</sup>In the EPA arrangement these costs may differ due to the presence of the MNC in the JV firm and this may influence (increases incentive) the EPA decision. However, we are not considering this aspect here.

<sup>7</sup>This may be that the third party enforcer has an imperfect ability to assess cost information.

<sup>8</sup>Here imitation or 'inventing around' with a non-infringing technology is permissible.

<sup>9</sup>If imitation costs are at least as large as  $(\Pi_2 - \Pi_0)$ , full monopoly rents from the good technology can be extracted even with direct inspection by the local firm before the purchase of technology.

1986 and Marjit, 1994).

We assume that the foreign technology supplier is itself a monopolist with respect to the domestic firm. The licensor maximizes its net income when designing a contract and gives a take-it-or-leave-it offer to the local firm. First the MNC calculates its net profit from TLA and EPA and then it offers that arrangement which gives it more net profit. Then the local firm either accepts or rejects the offer. If the local firm rejects the offer then the MNC makes no further offer. We assume that if the local firm gets the same net profit from either of the bad and good technology it asks for the good one.<sup>10</sup> Further we assume that if acceptance or rejection of an offer gives the local firm same net payoff then it accepts the offer. If the offer is accepted then the technology will be transferred and the local firm decides whether to imitate or not. If the local firm does not imitate, then the two parties get according to the terms of the contract.

We assume that the local firm's outputs and profits are verifiable, while (constant) marginal production costs<sup>11</sup> observable ex post by both the MNC and the local firm but cannot be verifiable by a third-party enforcer.<sup>12</sup>

Another assumption is that  $(\Pi_2 - \Pi_1) > (v_2 - v_1)$ . It implies that if it is a complete information game then the net payoff to the MNC from good technology,  $(\Pi_2 - \Pi_0 - v_2) > 0$ , is greater than the bad technology,  $(\Pi_1 - \Pi_0 - v_1) > 0$ , and the MNC always has an incentive to transfer good technology and gets a payment  $(\Pi_2 - \Pi_0)$  from the local firm while the local firm accepts this offer.

In the following analysis we assume that the majority shareholder controls the JV firm (see, Lee and Shy, 1992, Gangopadhyay and Gang, 1993, etc.) and takes the decision in the product market.<sup>13</sup> Further, assume that  $\Pi_2 > 2\Pi_0$ . This implies that there is a large difference between the technologies of local firm and MNC's superior technology. Later we shall see the implication of this condition. We prove the Propositions of this section with the assumption that  $\Pi_2 > 2\Pi_0$ . Then we discuss for  $\Pi_2 < 2\Pi_0$ .

Now we see how this asymmetric information characterizes the equilibrium. First we start with a zero imitation cost.

**Proposition 3.2.1** *If imitation cost is zero then EPA dominates TLA iff  $\bar{\alpha}(\Pi_2 - \Pi_1) > (v_2 - v_1)$ , where ' $\alpha$ ' is the MNC's ownership in the JV firm and  $\bar{\alpha}$  is the maximum that the local firm can afford and is given by  $\bar{\alpha} = \frac{(\Pi_2 - \Pi_0)}{\Pi_2}$ . Under EPA the MNC gets the full rent from the  $t_2$  technology and  $t_2$  will be transferred.*

<sup>10</sup>It may be that for the good technology the MNC gives the local firm a positive but very small amount and still retains a larger surplus than what it could get from transferring bad technology.

<sup>11</sup>Here and in the following chapters, technology level is given by marginal cost of production and better technology implies lower marginal cost.

<sup>12</sup>Again this may be due to third party enforcer's imperfect ability to assess cost information.

<sup>13</sup>Majority shareholder not necessarily controls the JV always (see, Nye, 1992). In that case, depending on the managerial control one has to follow our analysis for control by MNC or by the local firm for any distribution of shareholding.

**Proof :** Since imitation cost is zero, the MNC cannot get anything once the technology is transferred. So, the MNC can get only a fixed up-front fee. Also, the quality of the technology cannot be verified by the local firm and ,therefore, the MNC can gain by misreporting  $t_1$  as  $t_2$  as

$$x - v_1 > x - v_2$$

where  $x$  is any up-front fee.

So, the local firm will accept a licensing contract with an up-front fee  $x = (\Pi_1 - \Pi_0)$ . With this payment it is better for the MNC to give  $t_1$  rather than  $t_2$ . Therefore, under TLA,  $t_1$  will be transferred and the MNC will get a fixed up-front fee  $(\Pi_1 - \Pi_0)$ .

Next, we see what happens if the MNC opts for EPA.

First, we suppose that the local firm believes that the MNC will give  $t_2$  under EPA. We shall show the credibility of this belief later. Now with this belief the local firm's participation constraint is given by

$$(1 - \alpha)\Pi_2 \geq \Pi_0 \quad (3.1)$$

This gives an upper bound on ' $\alpha$ ', i.e.,  $\bar{\alpha} = \frac{(\Pi_2 - \Pi_0)}{\Pi_2} < 1$ . Also with  $\Pi_2 > 2\Pi_0$  we get  $\bar{\alpha} > \frac{1}{2}$ .

Suppose the MNC announces this  $\bar{\alpha}$ , i.e., it gives an offer which gives the local firm its reservation payoff  $\Pi_0$ . We need to see whether  $\bar{\alpha}$  satisfies the MNC's participation constraint, i.e., whether it is better for the MNC to give an EPA offer rather than a TLA offer. For this we need to satisfy,

$$\bar{\alpha}\Pi_2 - v_2 \geq (\Pi_1 - \Pi_0) - v_1 \quad (3.2)$$

i.e.  $(\Pi_2 - \Pi_1) \geq (v_2 - v_1)$  and this is satisfied with strict inequality. So this  $\bar{\alpha}$  satisfies the two participation constraints.

Further, we need to show that the belief of the local firm that MNC will give  $t_2$  under EPA is credible. For this we need to satisfy the truth telling constraint for the MNC. So we need

$$\begin{aligned} \bar{\alpha}\Pi_2 - v_2 &> \bar{\alpha}\Pi_1 - v_1 \\ \Rightarrow \bar{\alpha}(\Pi_2 - \Pi_1) &> (v_2 - v_1) \end{aligned} \quad (3.3)$$

If (3.3) does not hold then there does not exist any ' $\alpha$ ' less than ' $\bar{\alpha}$ ' that induces the local firm to believe that the MNC will give  $t_2$  under EPA and EPA cannot dominate TLA. Again, it is not possible to offer any ' $\alpha$ ' greater than ' $\bar{\alpha}$ ' since it will not satisfy the participation constraint of the local firm. So, this condition is a necessary condition.

If (3.3) holds then it is a credible belief for the local firm that the MNC will give  $t_2$  under EPA when it announces ' $\bar{\alpha}$ ' and ' $\bar{\alpha}$ ' satisfies other two participation constraints. Hence this is sufficient also. ■

Now see the implications of  $\Pi_2 > 2\Pi_0$ . With  $\Pi_2 > 2\Pi_0$  we get that  $\bar{\alpha} > \frac{1}{2}$ . This implies that the MNC has the control over the joint venture firm. If in the EPA arrangement the MNC cannot prevent the local partner from imitating the technology anyway then it may be possible

for the local firm to imitate the technology and opens a new local subsidiary. However, as the MNC has the control over the JV firm then this new subsidiary has to compete with the JV firm and assuming price competition with homogeneous good both firms' operating profit will be zero and so by doing this the local firm's net payoff, with sunk investment cost,  $F$ , will be negative. Otherwise, it can get  $\Pi_0 > 0$ . So, it is not in the interest of the local firm to do this.<sup>14</sup>

The above game is shown in Figure 2 where payoffs are the payoffs from the concerned project.

Figure 2

This Figure 2 assumes that  $\alpha(\Pi_2 - \Pi_1) > (v_2 - v_1)$  is being satisfied. Solving this game through backward induction and with the assumptions made for the local firm's behavior we get the equilibrium as (EPA, Accept).

Next we consider the situations where imitation costs are positive and the next Proposition follows immediately.

**Proposition 3.2.2** *For imitation costs  $I < (v_2 - v_1)$ , Proposition 3.2.1 holds.*

**Proof :** If imitation cost  $I < (v_2 - v_1)$ , then it is in the MNC's interest to give  $t_1$  under TLA. Because for  $t_2$  it can get only upto  $(x + I)$ <sup>15</sup> where the MNC gets  $x$  up-front and  $I$  as an ex post fixed fee, but loses  $v_2$  while for  $t_1$  it can get only  $x$  for  $x \geq (\Pi_1 - \Pi_0)$ <sup>16</sup> but loses  $v_1$ . Since  $I < (v_2 - v_1)$ ,  $x + I - v_2 < x - v_1$ . Therefore, here the MNC prefers to give  $t_1$  under TLA. Knowing this the local firm is willing to give  $x$  at most  $(\Pi_1 - \Pi_0)$ . Therefore, here also  $t_1$  will be transferred and the MNC will get an up-front fee  $(\Pi_1 - \Pi_0)$ .

But with the satisfaction of (3.3), the MNC can get  $(\Pi_2 - \Pi_0)$  for the technology  $t_2$  and  $t_2$  will be transferred, as shown in Proposition 3.2.1. ■

Next we consider the value of  $I$  such that  $I > (v_2 - v_1)$ .

**Proposition 3.2.3** *If we have  $I > (v_2 - v_1)$ , then under TLA it is better for the MNC to give  $t_2$  and the MNC is indifferent between EPA and TLA provided (3.3) holds.*

**Proof :** If  $I > (v_2 - v_1)$ , then the MNC's benefit from cheating is less than the amount it can get ex post. So for any up-front fee greater than or equal to  $(\Pi_1 - \Pi_0)$  the MNC cannot get anything more if  $t_1$  is transferred but can get  $I$  ex post (while the total payment for  $t_2$  must not exceed  $(\Pi_2 - \Pi_0)$ ), which is greater than its cost saving from giving  $t_1$  rather than  $t_2$ , if it gives  $t_2$  under TLA. Since it is better for the MNC to give  $t_2$  in TLA, the local firm accepts

<sup>14</sup>If we assume quantity competition then we need some other conditions also to prevent the local firm from doing this.

<sup>15</sup>For this solution concept one may see Gallini and Wright (1990).

<sup>16</sup>Actually there is no reason for  $x$  to be less than  $(\Pi_1 - \Pi_0)$  since the local firm always wants to give for  $t_1$  at most  $(\Pi_1 - \Pi_0)$ .

an up-front fee equal to  $(\Pi_2 - \Pi_0 - I)$  because now it is better for the MNC to give  $t_2$  and get another  $I$  rather than to give  $t_1$  and get nothing more since

$$\Pi_2 - \Pi_0 - I - v_1 < \Pi_2 - \Pi_0 - I + I - v_2$$

So under TLA the MNC gets  $(\Pi_2 - \Pi_0)$  for  $t_2$  and gives  $t_2$ .

Now consider EPA. With the satisfaction of (3.3), the MNC can get  $(\Pi_2 - \Pi_0)$  while gives  $t_2$ . So, in this case these two offer are same for the MNC. ■

From the above three Propositions we see that if (3.3) holds then EPA is always preferable arrangement for the MNC except for the Proposition 3.2.3 where the MNC is indifferent between TLA and EPA. We see that JV agreement helps to prevent imitation by the local firm while at the same time satisfying the incentive compatibility constraint of the MNC.

Now consider that  $v_1 = v_2 = 0$ . With this change, incentive for the MNC to cheat under the TLA disappears. So the local firm may want to give  $(\Pi_2 - \Pi_0)$  up-front and the MNC gives  $t_2$ .

So far we have considered only the possibility of profit sharing under EPA.<sup>17</sup> Also we have considered the case of  $\bar{\alpha} > \frac{1}{2}$ . Now we see how the analysis will be affected for  $\bar{\alpha} < \frac{1}{2}$  and also allow the provision of fixed fee or output based royalty payment along with profit sharing under EPA.

We have seen that if  $\bar{\alpha} (> \frac{1}{2})$  is allowed and (3.3) is satisfied then there is no need for any up-front fixed fee/royalty payment in EPA. Assume that  $\bar{\alpha}$  is allowed but  $\Pi_2 < 2\Pi_0$ , that in turn, implies that  $\bar{\alpha} < \frac{1}{2}$ . Also assume that (3.3) holds. So truth telling constraint of the MNC is satisfied at  $\bar{\alpha}$ . But now local firm has control over the JV and it gives the local firm the power to take the output decision of the JV. Imitating the foreign technology, the local firm may close the JV firm and operate a 100% own new subsidiary, if it wants (i.e., none, eg., regulatory body, can prevent it from doing that). However, even in this situation the local firm will operate the JV firm and will not open its 100% own new subsidiary iff

$$(1 - \bar{\alpha})F \geq \Pi_2 - \Pi_0 - I \quad (3.4)$$

Therefore, even if  $\bar{\alpha} < \frac{1}{2}$ , the JV will continue its production iff the above condition (3.4) holds. This condition shows that it is better for the local firm to operate the JV firm rather than to imitate the MNC's technology, open a 100% own new subsidiary and produce zero output in the JV firm. Therefore, Propositions 3.2.1 - 3.2.3 will hold even if  $\Pi_2 < 2\Pi_0$  but (3.3) and (3.4) are satisfied. Also see that in these situations only profit sharing under EPA is enough for the MNC to make EPA at least as good as TLA.

So far we have concentrated only on profit sharing under EPA. Further, we have assumed that government allows  $\bar{\alpha}$  to hold by the MNC. But government regulation may prevent the

~~that~~ This may be the result of a government policy that prevents royalty provision in JV. Tang and Yu (1990), in a ~~model~~ with complete information, also considered the optimal entry policy of a foreign firm in a developing country ~~under these~~ type of policy restrictions.

MNC from holding  $\alpha$  proportion of share in the JV. Without the possibility of royalty payment in EPA makes it is difficult to satisfy the truth telling constraint of the MNC. Further, in this situation only profit sharing in EPA will leave some surplus to the local partner. But the provision of royalty payment along with profit sharing under EPA may help to satisfy the truth telling constraint and can lead to greater profit extraction by the MNC. More specifically, with the provision of output based lump sum royalty  $L$  paid by the local partner to the MNC, up-front fixed fee  $H$  paid by the local partner to the MNC and profit sharing under EPA, MNC will have to satisfy the following constraints:<sup>18</sup>

$$\alpha\Pi_2 + L - v_2 \geq \alpha\Pi_1 - v_1 \quad (3.5)$$

$$H + \alpha\Pi_2 + L - v_2 > \Pi_1 - \Pi_0 - v_1 \quad (3.6)$$

$$(1 - \alpha)\Pi_2 - H - L \geq \Pi_0 \quad (3.7)$$

$$I \geq L \quad (3.8)$$

$$(1 - \alpha)F \geq \alpha\Pi_2 + L - I \quad (3.9)$$

Condition (3.5) is the truth telling constraint. We assume that MNC will give  $t_2$  if it cannot gain by giving  $t_1$ . Condition (3.6) says that it is better for the MNC to give an EPA offer and to give  $t_2$  rather than TLA and giving  $t_1$ . This take-it-or-leave-it offer will be accepted by the local firm provided (3.7) is satisfied with (3.5). Conditions (3.8) and (3.9) are the conditions need to prevent imitation by the local firm in the JV.

In case MNC controls the JV, then (3.8) and (3.9) are not relevant since the local firm will not imitate here.<sup>19</sup> The reason is similar to the previous Propositions. If local firm controls the JV (i.e., taking all major decisions in the JV) then both (3.8) and (3.9) are relevant. Here the constraint (3.8) shows that if the MNC charges  $L$  higher than  $I$  then it will be better for the local partner (who is the controlling partner of the JV) to imitate the MNC's technology and to produce with this imitated technology in the JV, if it produces in the JV. While imitating the MNC's technology under EPA, local partner has another incentive to produce zero output in the JV and operating its 100% own new subsidiary with this imitated technology. To prevent this, we need to satisfy the constraint (3.9). Therefore, in case of local partner controls the JV, (3.8) and (3.9) are valid constraints.

However, with local partner control, MNC may have a say to the use of the technology in the JV. In such a situation, MNC can prevent production in the JV with the imitated technology

<sup>18</sup>Assuming  $I < v_2 - v_1$ .

<sup>19</sup>Like the royalty payment of Gallini and Wright (1990),  $L$  will be determined in a similar fashion. However, one has to careful while considering output based royalty in EPA since MNC may have incentive to produce that critical output with bad technology for getting the royalty payment and also saving cost when MNC controls the JV. Then both output level and amount of royalty payment can be used to satisfy truth telling constraint or JV may be operated by a management who does not look at the partner's interest.



and (3.8) is not a valid constraint now. But (3.9) remains a constraint as the local partner takes the output decision of the JV.

With a restriction on the royalty payments from the affiliates to the foreign partner due to government regulation, such as in Colombia (see, Tang and Yu, 1990, p. 482), flexibility of the MNC is reduced. Sometime there exists a minimum value of ownership share that gives a partner to influence major decisions of the JV.<sup>20</sup> With this possibility, it is more unlikely for the MNC to reduce  $\alpha$  from that critical level because this critical level will help the MNC to influence major decisions in the JV, which in turn will help to relax some constraints. Further, note that under EPA, it is better for the MNC to make output based royalty than up-front fixed fee. Even if this up-front fixed fee helps to satisfy (3.6), it makes difficult to satisfy truth telling constraint as higher  $H$  implies lower  $\alpha$  and/or  $L$ . But a lump sum output based royalty payment helps to relax this constraint also as the truth telling constraint is independent of  $H$ .

To sum up, in a world where other possible arrangements like countertrade arrangement and licensing agreement cannot solve the problem addressed here, a joint venture arrangement (which may include royalty payments/up-front fixed fee) is likely to be a preferred instrument.

### 3.3 Problem with one technology

Now consider a problem very similar to that of Gallini and Wright (1990) and assume  $v_1 = v_2 = 0$ . Rather than having two foreign technologies we consider a case where the foreign technology supplier has one technology, which may be good or bad. The domestic monopolist has the option to purchase the foreign technology and the foreign technology supplier is itself a monopolist with respect to the local firm and the MNC gives a take-it-or-leave-it offer to the local firm. Consider that the agents are risk neutral.

Suppose the MNC has actually the good technology which can yield profit  $\Pi_2$ , but the MNC's problem is that it cannot convince the local firm about the type of the technology. Appealing to Myerson (1979), we look for a set of contracts that induces truthful reports by the licensor regarding the innovation type. We focus on separating equilibrium contracts. Further, to avoid the problems due to the arbitrariness of off-equilibrium beliefs, we consider the set of equilibrium contracts by eliminating the dominated ones as proposed by Milgrom and Roberts (1986).<sup>21</sup>

Again imitation cost plays a crucial role and for  $I \in [0, \Pi_2 - \Pi_0]$  it is not in the MNC's interest to allow direct inspection of the technology by the local firm before its purchase. Therefore, the

<sup>20</sup>Bhandari (1997) has addressed related issues.

<sup>21</sup>A contract  $g$  is dominated for the type  $i$  licensor if, under the most optimistic belief of the licensee, it yields lower payments to the licensor than does  $g'$ , whatever the licensee's belief. In a separating equilibrium a contract for low-cost licensor must satisfy the incentive compatibility constraint. In particular, a contract with fixed fee  $\Pi(c'_1)$  will not give the high-cost licensor less payoff than a situation where he or she accepts the contract for low-cost licensor. So, a contract for low-cost licensor satisfying incentive compatibility is (weakly) dominated by the contract with fixed fee  $\Pi(c'_1)$  for high-cost licensor; hence it is reasonable for licensee to presume that such contract for low-cost licensor would not be accepted by a high-cost licensor.

MNC wants to signal the technology and we want to see whether it is better for the MNC to opt for TLA or EPA. Further we assume that  $\Pi_1 > 2\Pi_0$ .<sup>22</sup> Like the previous section, we prove the Propositions of this section under this assumption. Then we relax this assumption and discuss for  $\Pi_1 < 2\Pi_0$ .

First we consider the case where  $I = 0$ .

**Proposition 3.3.1** *EPA dominates TLA for the MNC holding a good type technology and it gets  $(\hat{\alpha} - \epsilon)\Pi_2$  under EPA, where  $\hat{\alpha} = \frac{(\Pi_1 - \Pi_0)}{\Pi_1}$  and  $\epsilon > 0$  but very small.*

**Proof:** Since ex ante the local firm cannot know the type of the technology and since  $I = 0$ , the MNC charges an up-front fee from the local firm under TLA and the MNC can get at most  $(\Pi_1 - \Pi_0)$  as an up-front fee. So, even if the MNC has good type technology, it can get only  $(\Pi_1 - \Pi_0)$  through TLA.<sup>23</sup>

Let us see what will happen if the MNC with a good technology opts for EPA. For EPA to be a successful device, we need that the EPA offer of the MNC with good type technology cannot be mimicked by the monopolist if it has a bad technology. That means if the monopolist with bad technology mimic this EPA offer rather than giving a TLA offer, it will be worse off.

Consider the maximum share in the EPA the monopolist with the bad technology requires to be indifferent between the TLA and EPA. We see that it gives a critical value of  $\alpha$  since we need for this

$$\alpha\Pi_1 = (\Pi_1 - \Pi_0)$$

This gives  $\hat{\alpha} = \frac{(\Pi_1 - \Pi_0)}{\Pi_1} < 1$ .

So we see that the MNC with bad technology will not mimic the EPA offer where the MNC wants to hold  $(\hat{\alpha} - \epsilon)$  share in EPA. Therefore, if the MNC has a good technology then it can announce that it wants to hold  $(\hat{\alpha} - \epsilon)$  fraction in EPA and if this offer is accepted then the

<sup>22</sup>This condition plays the same role as that of  $\Pi_2 > 2\Pi_0$ .

<sup>23</sup>This  $(\Pi_1 - \Pi_0)$  amount of fixed fee will be charged in the equilibrium as we are looking at the separating equilibrium. However, the MNC of good type can charge an up-front fixed fee  $k = p\Pi_2 + (1-p)\Pi_1 - \Pi_0$ , where  $p$  is the prior probability that the technology is of type  $t_2$ . This  $k$  is higher than  $(\Pi_1 - \Pi_0)$ . The licensee can pay  $k$  as it guarantees the licensee its expected payoff equal to  $\Pi_0$ . But this offer will lead to a pooling equilibrium because it will be mimicked by the licensor of bad type as  $k > \Pi_1 - \Pi_0$ . Now assume that there is an arbitrator (say, a regulatory body) and it approves the contract. While approving the contract, it wants socially desirable contract in the sense that the contract will reveal the true type of the licensor, whenever it is possible. This role of arbitrator, however, will lead to the equilibrium contract with fixed fee  $(\Pi_1 - \Pi_0)$  rather than a contract that generates pooling equilibrium. Strictly speaking, for  $I = 0$ , one cannot generate separating equilibrium as both will offer only up-front fixed fee. But a positive imitation cost will justify the role of the arbitrator. Thus, except this borderline case, one can justify the reason for looking at the separating equilibrium. However, to maintain the similarity throughout the analysis, we focus on separating equilibrium even for zero imitation cost.

Since the JV gives an ownership benefit, it helps to reduce imitation threat more effectively and may help to extract more surplus by the licensor. Further, it is easier to get separating equilibrium under JV. Thus, our qualitative results will go through even if we consider pooling equilibrium. However, following Gallini and Wright (1990) and appealing to Myerson (1979), in this chapter and in the following chapter, we focus on separating equilibrium contracts.

MNC gets  $(\hat{\alpha} - \epsilon)\Pi_2$  which is greater than  $(\Pi_1 - \Pi_0)$ . However, for the local firm to accept this offer we need to satisfy its participation constraint. And it can be shown easily that the local firm's participation constraint is satisfied. ■

Figure 3 shows the Proposition 3.3.1.

**Figure 3**

From Figure 3 we see that if the MNC has good technology and offers EPA then it will get  $AB$ . But if the MNC with bad technology wants to mimic this offer then it will get  $BD$  while from TLA it gets  $CB > BD$ .

From figure 3 the following Proposition is immediate.

**Proposition 3.3.2** *If  $I \in (0, \hat{\alpha}\Pi_2 - (\Pi_1 - \Pi_0))^{24}$  then EPA dominates TLA.*

**Proof :** For  $I \in (0, \hat{\alpha}\Pi_2 - (\Pi_1 - \Pi_0))$ , the MNC with good technology can signal the type of the technology through TLA and can get  $(\Pi_1 - \Pi_0 + I)$ .<sup>25</sup> But with EPA it can get  $(\hat{\alpha} - \epsilon)\Pi_2$  (where  $\epsilon > 0$  can be chosen as small as one wishes), which is greater than  $(\Pi_1 - \Pi_0 + I)$ . And this EPA offer will not be mimicked by the MNC with bad technology. Because if the MNC with bad technology wants to mimic this EPA offer then it will get less than TLA. ■

Now we see for the value of  $I \in [\hat{\alpha}\Pi_2 - (\Pi_1 - \Pi_0), \Pi_2 - \Pi_1]$ .

**Proposition 3.3.3** *For  $I \in [\hat{\alpha}\Pi_2 - (\Pi_1 - \Pi_0), \Pi_2 - \Pi_1]$ , TLA dominates EPA.*

**Proof :** For  $I$  belonging to this range it is not possible for the EPA offer to satisfy both objectives - to signal that the technology is a good type and to get at least that profit which TLA gives to the MNC having good technology. This is clear from figure 3. For this two objectives to be satisfied simultaneously the MNC with good technology needs to announce more than  $\hat{\alpha}$  in EPA. But then this offer will be mimicked by the MNC with bad technology and so it violates first objective and if good type announces  $(\hat{\alpha} - \epsilon)$  then it will get less than TLA and so it violates second objective. ■

From the above analysis we see that for  $I \in [0, \hat{\alpha}\Pi_2 - (\Pi_1 - \Pi_0)]$  EPA dominates TLA for the MNC with good technology.

Propositions 3.3.1 - 3.3.3 are derived under the assumption of no provision of royalty payment. Assuming  $\hat{\alpha} > \frac{1}{2}$  and with the provision of royalty payment, MNC may offer a combination of  $\hat{\alpha} - \epsilon$  and  $L$  such that it gets  $\Pi_2 - \Pi_0$  and this offer will not be mimicked by the seller with bad

<sup>24</sup>Previous proposition captures the case of  $I = 0$ .

<sup>25</sup>See, Gallini and Wright (1990). As in footnote 23, the licensor of good type can offer a contract that will give it more payoff than  $(\Pi_1 - \Pi_0 + I)$ ; in particular, an up-front fixed fee,  $h = p\Pi_2 + (1 - p)\Pi_1 - pI - \Pi_0$ , and a lump sum royalty,  $I$ , based on the output level. This will leave the expected payoff of the licensee equal to  $\Pi_0$  as  $p(\Pi_2 - h - I) + (1 - p)(\Pi_1 - h) = \Pi_0$ . But this contract  $(h, I)$  will be mimicked by the licensor of bad type as  $h > \Pi_1 - \Pi_0$  for  $p > 0$ . Hence like Gallini and Wright (1990) and appealing to Myerson (1979),  $(h, I)$  will not be the equilibrium contract.

technology. Here the MNC can charge an output based lump sum royalty so that this royalty payment will be obtained iff output exceeds certain amount. Therefore, this output level can be chosen in such a way that it is not better for the seller with bad technology to follow this offer. Thus we have the following proposition.

**Proposition 3.3.4** *If the MNC can charge output royalty along with equity share under EPA then even for  $I \in [\hat{\alpha}\Pi_2 - (\Pi_1 - \Pi_0), \Pi_2 - \Pi_1]$ , EPA will dominate TLA.*

**Proof:** If allowed  $L > \Pi_2 - \Pi_0 - \hat{\alpha}\Pi_2$  then MNC with better technology can always make an EPA offer that consists of  $\hat{\alpha} - \epsilon$  and  $L = \Pi_2 - \Pi_0 - (\hat{\alpha} - \epsilon)\Pi_2$ . This proves the result. ■

In Proposition 3.3.4, we have assumed that there always exists a value of output, which is less than the monopoly output with marginal cost of production  $c_2$ , such that the MNC with bad technology will have no incentive to mimic this contract and produce upto that critical output level with bad technology to get royalty payment. Otherwise, the MNC with good technology has to sacrifice some surplus by reducing the amount of royalty payment and/or by deviating from its profit maximizing output level. In this situation, again we may get a critical value of imitation cost, say  $I^*$ , so that for  $I \in (I^*, \Pi_2 - \Pi_1]$ , TLA dominates EPA. Therefore, with Proposition 3.3.4, one can say that the profit is distributed in proportion to the true bargaining power of the partners. This is a similar finding of Svejnar and Smith (1984). But, in case the MNC with good technology has to sacrifice some information rent to get the separating equilibrium, then profit is not distributed in proportion to the true bargaining power.

Now assume that government regulation prevents the MNC to hold  $\hat{\alpha}$  fraction but it can hold upto a level which is greater than  $\frac{1}{2}$ . In this situation, an EPA arrangement with only profit sharing makes TLA better option than EPA for a larger range of imitation cost than the one mentioned in Proposition 3.3.3. But the introduction of royalty payment too may make EPA more attractive. However, in this situation one has to be cautious because now the MNC with bad technology has an incentive to mimic the offer by a MNC with good technology to get the royalty payment. Since the MNC now holds relatively less amount of equity share, its loss from producing an output level different from its profit maximizing output is less but the gain from royalty payment is more than where MNC can hold  $\hat{\alpha}$  fraction. It makes more difficult to get separating equilibrium and as a result it is relatively more likely that MNC with good technology has to sacrifice information rent than where it is allowed to hold  $\hat{\alpha}$ . Further, in the EPA, MNC may charge up-front fixed fee too. But it creates more difficulty to get the separating equilibrium than output based royalty payment. In general, the MNC with good technology needs to satisfy the following constraints while offering an EPA offer:

$$H + \alpha\Pi_2 + L \geq \Pi_1 - \Pi_0 + I \quad (3.10)$$

$$(1 - \alpha)\Pi_2 - H - L \geq \Pi_0 \quad (3.11)$$

$$H + \alpha\Pi_1 \leq \Pi_1 - \Pi_0 \text{ and } H + \alpha\tilde{\Pi}_1 + L \leq \Pi_1 - \Pi_0 \quad (3.12)$$

First constraint shows that MNC with good technology prefers EPA to TLA and second constraint says that this EPA offer will be accepted by the local firm. Constraint (3.12) shows that this EPA offer will not be mimicked by the MNC with bad technology and  $\bar{\Pi}_1$  shows the profit of the JV firm when it is operated with  $t_1$  technology and producing the critical output level necessary to get the royalty payment.<sup>26</sup>

So far we have assumed that  $\alpha > \frac{1}{2}$  and MNC controls the JV. Now consider local firm controls the JV. Assume that  $\Pi_1 < 2\Pi_0$  and it implies that  $\hat{\alpha} < \frac{1}{2}$ . First, assume that EPA consists of only profit sharing arrangement.

Under the local firm control of the JV, there is always the possibility that local firm can produce none in the JV and operate its 100% own subsidiary. We see whether this power of the local firm helps the MNC with good technology to hold  $\alpha \in (\hat{\alpha}, \frac{1}{2}]$ .<sup>27</sup> Even with no fixed fee and/or royalty payment, if the MNC with good technology wants to hold higher  $\alpha$  than  $\hat{\alpha}$ , then it may induce the MNC with bad technology to mimic this offer. If the local partner accepts this offer which actually comes from a MNC with bad technology, even then it will continue to produce in the JV provided

$$(1 - \alpha')\Pi_1 + (1 - \alpha')F > \Pi_0, \text{ when } \Pi_0 > \Pi_1 - I \quad (3.13)$$

$$(1 - \alpha')\Pi_1 + (1 - \alpha')F > \Pi_1 - I, \text{ when } \Pi_1 - I > \Pi_0 \quad (3.14)$$

where,  $\alpha' \in (\hat{\alpha}, \frac{1}{2}]$ . Hence, in this situation local firm will not accept an offer with  $\alpha = \alpha'$  and the analysis will be similar to the situation where the MNC with good technology holds  $\hat{\alpha}$  fraction of equity shares provided

$$(1 - \hat{\alpha})F + (1 - \hat{\alpha})\Pi_2 \geq \Pi_2 - I \quad (3.15)$$

If  $\hat{\alpha}$  cannot satisfy (3.15) then a lower  $\alpha$  than  $\hat{\alpha}$  can help to satisfy it but at the same time it reduces profit extraction from EPA relative to TLA with the absence of any fixed fee and/or royalty payment. On the other hand, if  $(1 - \alpha')F + (1 - \alpha')\Pi_1 < \max\{\Pi_1 - I, \Pi_0\}$ ,  $\alpha' \in (\hat{\alpha}, \frac{1}{2}]$ , then the local firm will operate its 100% own subsidiary if it accepts the offer of  $\alpha'$  of a MNC with bad technology. Hence, the MNC with bad technology will get none from this EPA offer and this may help the MNC with good technology to offer  $\alpha' \in (\hat{\alpha}, \frac{1}{2}]$  provided<sup>28</sup>

$$(1 - \alpha')F + (1 - \alpha')\Pi_2 \geq \Pi_2 - I \quad (3.16)$$

If government regulation induces the MNC to hold  $\alpha < \hat{\alpha}$  then the MNC will be able to hold upto the government permitted level and it will prefer EPA provided it allows the MNC to get more than TLA and satisfies (3.16) too with the offered  $\alpha$ . Same will occur even if  $\Pi_1 > 2\Pi_0$ , but MNC is allowed to hold upto a level which is less than  $\frac{1}{2}$ .

<sup>26</sup> Assuming that the critical output level is different from that of the profit maximizing output level corresponding to  $t_1$  technology.

<sup>27</sup> Assuming  $\Pi_2 > 2\Pi_0$ .

<sup>28</sup> Both (3.16) and  $(1 - \alpha')F + (1 - \alpha')\Pi_1 < \max\{\Pi_1 - I, \Pi_0\}$  can be satisfied simultaneously only if  $\Pi_0 > \Pi_1 - I$ .

Now consider that the MNC can charge up-front fixed fee,  $H$ , and output based royalty payment,  $L$ , along with profit sharing arrangement. Here, the MNC with good technology needs to satisfy the following conditions while offering EPA:

$$H + \alpha\Pi_2 + L \geq \Pi_1 - \Pi_0 + I \quad (3.17)$$

$$(1 - \alpha)\Pi_2 - H - L \geq \Pi_0 \quad (3.18)$$

$$L \leq I \quad (3.19)$$

$$(1 - \alpha)F \geq \alpha\Pi_2 + L - I \quad (3.20)$$

$$\Pi_{MNC}(H, \alpha, L; t_1) \leq \Pi_1 - \Pi_0 \quad (3.21)$$

The constraints (3.18), (3.19) and (3.20) and their implications are similar to (3.7), (3.8) and (3.9) respectively. Constraint (3.17) means that MNC with good technology prefers EPA than TLA and (3.21) shows that this EPA offer will not be mimicked by the MNC with  $t_1$  technology.

Therefore, from the above analysis we can say that for sufficiently low imitation cost EPA is a preferred arrangement than pure technology licensing to the technology seller. However, royalty payment and/or fixed fee along with profit sharing is likely to increase the preference for joint venture even for relatively higher imitation cost.

If the JV is controlled by the local firm then the finding that the profit of the JV is distributed according to the true bargaining power may be less likely to hold due to the threat of opening up a 100% own subsidiary by the local firm and zero production in the JV.

### 3.4 Conclusion

This chapter deals with a problem related to technology transfer. We consider a situation where the quality of the technology to be transferred is private information of the technology seller. Countries looking for foreign technology may face this problem. While the developing countries are liberalizing their economy towards foreign investment, they are interested in the collaborative agreements rather than 100% foreign investment. We have shown that if the technology supplier cannot convince the technology buyer about the type of the technology, then for most of the cases the MNC prefers EPA than TLA as an entry strategy. Only for Proposition 3.2.3 and for Proposition 3.3.3 EPA will not dominate TLA. Hence, in general, for low imitation costs EPA dominates TLA. We also argue that if the MNC has freedom to choose output based royalty along with equity share under EPA, then it is more likely that EPA will not be dominated by TLA and this alters Proposition 3.3.3.

## Chapter 4

# Future Benefit: One Motive for Joint Venture Formation<sup>1</sup>

### 4.1 Introduction

In this chapter we draw our attention to the formation of JV for sharing expected future benefits as distinct from current benefits. This issue has been more or less ignored in the literature so far. Based on interview, Saqib (1995) notes that Indian 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. In fact, almost 60% of the respondents seem to attach a high importance to this factor. However, technologies transferred in future are not available as free lunch; it requires additional payments. In this chapter we argue that even if there may be no immediate benefit from the JV formed currently, the local firms think that there may be some long term benefits particularly when the foreign partner, called MNC, brings a new technology.

Theoretically this is an intriguing problem because if the foreign partner does have a new technology in the future, *ceteris paribus*, it may license the technology to any firm, not necessarily to its own subsidiary in the host country. 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. However, if for some reason the technology generates more payoff to the joint venture, the local partner can always outbid any outside competitor by offering a higher price to the MNC. We also argue that even if technology is given to the local joint venture, it may involve additional payment on top of the additional dividend earned by the MNC from a more profitable venture. This chapter shows how the absence of a credible government policy affects the anticipated future benefits from joint venture. In particular, we argue that if firms believe that in future the government may not continue a more liberal policy (i.e., if the government does not allow new foreign-equity participation in the future), then it is optimal for the local firm and the MNC to

---

<sup>1</sup>This chapter is based on Marjit, Mukherjee and Kabiraj (1997a).

make a JV at the current period.

A salient characteristic of developing countries is the relative instability of their policies. In the initial stage of liberalization, an economy which is liberalizing its policy towards foreign equity participation in the local market may face strong opposition from various quarters. One can interpret that as the outcome of a struggle between pressure groups. Problem of this sort is likely to be prevalent in countries where governments (and finance ministers) rotate rapidly, and in developing countries in particular. This may create difficulty for the private sector to tell how serious the government really is about the reform process or the private sector is just confused with an alternative government whose objectives differ. Thus private sector may be skeptical about the continuance of the government policy. This chapter focuses on this source of credibility problem in the policy of the host government and tries to show how this policy uncertainty plays a role to the formation of JV. Hence, this work falls in the class of literature where policy uncertainty may give firms incentive for making JV (see, Marjit, 1990a, 1998 (forthcoming), Marjit et al., 1995, Das, 1995, 1996, etc.).<sup>2</sup>

We consider a different type of government policy uncertainty, viz., the policy uncertainty regarding foreign ownership of domestic business in future. This policy uncertainty along with the threat of entry provides the rationale for a local firm to go for a JV even if this JV does not give any immediate benefit to the local firm. We consider a situation where the MNC invents a superior technology in future and at present has a technology which is as good as the technology of the incumbent local firm. With a new entrant in the domestic market in future, the MNC finds two potential bidders for its new technology (if invented). Without any restriction on the profit extraction, the MNC will be able to extract all the surplus generated from its superior technology. But if it cannot extract full surplus for any reason, some of this surplus will be left to the buyer. In case of policy reversal (i.e., not allowing new foreign equity participation in future), the asymmetric information with the threat of imitation by the licensee may prevent the MNC from extracting full surplus generated from its superior technology. Hence the remaining surplus is left with the local firm. With the threat of entry, it is possible that the entrant wins the technology bid and captures the surplus. Such a possibility in the future gives an incentive to the local incumbent to go for a JV today even with no immediate gain. Such a JV formation acts as a hedging to the local incumbent against the risk of not getting the surplus left to the technology buyer in case of government policy reversal. However, one has to be cautious while focusing on the role of policy uncertainty, threat of entry, etc., for giving a reason for formation of the JV in a situation where it is entirely motivated from future expected benefit, because the decision of JV formation in the current period also depends on the degree of future technological advancement.

We analyze for both drastic and non-drastic innovations. Also, we see how incentive for

---

<sup>2</sup>Al-Saadon and Das (1996) show the optimal sharing in JV with the presence of uncertainty in government tax policy. In different context, see Rodrik (1989), Aizenman (1992) and Buffle (1995) for works on the credibility of the host country government policies.



making a JV in period 0 is influenced by the initial technology level of the entrant.

This chapter is divided into three sections. The second one analyses the model and the last section concludes the chapter.

## 4.2 Model

We consider a two period model with the following scenario. Think of a transitional economy which is so far protected by a prohibitive tariff and which does not allow any foreign equity participation into the domestic economy. At  $t = 0$ , it has opened up to less than 100% equity ownership of the foreign firm but there is an element of uncertainty in the continuation of the policy in the future. Hence there is a positive probability that the economy may backtrack from its liberalization policy and may not allow any new foreign equity ownership agreement.<sup>3</sup> Let  $q > 0$  be the probability that in future the host country government will not allow any new foreign equity participation arrangement but only allow technology transfer, so  $(1 - q)$  is the probability that in future the government will continue the present period policy (i.e., will allow both technology transfer (TT) and JV).<sup>4</sup> Further assume that all contracts (either JV or TT), if any, are made at the beginning of any period.

At  $t = 0$ , there are two firms, one domestic and one foreign, each with the identical production technology. We call these firms as incumbent and MNC respectively. The technology corresponds to a marginal cost of production  $c_1$  which is constant and equal to the average cost of production.<sup>5</sup> We suppose that initially there is no technological advantage that may result in a technology deal between the firms through JV or TT.

Then we assume that, at  $t = 1$ , one entrant appears in the market with a technology represented by the marginal cost  $c_1$ , and the market is characterized by Bertrand competition. In our analysis, given that the incumbent cannot do any R&D, it has  $c_1$  technology at  $t = 1$ . But we assume that the multinational is capable of emerging with a superior technology, at the beginning of  $t = 1$ , which corresponds to a marginal cost  $c_2$ ,  $c_2 < c_1$  and the decision on R&D does not depend on the profit level of this market. The domestic firms are, however, not sure about the quality of the new technology and thinks that this new technology will yield either

<sup>3</sup>Recently, in India the controversy on the joint venture proposal of Tata-SIA is a classic example of this situation. Though Indian government previously approved foreign equity participation in the Airline sector, recently it has refused to sanction the Tata-SIA joint venture proposal.

<sup>4</sup>In the text we have assumed that the government will either continue its policy on foreign equity participation or backtrack by discontinuing its sanction to new JV in the future. One can, however, include the third possibility that the government will allow 100% foreign equity participation in the future. This will not change the basic conclusion as long as there is a positive probability of backtracking.

<sup>5</sup>We assume that production does not involve any fixed costs. If the project would involve a fixed cost that is spent once-for-all, the incumbent would have to incur it at  $t = 0$  whereas the entrant would incur it at  $t = 1$ . Then the existence of fixed cost would give the incumbent an additional advantage while bidding at  $t = 1$ . Hence, there would be no point of forming JV at  $t = 0$ . However, if production involves a per-period fixed cost or foreign-technology specific cost, then both firms will be symmetric at  $t = 1$  and our argument go through.

(constant) marginal cost of production  $c_2 < c_1$  with probability  $p$  or  $c'_1$ ,  $c_2 < c'_1 < c_1$  with probability  $(1 - p)$ . Further assume that there is an incompleteness in research contracts. More specifically, following the literature on contractual incompleteness, we assume that the exact nature of the innovation is ill defined ex ante, so that at the beginning of period 0 it is not possible to make a contract for delivery of innovation but the magnitude of potential benefits to the firms are known.<sup>6</sup> Consider that at the beginning of period 1 the MNC will invent the technology with certainty.<sup>7</sup> We also assume that technology transfer through TT encourages imitation by the licensee with an imitation cost  $I$  whereas in JV the MNC can credibly eliminate the threat of imitation.<sup>8</sup> Hence the entrant cannot extract full rent under TT (see, Gallini and Wright, 1990) but it can extract full rent under JV (see, previous chapter). However, our qualitative results will go through as long as the possibility of imitation is lower with JV than with technology transfer. Insofar as JV is stronger form of vertical integration than TT, it may be reasonable to assume that the threat of imitation under JV is less compared to TT. Thus the MNC can extract higher rent under JV compared to TT.<sup>9</sup> In fact, higher rent extraction in JV compared to TT by the MNC is crucial for the result of this chapter. However, for the simplicity of exposition, we take the extreme route where the threat of imitation is being eliminated totally under JV.<sup>10</sup> Hence, we consider a situation where under JV agreement threat of imitation is eliminated and through suitable combination of equity share, up-front fixed fee and output based royalty the seller can extract full rent arising from its technology. Within this scenario we are interested to see whether it is better for the MNC and the incumbent to make the JV agreement at the beginning of period 0 when the incumbent has nothing to gain from the JV at period 0. We assume that the agents are risk-neutral, all the parameter values are common knowledge and both the incumbent and the entrant have identical beliefs about the quality of the foreign technology. Further, like the previous chapter, assume that outputs are verifiable, while marginal production costs observable ex post by both the MNC and local firms, are not verifiable by a third-party enforcer.

Thus we consider the following game. At the beginning of period 0 the incumbent and the MNC decide whether to make a JV or not (since our model specification shows that initially

<sup>6</sup>See, for example, Grossman and Hart (1986), Aghion and Tirole (1994), Dasgupta and Tao (1995), etc.

<sup>7</sup>This is a simplifying assumption. As long as there is a positive probability of inventing new technology, our results hold.

<sup>8</sup>One can find similar type of assumption in Tang and Yu (1990).

<sup>9</sup>As mentioned earlier, for empirical evidence, one may refer to Mansfield (1994).

<sup>10</sup>Another justification may be to consider that the JV firm is operated by the professional managers who are interested in maximizing the JV profit rather than maximizing the interest of any venturing partner (see, eg., Bresnahan and Salop, 1986, Kwoka, 1992, Darrrough and Stoughton, 1989, etc.). This particular structure of the JV helps to eliminate the conflict between partners. More specifically, here it helps to eliminate the threat of imitation and makes it easier to implement output based royalty under JV agreement. Further, the work of the previous chapter explains when the MNC can extract more surplus relative to TT even when the threat of imitation is same under JV and TT.

there is no possibility of TT). Conditional on JV or no collaboration at the beginning of period 1, the incumbent and the entrant, after the invention of the new foreign technology, bid for this technology simultaneously and once for all. We assume that the government policy uncertainty is resolved before this bidding takes place. We use the solution concept of Nash equilibrium for the bids with the property that no firm wishes to unilaterally change its bid. The firm with the largest bid gets the technology; if both firms give the same offer then the technology is given to one firm randomly between the firms. Suppose  $z$  is the probability that incumbent gets the technology and  $(1 - z)$  is the probability that entrant gets the technology. We assume that the firms will bid for any price that will not make them worse off from not having the technology. Each offer will specify the price for the technology and also the mode of transfer (i.e., JV or TT). Appealing to Myerson (1979), we look for a set of contracts that induces truthful reports by licensor regarding the innovation type. We focus on separating equilibrium contracts. Further, to avoid the problem due to arbitrariness of off-equilibrium beliefs, we assume that the MNC will not accept any (weakly) dominated offer (see Milgrom and Roberts, 1986).<sup>11</sup> After the MNC chooses the best offer, production of period 1 takes place. Figure 4 describes the sequence of moves.

Figure 4

First look at the game of period 1. We first consider the game of period 1 conditional on no collaboration in period 0. Throughout the analysis we assume that  $c_1$  and  $c'_1$  are such that a firm with  $c'_1$  technology will be a restricted monopolist under a price competition between the firms. But we shall examine both restricted and unrestricted monopoly case for a firm with  $c_2$  technology. Firstly, consider that  $c_1$  and  $c_2$  are such that the firm with  $c_2$  technology will be unrestricted monopolist. We have the implied restriction  $\Pi(c'_1) + I \leq \Pi(c_2)$ . For strict inequality imitation is a binding constraint. Then we have the following Lemma.<sup>12</sup>

**Lemma 4.2.1** *Suppose there is no collaboration in period 0.*

(a) *If in period 1 the government does not allow any new JV formation, then both the incumbent and the entrant each will offer two contracts - (i) consists of a fixed fee  $\Pi(c'_1)$ , (ii) consists of a fixed fee  $\Pi(c'_1)$  and an output based royalty  $I$  when  $I$  will be paid iff output exceeds some critical value.*

(b) *If in period 1 the government allows both new JV and TT then both the incumbent and the entrant will offer two contracts - (i) the TT agreement consists of a fixed fee  $\Pi(c'_1)$ , (ii) the JV agreement consists of  $\alpha$  share for the MNC,  $(1 - \alpha)$  share for the domestic firm and an output based royalty  $\Pi(c_2) - \alpha\Pi(c_2)$  when this royalty will be paid iff output exceeds some critical value (specifically, when output exceeds  $q(c_1)$  where  $q(c_1)$  is the output level corresponding to price  $c_1$ ).*

<sup>11</sup>See footnote 21 of previous chapter.

<sup>12</sup>See footnotes 23 and 25 of the previous chapter.

**Proof:** (a) If in period 1 government allows only TT then for the MNC with  $c_1'$  technology, it is optimal for both firms to make an offer price  $\Pi(c_1')$  since for any price offered lower than this, the other firm will get the technology for a slight better offer and none will offer more than this as maximum profit from this technology is given by  $\Pi(c_1')$ .

But for the MNC with  $c_2$  technology, both firms will offer an up-front fixed fee  $\Pi(c_1')$ ; any up-front fixed fee more than this will attract a MNC with  $c_1'$  technology. Also for this MNC with  $c_2$  technology domestic firms will offer an output based royalty  $I$  when output exceeds a critical value.<sup>13</sup> Any royalty offer above  $I$  will not convince the MNC that the buyer will not imitate. Similarly, if any firm offers a royalty less than  $I$  then the other firm can always outbid this firm with a slightly higher bid.

So in Nash equilibrium both firms will offer - (i) one offer with up-front fee  $\Pi(c_1')$  and (ii) one offer with up-front fixed fee  $\Pi(c_1')$  and an output based royalty  $I$ . Since MNC will not accept any (weakly) dominated offer it will accept only fixed fee offer if it has  $c_1'$  technology; MNC with  $c_2$  technology will accept the other offer.

(b) Similarly, when the government allows both JV and TT, the domestic firms will offer an up-front fixed fee  $\Pi(c_1')$  for MNC with  $c_1'$  technology.

Since through a suitably formed JV agreement domestic firms can offer full profit  $\Pi(c_2)$ ,<sup>14</sup> both domestic firms will offer a JV agreement from which the MNC will get  $\Pi(c_2)$ . If one firm offers a less attractive offer for the MNC, then the other firm can always make a better offer than this and get the technology. So, in Nash equilibrium both will offer a suitably formed JV from which the MNC with  $c_2$  technology gets  $\Pi(c_2)$  and only the MNC with  $c_2$  technology will accept this offer. ■

Next consider the game of period 1 conditional on the JV between the MNC and the incumbent in period 0. Here we assume that the MNC can make a new JV (when the government allows new JVs) with the entrant even if it has an existing JV.

Now we have the following Lemma.<sup>15</sup>

**Lemma 4.2.2** *Conditional on JV between the MNC and the incumbent in period 0, if government allows only TT in period 1 then incumbent's and the entrant's offer, targeting a MNC with  $c_1'$  technology, will yield same payoff to the MNC. But while targeting the MNC with  $c_2$  technology, the incumbent can always outbid the entrant and the MNC gets more than  $\Pi(c_1') + I$ .*

**Proof:** Like Lemma 4.2.1, the entrant will give two offers - (i) consists of an up-front fixed fee  $\Pi(c_1')$  (which targets a MNC with  $c_1'$  technology), and (ii) consists of an up-front fixed fee

<sup>13</sup>Here the argument is similar to Gallini and Wright (1990).

<sup>14</sup>See previous chapter for details.

<sup>15</sup>If government allows new JV in period 1, then like Lemma 2.1(b) both firms will offer in such a way that MNC with  $c_2$  technology will get  $\Pi(c_2)$ . The difference is that in this situation incumbent will offer a fixed fee  $\Pi(c_1') - \alpha\Pi(c_1')$  for MNC with  $c_1'$  technology.

$\Pi(c'_1)$  and an output based royalty  $I$  (which targets a MNC with  $c_2$  technology). Any other contract targeting the MNC with  $c_2$  technology will not satisfy the condition for separating equilibrium and no imitation by the entrant. Thus, it is not possible for the entrant to pay more than  $\Pi(c'_1) + I$  to the MNC with  $c_2$  technology.

The incumbent too, targeting the MNC with  $c'_1$  technology, will give an offer in such a way that the MNC will derive exactly same payoff as it can derive from the entrant's offer. For less attractive offer of the incumbent, the entrant can give a slightly better offer and can outbid the incumbent. But for more attractive offer than the entrant's offer specifying an up-front fixed fee  $\Pi(c'_1)$  will not satisfy the incumbent's participation constraint when it beliefs that the MNC has a  $c'_1$  technology. Hence, the incumbent's offer will consist of an up-front fixed fee  $\Pi(c'_1) - \alpha\Pi(c'_1)$ , where  $\alpha$  is the share of the MNC in its existing JV and the MNC will choose the buyer randomly.

While targeting the MNC with  $c_2$  technology, the incumbent will offer an output based royalty payment  $\Pi(c'_1) + I + d - \alpha\Pi(c_2)$  (where  $d > 0$  and very small), for  $\alpha\Pi(c_2) \leq \Pi(c'_1) + I$ . Since, under JV the threat of imitation is being eliminated, incumbent can credibly commit to pay this royalty payment and this helps the incumbent to outbid the entrant. For  $\alpha\Pi(c_2) > \Pi(c'_1) + I$ , the incumbent does not need to offer any royalty payment and the incumbent outbids the entrant. Therefore, the incumbent gets the technology and MNC gets more than  $\Pi(c'_1) + I$ . ■

Following the above analysis we are now in a position to write the two period payoffs of the incumbent and the MNC. Due to simplicity, we consider that discount factor is equal to 1. As long as the discount factor is positive our results will hold. Therefore, the payoffs of the MNC and the incumbent conditional on no collaboration in period 0 are given by, respectively

$$\Pi_m(NC) = q(\Pi(c'_1) + I) + (1 - q)\Pi(c_2) \quad (4.1)$$

$$\Pi_i(NC) = \Pi(c_1) + pq(\Pi(c_2) - \Pi(c'_1) - I) \quad (4.2)$$

And the payoffs of the MNC and the incumbent conditional on JV in period 0 are given by, respectively

$$\Pi_m(JV) = \alpha\Pi(c_1) + q(\Pi(c'_1) + I + s) + (1 - q)\Pi(c_2) \quad (4.3)$$

$$\Pi_i(JV) = (1 - \alpha)\Pi(c_1) + pq(\Pi(c_2) - \Pi(c'_1) - I - s) \quad (4.4)$$

where,  $s = d > 0$ , for  $\alpha\Pi(c_2) \leq \Pi(c'_1) + I$  and  $s = \alpha\Pi(c_2) - \Pi(c'_1) - I > 0$ , for  $\alpha\Pi(c_2) > \Pi(c'_1) + I$ . So, we have the following Proposition.

**Proposition 4.2.1** *If  $\frac{pq(1-z)(\Pi(c_2) - \Pi(c'_1) - I)}{\Pi(c_1)} > 0$  then there will always be a JV in period 0.*

**Proof:** From (4.1) and (4.3) it is clear that (4.3)  $>$  (4.1). So, MNC has always an incentive for JV. From (4.4) and (4.2) we see that (4.4)  $\geq$  (4.2) iff

$$\alpha \leq \frac{pq(1-z)(\Pi(c_2) - \Pi(c'_1) - I)}{\Pi(c_1)} - \frac{pqs}{\Pi(c_1)}. \quad (4.5)$$

Let us define  $\alpha_0$  as a value of  $\alpha$  so that (4.5) holds with equality. Since  $s > 0$  and in a JV  $\alpha \in (0, \bar{\alpha}]$ , where,  $\bar{\alpha}$  is the government regulated upper bound of the foreign equity participation, then for the existence of  $\alpha_0 > 0$ , we need  $\frac{pq(1-z)(\Pi(c_2) - \Pi(c'_1) - I)}{\Pi(c_1)}$  to be positive. Assuming  $\frac{pq(1-z)(\Pi(c_2) - \Pi(c'_1) - I)}{\Pi(c_1)} > 0$ , applying the property of continuity, one can always find  $\alpha_0$  to be positive. This implies that in that situation  $\exists \alpha \in (0, \min\{\alpha_0, \bar{\alpha}\})$  for which the incumbent will go for JV in period 0. ■

Note that if imitation cost is non-binding, i.e.,  $\Pi(c_2) \leq \Pi(c'_1) + I$ , then there will be no JV in period 0. This shows that if the MNC can extract same rent from each of JV and TT agreements then there will be no JV in period 0. Also this implies that if patent protection is sufficiently weak then this gives the incumbent an incentive to go for a JV in period 0. Since weak patent protection prevents the MNC to extract full surplus generated from its technology under TT, it leaves some profit to the licensee. This benefit induces the incumbent to go for a JV in period 0 so that in period 1 it can get this surplus if the MNC is compelled to make any entrance in the future period with the entrant. However, even if  $\Pi(c_2) > \Pi(c'_1) + I$ , the JV will not occur in period 0 if there is no threat of entry in period 1 (i.e., if  $z = 1$ ). The absence of the threat of entry removes the fear of the incumbent of losing MNC's technology in period 1 and gives no incentive to go for JV in period 0. Further with no perception of government policy reversal (i.e.,  $q = 0$ ) the incumbent will not go for JV in period 0. If the government can credibly commit that it will continue its liberalization policy, i.e., it will allow new JV in period 1, then the MNC will be able to extract full surplus generated from its technology in period 1. So, there is no sense in sacrificing present profit by the incumbent. Therefore, if all these things hold simultaneously then the incumbent will go for JV in period 0 even if it does not get any benefit immediately.

Though we have considered a simple model to highlight the reason for making a JV by a local firm entirely due to expected future benefit, this model can help us to give some insight regarding social welfare of the domestic country and the sharing by the two partners in the JV. Assume that the MNC holds a fraction  $\beta$  of this  $\min\{\alpha_0, \bar{\alpha}\}$  in the JV. This fraction may represent bargaining power of the MNC. Therefore, the local incumbent holds  $(1 - \beta)\min\{\alpha_0, \bar{\alpha}\} + (1 - \min\{\alpha_0, \bar{\alpha}\})$  in the JV. Now we see that with the increase in the number of potential entrants in the future period, the value of  $z$  is more likely to go down. This implies that other things remaining the same a rise in the number of potential entrants will lead to a relatively higher value of  $\alpha_0$  and a more sacrifice of the present profit by the local incumbent (assuming  $\alpha_0 < \bar{\alpha}$ ). Similarly, ceteris paribus, higher belief of the local firms regarding low-cost technology of the MNC or more uncertainty in the government policy continuation may be a reason for less share holding by the local firm. If the government can credibly commit to the continuation of its present policy then local firm will not have incentive for sacrificing its present profit here. Thus, even if the government's intention is to carry forward its liberalized policy, the problem of making credible commitment will give the local firm incentive to sacrifice its present profit and will imply a loss in the domestic producer surplus in the first period while in the future MNC extracts total surplus

Let us define  $\alpha_0$  as a value of  $\alpha$  so that (4.5) holds with equality. Since  $s > 0$  and in a JV  $\alpha \in (0, \bar{\alpha}]$ , where,  $\bar{\alpha}$  is the government regulated upper bound of the foreign equity participation, then for the existence of  $\alpha_0 > 0$ , we need  $\frac{pq(1-z)(\Pi(c_2) - \Pi(c'_1) - I)}{\Pi(c_1)}$  to be positive. Assuming  $\frac{pq(1-z)(\Pi(c_2) - \Pi(c'_1) - I)}{\Pi(c_1)} > 0$ , applying the property of continuity, one can always find  $\alpha_0$  to be positive. This implies that in that situation  $\exists \alpha \in (0, \min\{\alpha_0, \bar{\alpha}\})$  for which the incumbent will go for JV in period 0. ■

Note that if imitation cost is non-binding, i.e.,  $\Pi(c_2) \leq \Pi(c'_1) + I$ , then there will be no JV in period 0. This shows that if the MNC can extract same rent from each of JV and TT agreements then there will be no JV in period 0. Also this implies that if patent protection is sufficiently weak then this gives the incumbent an incentive to go for a JV in period 0. Since weak patent protection prevents the MNC to extract full surplus generated from its technology under TT, it leaves some profit to the licensee. This benefit induces the incumbent to go for a JV in period 0 so that in period 1 it can get this surplus if the MNC is compelled to make any entrance in the future period with the entrant. However, even if  $\Pi(c_2) > \Pi(c'_1) + I$ , the JV will not occur in period 0 if there is no threat of entry in period 1 (i.e., if  $z = 1$ ). The absence of the threat of entry removes the fear of the incumbent of losing MNC's technology in period 1 and gives no incentive to go for JV in period 0. Further with no perception of government policy reversal (i.e.,  $q = 0$ ) the incumbent will not go for JV in period 0. If the government can credibly commit that it will continue its liberalization policy, i.e., it will allow new JV in period 1, then the MNC will be able to extract full surplus generated from its technology in period 1. So, there is no sense in sacrificing present profit by the incumbent. Therefore, if all these things hold simultaneously then the incumbent will go for JV in period 0 even if it does not get any benefit immediately.

Though we have considered a simple model to highlight the reason for making a JV by a local firm entirely due to expected future benefit, this model can help us to give some insight regarding social welfare of the domestic country and the sharing by the two partners in the JV. Assume that the MNC holds a fraction  $\beta$  of this  $\min\{\alpha_0, \bar{\alpha}\}$  in the JV. This fraction may represent bargaining power of the MNC. Therefore, the local incumbent holds  $(1 - \beta)\min\{\alpha_0, \bar{\alpha}\} + (1 - \min\{\alpha_0, \bar{\alpha}\})$  in the JV. Now we see that with the increase in the number of potential entrants in the future period, the value of  $z$  is more likely to go down. This implies that other things remaining the same a rise in the number of potential entrants will lead to a relatively higher value of  $\alpha_0$  and a more sacrifice of the present profit by the local incumbent (assuming  $\alpha_0 < \bar{\alpha}$ ). Similarly, ceteris paribus, higher belief of the local firms regarding low-cost technology of the MNC or more uncertainty in the government policy continuation may be a reason for less share holding by the local firm. If the government can credibly commit to the continuation of its present policy then local firm will not have incentive for sacrificing its present profit here. Thus, even if the government's intention is to carry forward its liberalized policy, the problem of making credible commitment will give the local firm incentive to sacrifice its present profit and will imply a loss in the domestic producer surplus in the first period while in the future MNC extracts total surplus

incumbent will offer  $\hat{\Pi}(c'_1) + d$  and gets the technology. Since  $\Pi(c'_1) > \hat{\Pi}(c'_1)$ ,  $\exists d > 0$  so that the incumbent will outbid the entrant always. So, whether government allows TT and JV, incumbent will outbid the entrant while targeting the MNC with  $c'_1$  technology.

Now consider that the government allows only TT and local firms are making offer targeting a MNC with  $c_2$  technology. Here, due to asymmetric information, entrant will offer  $\hat{\Pi}(c'_1) + I$  because the entrant will not offer an up-front fixed fee more than  $\hat{\Pi}(c'_1)$  to get separating equilibrium contract. But assuming  $\Pi(c_2) > \hat{\Pi}(c'_1) + I$ , here incumbent will outbid the entrant always by offering a contract  $(\hat{\Pi}(c'_1) + d) + I$ , where the value of  $d$  is same in both the offers *arrange*. But, if government allows JV targeting MNC with  $c'_1$  technology and MNC with  $c_2$  technology. But, if government allows JV in period 1, incumbent cannot outbid the entrant while making an offer targeting the MNC with  $c_2$  technology and in this situation the MNC extracts full surplus generated from its technology. Thus, it is clear that here incumbent has no incentive to go for a JV in period 0.

Formally, the payoffs of the MNC and the incumbent are given by, respectively, conditional on no collaboration in period 0

$$\Pi_m(NC) = q(\hat{\Pi}(c'_1) + I + d) + (1 - q)\Pi(c_2) \quad (4.6)$$

$$\Pi_i(NC) = \Pi(c_1) + pq(\Pi(c_2) - \hat{\Pi}(c'_1) - I - d) + (1 - p)(\Pi(c'_1) - \hat{\Pi}(c'_1) - d) \quad (4.7)$$

where  $d > 0$  and very small.

The payoffs, conditional on JV in period 0, of MNC and incumbent are given by, respectively

$$\Pi_m(JV) = \alpha\Pi(c_1) + q(\hat{\Pi}(c'_1) + I + d) + (1 - q)\Pi(c_2) \quad (4.8)$$

$$\Pi_i(JV) = (1 - \alpha)\Pi(c_1) + pq(\Pi(c_2) - \hat{\Pi}(c'_1) - I - d) + (1 - p)(\Pi(c'_1) - \hat{\Pi}(c'_1) - d) \quad (4.9)$$

From (4.6) - (4.9) we see that there is no incentive for the incumbent to make a JV in period 0.

If we assume that  $c_2$  is also non-drastic with respect to  $c_1$  then the incumbent will always outbid entrant for the new technology even if JV in future period is allowed and there is no collaboration in period 0. So, the incumbent has no incentive to go for a JV in period 0. Thus the following proposition is immediate from our above analysis.

**Proposition 4.2.3** (a) *If entrant comes with  $c_1$  technology, JV in period 0 between MNC and incumbent will always occur even if  $c_2$  is non-drastic relative to  $c_1$ .*

(b) *If entrant comes with no technology, then (i) JV will not occur in period 0 provided at least  $c'_1$  is non-drastic to  $c_1$  but (ii) JV will occur in period 0 provided  $c'_1$  is drastic with respect to  $c_1$ .*

### 4.3 Conclusion

In this chapter we try to explain an empirical observation. A recent survey on Indian firms shows that many of them give high importance on getting future technologies as a reason for



making a JV. We show that with the possibility of government policy reversal and the threat of entry, a JV can be formed even if the venturing partners get no immediate benefit but expected future benefit may encourage the local firm to go for the JV. We have also shown the importance of technological difference between the incumbent and the entrant in forming the JV. More precisely, we have shown that if the technologies of the incumbent and the entrant yield equal marginal costs of production, then JV will always occur in the present period whether the invented technology of the MNC is drastic or non-drastic with respect to the technology of the local firms. But if the entrant comes with an inferior technology relative to the incumbent's technology, then JV may or may not occur in the present period. In this situation, JV in the present period will occur provided the worst possible technology of the MNC perceived by the local firms is drastic with respect to the technology of the incumbent. Further, we have shown that if the local government wants to continue its JV policy in future but cannot commit it, then the welfare of the domestic country will be less relative to a situation where the domestic government can credibly commit its policy.

## Chapter 5

# Host-Country Policy: Commitment or No-Commitment<sup>1</sup>

### 5.1 Introduction

This chapter evaluates the host-country policies towards the multinationals where the host-country government may or may not commit to its policies. It is usually believed that if a government can credibly commit to continue its present policies in the future, by this it helps to increase welfare of the domestic country compared to a situation where the government cannot commit to its policy (see, Marjit, 1990a, Abdalla, 1992, Broll and Marjit, 1994, Marjit et al., 1994, etc.). Marjit (1990) and Abdalla (1992) have focused on the expropriation threat. Nowadays the threat of expropriation seems rather remote; however, the possibility of less extreme policy intervention in the form of tax/tariff or subsidy still exists. For example, Broll and Marjit (1994) and Marjit et al. (1994) focus on the problems due to uncertain tax policy of a host government. From these works one can argue that a committed government policy is welfare improving. Contrary to that, Al-Saadon and Das (1996) show the possibility of greater welfare under non-committed government tax policy.

We revisit to the question of whether social welfare is greater under committed or non-committed government tax policy. Under committed government policy, government announces its policy before the action taken by a firm and under non-committed policy, the firm moves first and then the government announces its policy.<sup>2</sup> When there exists the possibility of future government policy intervention, the MNC may strategically choose its mode of operation to fight against the future policy intervention and it may not open its fully owned subsidiary (S), rather it can go for technology transfer (TT). We find that if the bargaining power of the MNC is sufficiently high then host-country welfare will be higher under the committed government

<sup>1</sup>This chapter is based on Mukherjee (1997b).

<sup>2</sup>In case of strategic trade policy, Brander and Spencer (1985), Spencer and Brander (1983), Lee (1990), etc., examine the implications of committed (trade) policy of the governments of different countries.

policy; otherwise, like Al-Saadon and Das (1996), the welfare will be greater under the non-committed government policy. However, sometimes the nature of technology may prevent a firm from licensing its technology. Then only possibilities are S and JV. Further, it is often found that JV agreements consist of only equity sharing arrangements.<sup>3</sup> In this scenario, we highlight on the role of technology choice by the MNC. While looking at the role played by the technologies, we find that if the MNC has the technology level as a choice variable also along with its shareholding in the JV, again unlike Al-Saadon and Das (1996), the host-country welfare may be greater under the committed government policy.

Our analysis is related to the work of Al-Saadon and Das (1996) but differs significantly in several directions. First, we endogenously determine the mode of operation by the MNC when the MNC has the option to go for S, JV or TT. Under S, the MNC owns 100% ownership share of the firm. Under JV, both the MNC and the local firm own the share of the firm and under TT, the MNC sells its technology to a local firm and charges fee for its technology. Secondly, we focus on the effect of bargaining power between the local firm and the MNC on the government's policy choice (i.e., either to commit or not commit) and social welfare. Thirdly, though for simplicity, we shall concentrate only on a situation where the goods are sold entirely in the foreign market, to show the importance of the nature of the market, we shall briefly consider the implication for goods sold entirely in the domestic market.<sup>4</sup> Finally, we address the effect of technology choice by the MNC on policy choice.

To highlight the role of bargaining power and technology choice by the MNC separately, we divide the analysis into two parts. In the first part (section 5.2), we consider a situation where the MNC has one technology to produce the good and choose its optimal mode of entry - S, JV or TT. Here we assume that the MNC can charge a fee along with equity sharing in JV. In this structure, we see the role of bargaining power on the choice of government policy. However, sometimes it is not possible to make a TT arrangement (may be due to the nature of technology) as well as to charge a fee in a JV. Section 5.3 considers this aspect and focuses on the role of technology choice by the MNC.

## 5.2 Bargaining power

### Products for foreign market

In this section we assume that the MNC has a single technology to produce the good and it wants to enter a country, called host country (H). This MNC can choose its entry strategy from S, JV and TT.<sup>5</sup> We assume that the goods are sold entirely in the foreign market.<sup>6</sup>

<sup>3</sup>This may be due to government restriction (see, Tang and Yu, 1990). Also, see Lee and Shy (1992), Al-Saadon and Das (1996, section 3) for this type of JV agreement.

<sup>4</sup>One can easily extend this analysis to a situation where the goods are sold in both domestic and foreign markets. Since our main focus is different, we are not doing it here.

<sup>5</sup>We assume, without loss of generality, that the MNC will choose S if it is indifferent between these options.

<sup>6</sup>One can think that this type of plant set up and selling decision may be due to the reason that the host country

Assume that inverse market demand is given by

$$p = a - q, \quad a > 0 \quad (5.1)$$

where the notations have usual meaning. The (constant) marginal cost of production is given by  $c$ ,  $c < a$ , and there is no other cost of production.

Now consider the problem of host country government. The government of H imposes a specific production or excise tax,  $t$ , on the output of the firm to maximize social welfare which is the sum of local firm's profit and tax revenue.<sup>7</sup> We consider two situations, called 'commitment' and 'no-commitment', like Al-Saadon and Das (1996). In case of 'commitment', first government sets  $t$ , then the MNC takes its action, but under 'no-commitment', first the MNC takes its decision and then the government takes its decision.

For both the commitment and no-commitment cases, output and profit of the firm, for a given  $t$ , will be

$$q = \frac{(a - c - t)}{2} \quad (5.2)$$

$$\Pi = \frac{(a - c - t)^2}{4} \quad (5.3)$$

### Commitment

First, we consider the commitment situation. Solving by backward induction, it is easy to check that the MNC will choose  $S$ .<sup>8</sup> So, government maximizes<sup>9</sup>

$$\max_{t_c} W_c = \max_{t_c} t_c \frac{(a - c - t_c)}{2} \quad (5.4)$$

First order condition (foc) of maximization gives

$$t_c = \frac{(a - c)}{2} \quad (5.5)$$

Second order condition (soc) is satisfied.

Therefore, payoff of the MNC and welfare of the host country will be respectively

$$\Pi_m^c = \frac{(a - c)^2}{16} \quad (5.6)$$

$$W_c = \frac{(a - c)^2}{8} \quad (5.7)$$

---

provides some critical inputs to produce the good but domestic consumers have no desire for the good. Alternatively, one can think that the MNC wants to set up its plant in a state which provides the critical inputs but demand for this product comes totally from the other state. In this situation government's policy implies state government's policy of maximizing state's welfare.

<sup>7</sup> $t$  can be alternatively interpreted as a specific tariff on imported inputs.

<sup>8</sup>Here MNC will be indifferent between  $S$ ,  $JV$  and  $TT$  as it can choose a fixed fee,  $L$ , under  $JV$  and  $TT$  so that its payoff is similar to that of  $S$ .

<sup>9</sup>Throughout the analysis we assume that all profits of the MNC will be repatriated.

### No-commitment

In this situation government acts as a second mover and first the MNC decides whether to go for S, JV or TT. So, here the government maximizes

$$\max_{t_n} W_n = \max_{t_n} \frac{(1-s)(a-c-t_n)^2}{4} + \frac{t_n(a-c-t_n)}{2} - L \quad (5.8)$$

where,  $s$  is ownership share of the MNC and  $L$  is the up-front fixed fee paid by the local partner (in case of JV and TT) to the MNC.

foc gives

$$t_n = \frac{(a-c)s}{(1+s)} \quad (5.9)$$

soc is satisfied.

Knowing the optimal behavior of the government from (5.9) MNC chooses the option which maximizes the firm's profit and bargains with the local partner (if it is JV or TT) for its payoff. Now we see that firm's profit is given by (substituting (5.9)),

$$\Pi = \frac{(a-c)^2}{4(1+s)^2} \quad (5.10)$$

Therefore, firm's profit will be maximum for  $s = 0$ . With  $s = 0$ , firm's profit will be  $\Pi = \frac{(a-c)^2}{4}$  whereas, the profit under a fully owned foreign subsidiary will be  $\Pi_m(s = 1) = \frac{(a-c)^2}{16}$ . This implies that here TT maximizes firm's profit. So, the MNC prefers TT over JV and S. Therefore, the following Proposition is immediate.

**Proposition 5.2.1** *In the 'no-commitment' regime, TT maximizes firm's profit.*

The intuition of the above result is simple. Under no-commitment regime, the rent seeking motive of the host government will be reduced if it has to take care of the local firm's profit. Further, the incentive for rent seeking by the host government will be less the more will be local firm's profit. This induces the MNC to charge an up-front fixed fee and transfer its technology to the local firm. Since after the technology deal, all profits generated in the project will be retained by the local firm, it eliminates the incentive for rent seeking by the host government and generates maximum possible profit in the project.

Now the MNC will charge an up-front fixed fee,  $L$ , which maximizes

$$\left[ L - \frac{(a-c)^2}{16} \right]^\alpha \left[ \frac{(a-c)^2}{4} - L \right]^{1-\alpha} \quad (5.11)$$

where,  $\frac{(a-c)^2}{16}$ , is the reservation payoff of the MNC, i.e., what the MNC can get under S, reservation payoff of the local partner is 0 as it cannot produce the good without the technology of the MNC and  $\alpha$  shows the bargaining power of the MNC. Maximizing (5.11) with respect to  $L$  gives

$$L = \frac{(a-c)^2}{16}(3\alpha + 1) \quad (5.12)$$

Hence we can have the following Proposition.

**Proposition 5.2.2**  $\exists \alpha = \alpha^* > 0$  such that  $\forall \alpha < \alpha^*, W_n > W_c$  and  $\forall \alpha > \alpha^*, W_n < W_c$ .

**Proof:** For  $\alpha = 0$ , we see that  $L = \frac{(a-c)^2}{16}$  and the welfare (i.e., the payoff of the local partner) is

$$W_n(\alpha = 0) = \frac{3(a-c)^2}{16} > W_c = \frac{(a-c)^2}{8}. \quad (5.13)$$

But for  $\alpha = 1$ ,  $L = \frac{(a-c)^2}{4}$  and

$$W_n(\alpha = 1) = 0 < W_c = \frac{(a-c)^2}{8} \quad (5.14)$$

Since  $L$  and welfare are continuous in  $\alpha \in [0, 1]$ , we can say that  $\exists \alpha = \alpha^* > 0$  such that  $W_n(\alpha = \alpha^*) = W_c$ . So,  $\forall \alpha < \alpha^*, W_n > W_c$  and  $\forall \alpha > \alpha^*, W_n < W_c$ . This proves the result. ■

The above Proposition shows that if the MNC has sufficiently higher bargaining power then under non committed situation it can extract sufficiently larger amount of the surplus that is generated due to reduction of the rent seeking motive of the host government. Thus larger portion of the benefit of the less aggressive behavior of the host government goes to the MNC. In contrast, under committed regime, host government can internalizes the behaviour of the MNC. Hence, welfare under committed regime dominates that of the non-committed regime. On the other hand, for relatively less bargaining power of the MNC, most of the benefit due to the less aggressive behavior of the host government is retained by the local firm. At the same time, the reduction in rent seeking behavior of the host government eliminates the distortion due to the imposition of excise tax. This makes higher welfare under non-committed regime vis-a-vis committed regime.

Therefore, Proposition 5.2.2 shows that if the bargaining power of the local partner is sufficiently high then non-committed regime is better for the host government. But, for sufficiently higher bargaining power of the MNC, social welfare will be higher under committed policy compared to non-committed policy. It is usually believed that under non-committed government policy, foreign firms are reluctant to enter into the host country and as a result of it domestic country suffers welfare loss. This gives the local government an incentive to commit its policy. But Proposition 5.2.2 shows another reason for committed policy. Since the MNC can adjust its mode of entry as a response to the 'policy hazard' and can extract sufficient amount (in case of MNC's higher bargaining power), a committed government policy results more welfare relative to a non-committed government policy.

### Products for domestic market

So far we have considered that the goods are sold entirely in the foreign market. Another extreme situation is where the goods are sold entirely in the domestic market. With this modification there will be no qualitative change in Proposition 5.2.2, i.e., the effect of bargaining power on the choice of government policy is similar in both situations. But conclusion regarding the mode of operation may be changed when the goods are sold entirely in the domestic market. Hence, we are only focusing on how the mode of operation by the MNC may be affected.

### Commitment

Under the committed regime, the MNC will choose S option. So, the government's problem is to

$$\max_{t_c} W_c = \max_{t_c} \frac{t_c(a - c - t_c)}{2} + \frac{(a - c - t_c)^2}{8} \quad (5.15)$$

foc gives

$$t_c = \frac{(a - c)}{3} \quad (5.16)$$

soc is satisfied.

Therefore, profit of the MNC and welfare of H are

$$\Pi_m^c = \frac{(a - c)^2}{9} \quad (5.17)$$

$$W_c = \frac{(a - c)^2}{6} \quad (5.18)$$

### No-commitment

Here the government's problem is to

$$\max_{t_n} W_n = \max_{t_n} \frac{(a - c - t_n)^2}{8} + \frac{t_n(a - c - t_n)}{2} + \frac{(1 - s)(a - c - t_n)^2}{4} - L \quad (5.19)$$

foc implies

$$t_n = \frac{(a - c)(2s - 1)}{(1 + 2s)} \quad (5.20)$$

soc is satisfied.

Now we can have the following Proposition.

**Proposition 5.2.3** (a) *If there is no possibility of subsidization by the government, i.e.,  $t_n \geq 0$ , then firm's profit will be maximized under TT and JV with  $s \leq \frac{1}{2}$ .*

(b) *If government goes for subsidization also then firm's profit will be maximized under TT.*

**Proof:** (a) With no subsidization, from (5.20), we get that  $t_n = 0$ , for  $s \leq \frac{1}{2}$  and TT implies a situation with  $s = 0$ . Thus the result holds.

(b) With the possibility of subsidization, substituting the value of (5.20) in firm's profit, we get  $\Pi = \frac{(a-c)^2}{(1+2s)^2}$ . This implies that firm's profit will be maximized under TT, i.e., where  $s = 0$ . This proves the result. ■

Notice that Proposition 5.2.3 is based on an assumption under non-committed regime, viz., whether government will subsidize or not. Though we are considering a no-commitment regime, one can think this as a situation where the government can commit whether it will subsidize or not.<sup>10</sup> But if we consider no-commitment in a wider sense, i.e., where the firms have no idea whether government will subsidize or not (eg., where government has ability to subsidize), then MNC, under non-committed regime, always prefers TT and the government will provide subsidy too.

<sup>10</sup>This may be the result of a resource crunch of the government or may be a result of some other government policy unrelated to this work.

## 5.3 Technology choice

Often TT may not be a feasible choice to the MNC and the collaborative option that is left is only JV. Further, the JV agreement often consists of only equity sharing arrangement.<sup>11</sup> This section focuses on these aspects. Hence, the JV agreement is similar to the one considered by Lee and Shy (1992) and Al-Saadon and Das (1996, section 3). To focus on these issues only, we shall assume that the MNC has full bargaining power. However, whether the MNC has a single technology or multiple technologies to produce the good has an important consequence on the choice of the government policy. To make it more clear, we start with a situation where the MNC has only one technology for producing the good. Then we shall consider the possibility of multiple technologies.

### 5.3.1 Single technology

#### Products for foreign market

##### Commitment

We start with commitment regime. Here, first government sets  $t$ . Then MNC takes its action regarding S or JV. The problem is solved backwards. Here we consider that MNC has a single technology. It will help us to realize the role played by the quality choice of the technology.

Therefore, MNC's problem is to

$$\max_s \Pi_m^c = \max_s \frac{s(a - c - t_c)^2}{4} \quad (5.21)$$

Maximization of (5.21) implies that  $s = 1$ , i.e., MNC will opt for fully owned subsidiary. So, the government's problem is to

$$\max_{t_c} W_c = \max_{t_c} \frac{t_c(a - c - t_c)}{2} \quad (5.22)$$

for maximization gives

$$t_c = \frac{(a - c)}{2} \quad (5.23)$$

so is also satisfied. So, MNC's optimal profit is given by

$$\Pi_m^c = \frac{(a - c)^2}{16} \quad (5.24)$$

##### No-commitment

Now consider no-commitment regime. Here, first MNC takes its decision. Then government chooses  $t$ . So, government's problem is to

$$\max_{t_n} W_n = \max_{t_n} (1 - s) \frac{(a - c - t_n)^2}{4} + t_n \frac{(a - c - t_n)}{2} \quad (5.25)$$

---

<sup>11</sup>See, footnote 3.



foc for maximization gives

$$t_n = \frac{(a-c)s}{(1+s)} \quad (5.26)$$

So, MNC maximizes following expression:

$$\max_s \Pi_m^n = \max_s \frac{(a-c)^2 s}{4(1+s)^2} \quad (5.27)$$

foc gives

$$s = 1 \quad (5.28)$$

Therefore, even under no-commitment, MNC opts for S and government sets  $t_n = \frac{(a-c)}{2}$ , which is same as that of under commitment. So, MNC's profit and social welfare is same under both regime - commitment and no-commitment and JVs are not the outcome.

**Proposition 5.3.1** *If goods are sold entirely in the foreign market then social welfare is same under commitment and no-commitment. Also in this situation foreign firm prefers fully owned subsidiary for committed and non-committed government policy.*

**Proof:** See the above discussions. ■

This above result considers a situation where technology transfer is not a feasible option and JV agreement consists of only equity sharing agreement. Therefore, under JV the MNC gets according to its share in the JV. While, under non-committed regime, the MNC can reduce the rent seeking motive of the host government by giving some share to the local firm, it makes less share for any given profit of the firm. For any share of the MNC less than one, the loss to the MNC due to less share outweighs the gain due to reduced aggressive behavior of the host government. This induces the MNC to go for fully owned subsidiary even under non-committed regime and makes the both regime equal.

### Products for domestic market

Now instead of assuming that the goods are sold entirely in a foreign market, let us assume that all products are sold in the host-country. So, now consumer surplus enters in the social welfare function. Like the previous section we assume that MNC has one technology to produce the good.

#### Commitment

Here MNC's problem is to

$$\max_s \Pi_m^c = \max_s s \frac{(a-c-t_c)^2}{4} \quad (5.29)$$

Maximization of (5.29) gives us  $s = 1$ . Government's problem is to

$$\max_{t_c} W_c = \max_{t_c} \frac{(a-c-t_c)^2}{8} + t_c \frac{(a-c-t_c)}{2} \quad (5.30)$$

From (5.52) and (5.53) we get that  $t_c \begin{matrix} \geq \\ < \end{matrix} t_n$  iff (applying (5.43))

$$\frac{-f'(c_c)}{-2f'(c_n)} \begin{matrix} \geq \\ < \end{matrix} \frac{f''(c_c)}{(f''(c_c) - \frac{1}{2})} \quad (5.54)$$

Optimal welfare under no-commitment regime is given by

$$W_n = \frac{(a - c_n)^2}{8} \quad (5.55)$$

Now compare  $W_c$  and  $W_n$ .  $W_c \begin{matrix} \geq \\ < \end{matrix} W_n$  iff

$$\frac{-f'(c_c)}{-2f'(c_n)} \begin{matrix} \geq \\ < \end{matrix} \sqrt{\frac{f''(c_c)}{(f''(c_c) - \frac{1}{2})}} \quad (5.56)$$

Denoting,  $x = \frac{-f'(c_c)}{-2f'(c_n)}$  and  $y = \frac{f''(c_c)}{(f''(c_c) - \frac{1}{2})}$ , from (5.54) and (5.56), we have the following Proposition.

**Proposition 5.3.3** (a) If  $x > y$ , then  $W_c > W_n$  and  $t_c > t_n$ .

(b) If  $y > x > \sqrt{y}$ , then  $W_c > W_n$  and  $t_c < t_n$ .

(c) If  $\sqrt{y} > x$ , then  $W_c < W_n$  and  $t_c < t_n$ .

If the MNC has the quality of technology to be used in the project as a choice variable then no-commitment by the host government encourages relatively inferior quality technology in the project. This efficiency loss may not be outweighed by the gain from 'policy hazard'. Hence, committed regime may give more welfare relative to non-committed regime.

From Proposition 5.3.3 we see that depending on the cost function  $f(c)$ , welfare under commitment may be more than that of no-commitment. Here committed or non-committed government policy does not affect foreign firm's entry decision but can affect technology choice in such a way that commitment may be better than no-commitment for domestic welfare. So, Proposition 5.3.3 modifies the result of Al-Saadon and Das (1996) where welfare under no-commitment is greater than commitment.<sup>13</sup>

## 5.4 Conclusion

This chapter shows whether a committed or non-committed government policy is preferable from the point of view of a host country. We develop a model where a foreign firm can choose its entry decision strategically in the presence of future government policy intervention. It is obtained that if the government does not commit its policy, it is better for the MNC to transfer its technology against an up-front fixed fee. On the other hand, under the committed government

<sup>13</sup>In case of sale in domestic market only, the MNC will go for a JV under non-committed regime but welfare under non-committed regime may or may not be greater than the welfare under committed regime.

foc gives

$$t_c = \frac{(a - c)}{3} \quad (5.31)$$

So, optimal welfare is given by

$$W_c = \frac{(a - c)^2}{6} \quad (5.32)$$

Also

$$\Pi_m^c = \frac{(a - c)^2}{9} \quad (5.33)$$

#### No-commitment

Here, first MNC takes its decision on the mode of entry. Then government takes its decision on  $t$ . So, government's problem is to

$$\max_{t_n} W_n = \max_{t_n} \frac{(a - c - t_n)^2}{8} + t_n \frac{(a - c - t_n)}{2} + (1 - s) \frac{(a - c - t_n)^2}{4} \quad (5.34)$$

foc gives

$$t_n = \frac{(a - c)(2s - 1)}{(1 + 2s)} \quad (5.35)$$

So, MNC's problem is to

$$\max_s \Pi_m^n = \max_s \frac{(a - c)^2 s}{(1 + 2s)^2} \quad (5.36)$$

Maximization gives

$$s = \frac{1}{2} \quad (5.37)$$

Therefore, optimal tax rate under no-commitment is zero, i.e.,  $t_n = 0$ . So, optimal welfare is given by

$$W_n = \frac{(a - c)^2}{4} \quad (5.38)$$

and,

$$\Pi_m^n = \frac{(a - c)^2}{8} \quad (5.39)$$

From (5.32), (5.33), (5.38) and (5.39) we have the following Proposition.

**Proposition 5.3.2** *If goods are sold entirely in the domestic market then under no-commitment situation both welfare and MNC's profits are higher than that of under commitment situation. In case of no-commitment, MNC's optimal entry strategy is to form a JV whereas under commitment it operates its fully owned subsidiary.*

Since the host government cares for the domestic consumers also, for any larger profit share of the local firm, the incentive for rent seeking by the host government reduces in a greater extent relative to a situation where the goods are sold entirely in the foreign market. Thus, unlike the previous Proposition, if the MNC does not go for fully owned subsidiary, the gain to the MNC due to less aggressive behavior of the host government outweighs the loss due to less share holding in the project. This induces the MNC to go for JV while taking decision

on shareholding. This less shareholding of the MNC induces the host government to play less aggressively which, in turn, eliminates the distortion of the excise tax and creates more welfare relative to committed situation.

Proposition 5.3.2 shows that it is better for the MNC to form JV in response to ‘policy hazard’. Therefore, in contrast to Proposition 5.3.1, here MNC favors JV to fight against ‘policy hazard’. Also like Al-Saadon and Das (1996), here non-committed government policy gives more welfare than committed government policy to the domestic country.

### 5.3.2 Multiple technologies

Here we assume that the MNC has to decide the quality of the technology too along with the mode of entry. Further, consider that the MNC has to incur higher cost to get better technology where the cost incurred by the MNC cannot be verified.

We assume that to operate the project with a better technology the MNC has to incur a cost  $f(c)$  with  $f' < 0$ ,  $f'' > 0$  and  $c \in [0, a]$  with  $f(a) = 0$ . Existence of  $f$  may have different reasons. One simple interpretation is that MNC needs to incur  $f(c)$  as resource cost of technology transfer (see, Teece, 1977, 1981).<sup>12</sup> Alternatively, one can think it as costs to produce different qualities of technologies (see, Marin and Schnitzer, 1995). So, here MNC chooses simultaneously  $s$  and  $c$  to maximize its profit. Note that this  $f(c)$  has to be incurred by the MNC irrespective of its mode of entry. So, welfare does not include this cost. For simplicity, here we concentrate only on sale in the foreign market. However, one can easily extend it for domestic market also.

#### Commitment

Here MNC's problem is to

$$\max_{s, c_c} \Pi_m^c = \max_{s, c_c} s \frac{(a - c_c - t_c)^2}{4} - f(c_c) \quad (5.40)$$

focs of maximization give

$$s = 1 \quad (5.41)$$

$$- \frac{s(a - c_c - t_c)}{2} - f'(c_c) = 0 \quad (5.42)$$

From (5.42) we get the optimum quality level of the technology. Assume that soc for maximization holds, i.e.,  $\frac{1}{2} < f''(c_c)$ . Differentiating (5.42) (with  $s = 1$ ) totally with respect to  $c_c$  and  $t_c$  we get

$$\frac{dc_c}{dt_c} = \frac{1}{2(f''(c_c) - \frac{1}{2})} > 0 \quad (5.43)$$

Now government's problem is to

$$\max_{t_c} W_c = \max_{t_c} t_c \frac{(a - c_c - t_c)}{2} \quad (5.44)$$

<sup>12</sup>See, Lee and Shy (1992) for similar type of cost function. In a different context, Kabiraj (1990) also uses a cost function which is related to technology level in a similar fashion.

foc gives

$$t_c = \frac{(a - c_c)}{(2 + \frac{dc_c}{dt_c})} \quad (5.45)$$

So, optimal welfare is given by

$$W_c = \frac{(a - c_c)^2(1 + \frac{dc_c}{dt_c})}{2(2 + \frac{dc_c}{dt_c})^2} \quad (5.46)$$

### No-commitment

Here government's problem is same as that of section 5.3.1 where MNC has single technology.

So, government's optimal tax is given by

$$t_n = \frac{(a - c_n)s}{(1 + s)} \quad (5.47)$$

MNC's problem is to

$$\max_{s, c_n} \Pi_m^n = \max_{s, c_n} \frac{(a - c_n)^2 s}{4(1 + s)^2} - f(c_n) \quad (5.48)$$

From maximization we find that  $s = 1$ , i.e., MNC will opt for fully owned subsidiary. Regarding technology choice foc gives

$$-\frac{(a - c_n)s}{2(1 + s)^2} - f'(c_n) = 0 \quad (5.49)$$

With  $s = 1$ , (5.49) reduces to

$$-\frac{(a - c_n)}{8} - f'(c_n) = 0 \quad (5.50)$$

Assume that soc for maximization holds, i.e.,  $\frac{1}{8} < f''(c_n)$ .

Therefore, optimal tax rate is given by  $t_n = \frac{(a - c_n)}{2}$ . Now, from (5.42) and (5.45) with  $s = 1$ , we get that

$$-\frac{(a - c_c)(1 + \frac{dc_c}{dt_c})}{2(2 + \frac{dc_c}{dt_c})} - f'(c_c) = 0 \quad (5.51)$$

Also see that

$$\frac{(1 + \frac{dc_c}{dt_c})}{2(2 + \frac{dc_c}{dt_c})} > \frac{1}{8} \text{ as } \frac{dc_c}{dt_c} > 0.$$

This implies that under commitment regime MNC chooses better technology relative to no-commitment regime, i.e.,  $c_c < c_n$ .

Now compare  $t_c$  and  $t_n$ .  $t_c \geq t_n$  iff

$$\frac{(a - c_c)}{(a - c_n)} \geq \frac{(2 + \frac{dc_c}{dt_c})}{2} \quad (5.52)$$

From (5.50) and (5.51), we get

$$\frac{(a - c_c)}{(a - c_n)} = \frac{-f'(c_c)(2 + \frac{dc_c}{dt_c})}{-4f'(c_n)(1 + \frac{dc_c}{dt_c})} \quad (5.53)$$

From (5.52) and (5.53) we get that  $t_c \begin{matrix} \geq \\ < \end{matrix} t_n$  iff (applying (5.43))

$$\frac{-f'(c_c)}{-2f'(c_n)} \begin{matrix} \geq \\ < \end{matrix} \frac{f''(c_c)}{(f''(c_c) - \frac{1}{2})} \quad (5.54)$$

Optimal welfare under no-commitment regime is given by

$$W_n = \frac{(a - c_n)^2}{8} \quad (5.55)$$

Now compare  $W_c$  and  $W_n$ .  $W_c \begin{matrix} \geq \\ < \end{matrix} W_n$  iff

$$\frac{-f'(c_c)}{-2f'(c_n)} \begin{matrix} \geq \\ < \end{matrix} \sqrt{\frac{f''(c_c)}{(f''(c_c) - \frac{1}{2})}} \quad (5.56)$$

Denoting,  $x = \frac{-f'(c_c)}{-2f'(c_n)}$  and  $y = \frac{f''(c_c)}{(f''(c_c) - \frac{1}{2})}$ , from (5.54) and (5.56), we have the following Proposition.

**Proposition 5.3.3** (a) If  $x > y$ , then  $W_c > W_n$  and  $t_c > t_n$ .

(b) If  $y > x > \sqrt{y}$ , then  $W_c > W_n$  and  $t_c < t_n$ .

(c) If  $\sqrt{y} > x$ , then  $W_c < W_n$  and  $t_c < t_n$ .

If the MNC has the quality of technology to be used in the project as a choice variable then no-commitment by the host government encourages relatively inferior quality technology in the project. This efficiency loss may not be outweighed by the gain from 'policy hazard'. Hence, committed regime may give more welfare relative to non-committed regime.

From Proposition 5.3.3 we see that depending on the cost function  $f(c)$ , welfare under commitment may be more than that of no-commitment. Here committed or non-committed government policy does not affect foreign firm's entry decision but can affect technology choice in such a way that commitment may be better than no-commitment for domestic welfare. So, Proposition 5.3.3 modifies the result of Al-Saadon and Das (1996) where welfare under no-commitment is greater than commitment.<sup>13</sup>

## 5.4 Conclusion

This chapter shows whether a committed or non-committed government policy is preferable from the point of view of a host country. We develop a model where a foreign firm can choose its entry decision strategically in the presence of future government policy intervention. It is obtained that if the government does not commit its policy, it is better for the MNC to transfer its technology against an up-front fixed fee. On the other hand, under the committed government

<sup>13</sup>In case of sale in domestic market only, the MNC will go for a JV under non-committed regime but welfare under non-committed regime may or may not be greater than the welfare under committed regime.

policy, the MNC is indifferent between three options - S, JV and TT - mentioned in this chapter. But, whether the host country welfare is greater under committed or non-committed government policy depends on the bargaining power of the MNC and the local firm.

When the nature of the technology is such that TT is not a feasible option and the JV agreement consists of only equity sharing arrangement, we find that social welfare under non-committed policy always (weakly) dominates that under committed policy when there is only one technology to produce the good. This is similar to Al-Saadon and Das (1996) where welfare under non-committed policy is strictly larger than that under committed policy. But, with the presence of multiple technologies welfare under committed policy may be greater relative to welfare under non-committed policy.

## Chapter 6

# Pre-commitment and Technology Transfer<sup>1</sup>

### 6.1 Introduction

This chapter deals with the problem of technology licensing when firms adopt strategies which can be pre-committed. It is closely related to the paper by Marjit (1990b) who considers the possibility of technology transfer in a duopoly where a technology seller and a technology buyer compete in the product market like Cournot duopolists. Using a fixed fee licensing contract<sup>2</sup>, Marjit (1990b) derives condition under which the technologically superior firm will sell its technology to the technologically inferior firm. The result of that paper is that technology will be transferred provided the initial technologies of the firms are sufficiently close. In this chapter we consider the possibility of technology transfer in a similar framework with an exception that here firm(s) can take an action before its production that helps to pre-commit to a higher output level.

In industries where strategic interactions play important role, firm(s) can get strategic advantage through pre-commitment. Two well known forms of pre-commitment are given by capacity installation and by incentive delegation. Entry-deterrence literature has showed how an incumbent firm can make a strategic capacity choice deterring entry of its competitor. The relevant contributions are Spence (1977), Dixit (1980) and Basu and Singh (1990). While Spence (1977) and Dixit (1980) focused only on the capacity choice, Basu and Singh (1990) allowed the firm to commit to capacity level as well as to the unit cost of capacity. Fershtman and Judd (1987) and Basu, (1995) focused on the possibility of pre-commitment by incentive delegation rather than capacity choice. They considered the role of incentive delegation through hiring a manager<sup>3</sup> for

<sup>1</sup>This chapter is based on Mukherjee (1997a).

<sup>2</sup>The implicit assumption is that the provision of output royalty in the licensing contract is not possible. The possibility of costless imitation by the technology buyer after getting it or lack of information needed for a royalty provision may be the reason for fixed fee licensing contract (see, Rockett, 1990 and Katz and Shapiro, 1985).

<sup>3</sup>Those papers and also this work use the term 'manager' to refer to an 'agent' who takes output or price decision



getting such an advantage. While Fershtman and Judd (1987) focus only on the properties of incentive equilibrium, Basu (1995) has endogenized the choice of hiring a manager.<sup>4</sup>

Although the topic of technology transfer has attracted fair amount of attention, until now the literature on technology transfer have not paid much attention to the possibility of strategic pre-commitment by the seller and/or buyer while addressing the problem of technology transfer in an oligopoly. The ability to pre-commit changes optimal behavior of the firms and gives a firm (who commits) strategic advantage against its competitor. This in turn, influences the decision of technology transfer. Also in this respect the nature of the firm (seller and/or buyer) who commits, has important role to play. As the identity of the committing firm changes, it changes market outcome and affects the likelihood of technology transfer. Hence, we think, it is important to see the role played by pre-commitment while addressing technology transfer in a market with strategic interactions.

We consider two types of pre-commitment - commitment by capacity installation and by incentive delegation. While the former shows the effect of a restriction on the ability to commit, the latter highlights the role of commitment cost (defined later). In case of commitment by capacity installation, we follow the path of Basu and Singh (1990) with the exception that competition in the product market is characterized by Cournot-Nash game (like Dixit, 1980). Here the firm(s) pre-commit by capacity installation and unit cost of capacity. However, the ability to pre-commit to unit cost of capacity is restricted by the marginal cost of production (more details later). In our study we discuss how the restriction on pre-commitment can affect the decision of technology transfer.

Then we devote our attention to a different way of pre-commitment - commitment by incentive delegation. Here commitment takes the form of hiring a manager and delegating decision-making power to this manager. However, hiring a manager may be a costly device and may act as commitment cost (defined later). Different commitment cost may give different equilibrium configurations (see, Basu, 1995) and may affect the possibility of technology transfer. In our analysis we shall see that in case of commitment by capacity installation, large market size<sup>5</sup> relative to the level of technology will act as a restriction to pre-commitment to the unit cost of capacity. In contrast to that, small market size relative to the level of technology and commitment cost may act as restrictions on hiring a manager, which in turn, acts as a restriction to commitment through incentive delegation. Therefore, these two types of commitment focus on two different restrictions on pre-commitment. Further, in case of commitment by both firms, we shall again find the difference of these two types of commitment on the equilibrium characterization. Hence it is interesting to see the effect of these two different forms of pre-commitment on the likelihood of technology transfer.

The plan of this chapter is as follows. In section 6.2 we consider the possibility of technology of a firm to maximize an objective function delegated to him or her by a profit-maximizing 'owner' or 'principal'.

<sup>4</sup>See, Basu, Ghosh and Ray (1997) for the use of strategic incentive delegation within government and the firm.

<sup>5</sup>In the following analysis the intercept term of the demand curve will be treated as a proxy of market size.

transfer when firm commits by capacity installation. First, we see the possibility of commitment by only one firm in an incumbent-entrant situation. We find that whether the incumbent is technologically efficient or technologically inefficient has important role to play in the technology transfer possibility. Then we look at the possibility where both firms move simultaneously in each stage. We compare the results with its no-commitment equivalence model (i.e., Marjit, 1990b). In section 6.3, we consider the possibility of pre-commitment by hiring a manager. Conclusions are given in section 6.4.

## 6.2 Commitment by capacity installation

### 6.2.1 Commitment by one firm

We consider a game of an incumbent and an entrant. They produce homogeneous products and face an inverse market demand function

$$p = a - q, \quad a > 0 \quad (6.1)$$

where  $p$  is the price of the product and  $q = q_1 + q_2$  is industry output. Suppose firm 1 can produce its product  $q_1$  with a (constant) marginal cost of production  $c_1 > 0$  and firm 2 produces  $q_2$  with a (constant) marginal cost of production  $c_2$  with  $0 < c_2 < c_1$  and  $c_1 \in (c_2, \frac{a+c_2}{2})$ ; otherwise, firm 1 will get zero profit even if firm 2 does not commit. Consider that there is no fixed cost of production. Suppose production requires capacity installation. Like Basu and Singh (1990) we assume that the incumbent can commit to a capacity level,  $k_i$ , as well as to the unit cost of capacity,  $r_i$ . The per unit cost of output is given by  $c_i$  and this is determined by the technology level of firm  $i$ . So, when an incumbent commits to  $r_i$  it can commit upto  $c_i$ ; so,  $r_i \in [0, c_i]$ . Therefore, while producing its output,  $q_i$ , firm  $i$  is facing marginal cost as  $(c_i - r_i)$  for  $q_i \leq k_i$  and  $c_i$  for  $q_i > k_i$  because the pre-committed cost act as a fixed cost at the production stage. Since the entrant has no prior commitment, it will operate with its actual marginal cost of production while choosing its output. We assume that firms choose their outputs simultaneously, if the entrant enters, and compete in quantities. Therefore, like Dixit (1980) the post-entry game, if entry occurs, is a Cournot-Nash game.

So far we have not introduced the possibility of technology transfer in this incumbent-entrant game. In other words, so far we have considered a game under the history of no technology transfer. Now consider the full game. At the first stage firms take decision on technology transfer where the technologically efficient firm sells its technology to its competitor. In stage two, the incumbent firm commits. In the third stage firms choose their outputs. Figure 5 describes the moves.

Figure 5

We assume that technology will be transferred whenever it is feasible and the patent licensing contract will consist of only up-front fixed fee. The justification is that this constraint in the

licensing contract exists due to the impossibility of monitoring the relevant actions necessary to enforce a royalty provision in a patent licensing agreement. It may be that the licensee can 'imitate' or 'invent around' the licensed technology costlessly after getting it (see, Rockett, 1990). Therefore, in case of technology transfer, the technology seller takes an up-front fixed fee from the transferee as a price of the technology and gives its technology.

### 6.2.2 Technologically efficient firm commits

This subsection addresses the problem of technology transfer assuming that the incumbent firm is technologically efficient firm. Therefore, in our framework we consider that firm 2 is an incumbent and can commit. First consider the following Lemma.

**Lemma 6.2.1** *Suppose  $a \leq 4c_2$ . Then under the history of no technology transfer firm 2 will produce  $\min\{\frac{a-2c_2+c_1}{2}, (a-c_1)\}$ .*

**Proof:** See Appendix A.1.

Now consider the game under the history of technology transfer. Given that technology transfer has occurred both firms will have identical marginal cost of production  $c_2$ . Firm 2 will choose  $r_2 = \frac{a-c_2}{4}$  and this  $r_2 \leq c_2$  iff  $a \leq 5c_2$ ; otherwise,  $r_2 = c_2$  always. Whatever is the commitment by firm 2, both will produce positive output.

Let us divide the analysis of this subsection into three parts - (i) when market size is fairly small relative to the marginal cost of production of the technologically efficient firm ( $a \leq 4c_2$ ), (ii) when market size is fairly large relative to the marginal cost of production of the technologically efficient firm ( $a > 5c_2$ ), and (iii) the intermediate market size relative to the marginal cost of production of the technologically efficient firm ( $4c_2 < a \leq 5c_2$ ).

First, suppose  $a \leq 4c_2$ . In this case under the history of no technology transfer industry profit is

$$\Pi_1^0 + \Pi_2^0 = \frac{(a - 3c_1 + 2c_2)^2}{16} + \frac{(a - 2c_2 + c_1)^2}{8}, \text{ for } c_1 \leq \frac{a + 2c_2}{3} \quad (6.2)$$

$$\Pi_1^0 + \Pi_2^0 = (c_1 - c_2)(a - c_1), \text{ for } c_1 \geq \frac{a + 2c_2}{3} \quad (6.3)$$

Industry profit under the history of technology transfer is given by

$$\Pi_1^t + \Pi_2^t = \frac{3(a - c_2)^2}{16} \quad (6.4)$$

For technology transfer to be profitable, industry profit under the history of technology transfer must be greater than the industry profit under the history of no technology transfer. Only in this situation licensor can charge an up-front fixed fee as a price of technology so that no one is worse-off under technology transfer vis-a-vis no technology transfer.

If  $a > 4c_2$ , then in the pre-transfer situation,  $\forall c_1 < 6c_2 - a$ ,  $r_2 < c_2$  but  $\forall c_1 \geq 6c_2 - a$ ,  $r_2 = c_2$  (see Appendix A.1). Hence we see that if  $a \geq 5c_2$ , then  $r_2 = c_2$ ,  $\forall c_1 \geq c_2$  (as long as both firms

produce positive output). This condition is same to that of necessary for  $r_2$  to be equal to  $c_2$  in the post-transfer situation.

Therefore, for  $4c_2 < a \leq 5c_2$ , (6.4) remains same but (6.3) and (6.2) (for  $c_1 > 6c_2 - a$ ) will be changed. This, in turn, will change the possibility of technology transfer. But for  $a > 5c_2$ , (6.4) will also change.

Assume that  $a > 5c_2$ . Consider the situation under the history of no technology transfer. Now  $q_1 \geq 0$  iff  $c_1 \leq \frac{a}{3}$ . Therefore, following the same reason of Lemma 6.2.1, firm 2 will produce  $\frac{a+c_1}{3}$ ,  $\forall c_1 \in (c_2, \frac{a}{3})$  and will produce  $(a - c_1)$  for  $c_1 \geq \frac{a}{3}$ . So,

$$\Pi_1^0 + \Pi_2^0 = \frac{(a - 2c_1)^2}{9} + \frac{(a + c_1)(a - 3c_2 + c_1)}{9}, \text{ for } c_1 \leq \frac{a}{2} \quad (6.5)$$

$$\Pi_1^0 + \Pi_2^0 = (c_1 - c_2)(a - c_1), \text{ for } c_1 \geq \frac{a}{2} \quad (6.6)$$

Under the history of post-transfer situation

$$\Pi_1^t + \Pi_2^t = \frac{(a - 2c_2)^2}{9} + \frac{(a + c_2)(a - 2c_2)}{9} = \frac{(a - 2c_2)(2a - c_2)}{9} \quad (6.7)$$

Now we have the following Proposition.

**Proposition 6.2.1** (a) When the market is fairly small relative to the marginal cost of production of technologically efficient firm ( $a \leq 4c_2$ ), technology transfer will occur iff  $c_1 \in (c_2, \hat{c}_1)$  where  $\hat{c}_1 = \frac{2a+9c_2}{11} < \frac{a+2c_2}{3}$ .

(b) When the market is fairly large compared to the marginal cost of production of technologically efficient firm ( $a > 5c_2$ ), technology will be transferred iff  $c_1 \in (c_2, \tilde{c}_1)$ , where,  $\tilde{c}_1 = \frac{2a-2c_2}{5}$ .

(c) In case of intermediate market size relative to marginal cost of production of technologically efficient firm ( $4c_2 < a \leq 5c_2$ ), technology transfer will occur for  $c_1 \in (c_2, \hat{c}_1)$ , where,  $\hat{c}_1 < \frac{a+2c_2}{3} < \frac{2a+3c_2}{5}$ .

**Proof:** See Appendix A.2.

Also we see that  $\frac{2a-2c_2}{5} \geq \frac{2a+9c_2}{11}$  iff  $a \geq \frac{67}{12}c_2$  but  $\tilde{c}_1 < \frac{2a+3c_2}{5}$ .

In Proposition 6.2.1, we consider a situation where the technologically efficient firm is an incumbent and has ability to commit to capacity level as well as to the unit cost of capital before production stage. This incumbency advantage helps the technologically efficient firm to play more aggressively in the output market and to raise its profits. Hence, it reduces the incentive for technology transfer relative to a situation where the technologically efficient firm cannot pre-commit.

To sum up, we see that if the incumbent firm, who can commit, is technologically efficient then the possibility of technology transfer is reduced relative to its no-commitment equivalence model.

### 6.2.3 Technologically inefficient firm commits

Now assume that the incumbent firm is technologically inefficient and it can pre-commit. Therefore, in our structure assume that firm 1 is an incumbent.<sup>6</sup> Here again we consider two situations separately - (i) when market size is fairly small relative to marginal cost of production of technologically efficient firm ( $a \leq 5c_2$ ), and (ii) when market size is fairly large relative to marginal cost of production of technologically efficient firm ( $a > 5c_2$ ).

First consider that  $a \leq 5c_2$ . Under the history of no technology transfer firm 1 will choose  $r_1 = \frac{a-2c_1+c_2}{4}$ . For  $a \leq 5c_2$ , we have  $0 < r_1 < c_1$ ,  $\forall c_1 \in (c_2, \frac{a+c_2}{2})$ . Therefore, in the post-entry Cournot-Nash equilibrium firm 1 will produce  $\frac{a-2c_1+c_2}{2}$  and firm 2 will produce  $\frac{a-3c_2+2c_1}{4}$ . Here, it is always optimal for both firms to produce positive output and both firms get positive profit. Therefore, in case of no technology transfer industry profit is given by

$$\Pi_1^0 + \Pi_2^0 = \frac{(a - 2c_1 + c_2)^2}{8} + \frac{(a - 3c_2 + 2c_1)^2}{16} \quad (6.8)$$

In case of technology transfer, firm 2 will sell its technology to firm 1. Therefore, both firm has marginal cost of production  $c_2$ . In this situation industry profit is given by (the assumption that  $a \leq 5c_2$  satisfies the constraint that  $r_1 \leq c_2$ )

$$\Pi_1^t + \Pi_2^t = \frac{3(a - c_2)^2}{16} \quad (6.9)$$

Now assume that  $a > 5c_2$ . This implies that in the post-transfer situation  $r_1 = c_2$  (since now  $c_1 = c_2$ ) and in the pre-transfer situation  $r_1 = c_1$  for  $c_1 \leq \frac{a+c_2}{6}$  but for  $c_1 > \frac{a+c_2}{6}$ ,  $r_1 < c_1$ . Therefore, like the previous subsection, industry profit in the post-transfer situation is given by (6.7), i.e.,

$$\Pi_1^t + \Pi_2^t = \frac{(a - 2c_2)(2a - c_2)}{9}.$$

For  $c_1 \geq \frac{a+c_2}{6}$ , industry profit will be given by (6.8). But for  $c_2 < c_1 \leq \frac{a+c_2}{6}$ , industry profit is given by

$$\Pi_1^0 + \Pi_2^0 = \frac{(a + c_2)(a - 3c_1 + c_2)}{9} + \frac{(a - 2c_2)^2}{9} \quad (6.10)$$

Now we have the following Proposition.

**Proposition 6.2.2** (a) When the market size is small relative to the marginal cost of production of technologically efficient firm ( $a \leq 5c_2$ ), then technology transfer will occur iff  $c_1 \in (c_2, \tilde{c}_1)$ , where,  $\tilde{c}_1 = \frac{a+2c_2}{3}$ .

(b) If the market is sufficiently large relative to marginal cost of production of technologically efficient firm ( $a > 5c_2$ ), then technology transfer will occur iff  $c_1 \in (c_2, c_1^0)$ , where,  $c_1^0 > \frac{a+2c_2}{3}$  and  $c_1^0 \geq \frac{2a+3c_2}{5}$ .

<sup>6</sup>Note that even if firm 1 is an incumbent it can commit upto  $c_1$  under no technology transfer since its per unit cost of production,  $c_1$ , is given by its technology.

**Proof:** See Appendix A.3.

Proposition 6.2.2 considers a situation where the technologically inefficient firm is an incumbent and the technologically efficient firm is an entrant. Here technology transfer will help the entrant to reduce its loss of profit due to the aggressive behavior of the incumbent through capacity installation. Further, comparing Propositions 6.2.1 and 6.2.2 one can say that if incumbent is technologically efficient firm then the range of  $c_1$  for which technology transfer will be profitable is less relative to a situation where incumbent is technologically inefficient.

Table 1 is showing the critical values of  $c_1$  upto which technology transfer is profitable.

**Table 1**

Thus, we can say that if the incumbent firm, who can commit, is technologically inefficient then possibility of technology transfer may be increased relative to its no-commitment equivalence model. However, for this to happen we need that the market size (given by  $a$ ) to be sufficiently higher relative to the cost of the technologically efficient firm (i.e.,  $c_2$ ).

#### 6.2.4 Commitment by both firms

In the previous subsections we consider a sequential entry game. Now in this subsection we consider a two stage game where in each stage both firms move simultaneously. More specifically, after the decision on technology transfer both firms commit to capacity level as well as to the unit cost of capital and then they choose output simultaneously.<sup>7</sup> Figure 6 describes the moves.

**Figure 6**

Here the firms will choose  $(r_i, k_i)$  in such a way that in the output stage both will produce their Cournot output level corresponding to their actual marginal cost of production. Hence, each will commit in capacity upto its Cournot output level corresponding to the actual marginal cost of production  $c_i$  (logic is similar to Tirole, 1989, p. 231 - 32). Therefore, equilibrium profits and technology transfer decision will be similar to its no-commitment equivalence model (Marjit, 1990b). Thus, we have the following Proposition.

**Proposition 6.2.3** *Technology transfer will occur iff  $c_1 \in (c_2, \frac{2a+3c_2}{5})$ .*<sup>8</sup>

Proposition 6.2.3 considers a situation where both firms simultaneously commit to the capacity level and then take output decision simultaneously. Since both have options to credibly commit to an output level through the capacity choice before the production actually takes place, both can eliminate the strategic advantage of its competitor through capacity installation.

<sup>7</sup>Recently, Gabszewicz and Poddar (1997) consider the problem of simultaneous capacity choice in a duopoly market with demand uncertainty.

<sup>8</sup>As the profits and proof of this Proposition are similar to Marjit (1990b), we are omitting the proof here.

Hence, it leads to the capacity choice at their Cournot output level corresponding to their actual marginal cost of production. Thus, this possibility of capacity installation by both firms simultaneously does not affect the incentive for technology transfer relative to its no-commitment equivalence model. This feature finds another importance for looking at the different types of commitment. Below we shall show that in case of commitment through incentive delegation, even if both firms can commit, technology transfer possibility can be changed relative to its no-commitment equivalence model.

Now we are in a position to summarize the results of this section. We see that whether the possibility of commitment through capacity commitment will increase or decrease the possibility of technology transfer relative to where pre-commitment is not possible (Marjit, 1990b) depends on the market size relative to the marginal costs of production as well as who has the ability to commit. In case of sequential entry game where the incumbent is technologically efficient, it always reduces the possibility of technology transfer relative to its no-commitment equivalence model; but in case of commitment by the technologically inefficient firm, for sufficiently large market size relative to the marginal cost of production of the efficient firm, likelihood of technology transfer increases relative to a situation where pre-commitment is not possible. However, commitment by both firms do not change the technology transfer possibility relative to its no-commitment equivalence model.

### 6.3 Commitment by incentive delegation

In this section we consider a different form of pre-commitment other than pre-commitment by capacity installation. Here we assume that both the firms have option to hire a manager and to delegate decision-making power to that manager. To be specific, we follow the structure of Basu (1995) with the introduction of technology transfer possibility. So, we consider the following game. In stage 1, firms take decision on technology transfer. In stage 2, owner of each firm decides whether to hire a manager or not. In particular, each owner  $i$  selects  $m_i \in \{0, 1\}$ , where  $m_i = 0$  means owner  $i$  does not hire a manager and  $m_i = 1$  means owner  $i$  hires a manager. Once a manager is chosen and manager's objective function is specified, which happens in stage 3, the manager decides how much to produce, in stage 4. In the absence of manager, the decision in stage 4 is taken by the owner. In stage 3, each owner, if hires a manager, picks an objective function for the manager. Following Fershtman and Judd (1987) and Basu (1995) we consider that manager  $i$ 's objective function can only belong to the following class<sup>9</sup>

$$R_i = \alpha_i \Pi_i + (1 - \alpha_i) S_i \quad (6.11)$$

---

<sup>9</sup>Following the literature on incentive delegation, we also assume that due to the output verification problem, incentive scheme is indexed to profits and sales (assumed to be verifiable).

where  $\Pi_i$  and  $S_i$  are the profits and sales function of the  $i$ th firm respectively and the owner has to ensure that the manager gets its reservation income  $E_i > 0$ .<sup>10</sup> Following Basu (1995), define

$$Z_i \equiv E_i - X_i \quad (6.12)$$

where  $X_i$  be the amount that owner  $i$  can earn elsewhere in the time that gets released after appointing a manager. Here  $X_i \leq E_i$  and it depends whether some supervision by the owner is needed or not. Therefore,  $Z_i$  may be called as cost of commitment.

To retain the similarity with the previous section we shall consider the cases of hiring a manager by only one firm and by both the firms. However, note that there is a difference between these two types of commitment. Previously we have seen that there is an upper bound to pre-commitment given by the technology level (i.e., marginal cost of production). In this situation, the value of  $Z_i$  may be so high that it is beneficial for a firm not to hire a manager and, therefore, it acts as a restriction to hire a manager; but, once manager is hired, then the owner can set any value of  $\alpha_i$  in (6.11). So, there is no restriction at the incentive delegation stage.

### 6.3.1 Commitment by one firm

Here we consider a situation where only one firm hires a manager. This may be due to different value of  $Z_i$ . Since the firm which hires a manager can set an unrestricted  $\alpha_i$  in (6.11), the results will be similar to that of the previous sections (section 6.2.2 and 6.2.3) where the constraint on the per unit cost of capacity is non-binding. Thus we just mention technology transfer possibility without proving it in detail.

### 6.3.2 Only technologically efficient firm hires a manager

For simplicity, we are assuming that  $Z_2 = 0$  and  $Z_1 > 0$  and very high so that it is firm 2, only who always hires a manager and delegates incentive.<sup>11</sup> Here, only firm 2 hires a manager and delegates incentive scheme to the manager. Since, after it, the manager of firm 2 will play with the owner of firm 1, owner of firm 2 will choose  $\alpha_2$  in such a way so that the outcome of the manager-owner game corresponds to the Stackelberg leader and follower output level of firm 2 and firm 1 respectively. Therefore, technology transfer will be profitable provided

$$\Pi_1^t + \Pi_2^t > \Pi_1^0 + \Pi_2^0$$

where, the values of  $(\Pi_1^0 + \Pi_2^0)$  and  $(\Pi_1^t + \Pi_2^t)$  are given by equations (6.2), (6.3) and (6.4). Hence, like Proposition 6.2.1(a) technology transfer will occur  $\forall c_1 \in (c_2, \hat{c}_1)$ , where,  $\hat{c}_1 = \frac{2a+9c_2}{11} < \frac{2a+3c_2}{5}$ .

<sup>10</sup>Owner 1 and 2 selects  $\alpha_1$  and  $\alpha_2$ , respectively, in stage 3. Actually manager  $i$  gets  $A_i + R_i B_i$  where  $A_i$  and  $B_i$  are constants. Since maximizing  $A_i + R_i B_i$  and maximizing (6.11) is same if the choice variable is  $q_i$ , we shall speak as if the manager's objective function is  $R_i$ .  $A_i$  and  $B_i$  are chosen by owner  $i$  to simply ensure that the manager gets its reservation income  $E_i > 0$ .

<sup>11</sup>Given the demand specification, firm 1 will not hire manager when firm 2 hires a manager provided  $Z_1 > \frac{2(a-3c_1+2c_2)^2}{35} - \frac{(a-3c_1+2c_2)^2}{16}$ .



### 6.3.3 Only technologically inefficient firm hires a manager

Like the previous subsection, we may assume that this is the outcome of  $Z_1 = 0$  and  $Z_2 > 0$  and very high so that only firm 1 always hires a manager. Following the similar reasoning of section 6.3.2, like Proposition 6.2.2(a) technology will be transferred always iff  $c_1 \in (c_2, \frac{a+2c_2}{3})$ .

### 6.3.4 Both firms hire a manager

In this section we consider two cases. Firstly, we consider a situation where  $X_i = E_i$ , i.e.,  $Z_i = 0$ . Then, we consider a case where  $E_i > X_i$ , i.e.,  $Z_i > 0$ . However, in this case we consider that  $Z_1 = Z_2 = Z > 0$  and also focus only on the equilibrium where under no technology transfer equilibrium outputs of the firms correspond to Stackelberg leader-follower output. Though here many possible situations may arise we restrict ourself to a particular situation because the analysis of this case only is enough to show the role of commitment cost (i.e.,  $Z$ ) to increase the likelihood of technology transfer. To be specific, we examine whether the range of  $c_1$  values over which technology transfer is profitable increases relative to other cases of this section. Also we examine whether the range of  $c_1$  values over which technology transfer is profitable may be larger than the  $c_1$  values of its no-commitment equivalence model (Marjit, 1990b). In particular, with  $Z_1 = Z_2 = Z > 0$ , we consider the case where firm 2 hires a manager and firm 1 does not hire a manager, i.e., on the equilibrium (0,1), where first (second) term stands for firm 1 (firm 2).<sup>12</sup>

### 6.3.5 Zero cost of hiring a manager

Here we consider the case where cost of hiring a manager,  $Z_i$ , is zero. First we consider the equilibrium under the history of no technology transfer. From Basu (1995), it is clear that in this situation if  $c_1 < \frac{a+2c_2}{3}$ , then both will hire a manager and get positive profit in (1,1) equilibrium; but for  $c_1 \geq \frac{a+2c_2}{3}$ , firm 1 will not get positive profit irrespective of its choice of hiring a manager and we assume that a firm will not hire a manager if it gets same profit from hiring and not hiring a manager. So, for  $c_1 \geq \frac{a+2c_2}{3}$ , only firm 2 will hire a manager and firm 2 will set  $\alpha_2$  in such a way that its manager produces  $q_2 = (a - c_1)$ .

So, industry profit is given by

$$\Pi_1^0 + \Pi_2^0 = \frac{2(a - 3c_1 + 2c_2)^2}{25} + \frac{2(a - 3c_2 + 2c_1)^2}{25}, \text{ for } c_1 \leq \frac{a + 2c_2}{3} \quad (6.13)$$

and

$$\Pi_1^0 + \Pi_2^0 = (c_1 - c_2)(a - c_1), \text{ for } c_1 \geq \frac{a + 2c_2}{3} \quad (6.14)$$

Now consider the game under the history of technology transfer. Here we can say that the

---

<sup>12</sup>From Basu (1995) it is clear that (1,0) cannot be an equilibrium here.

equilibrium will be (1,1) always and industry profit is given by

$$\Pi_1^t + \Pi_2^t = \frac{4(a - c_2)^2}{25} \quad (6.15)$$

Now we have the following Proposition.

**Proposition 6.3.1** *Technology will be transferred iff  $c_1 \in (c_2, c_1^*)$ , where  $c_1^* = \frac{2a+11c_2}{13} < \hat{c}_1 < \frac{a+2c_2}{3}$ .*

**Proof:** At  $c_1 = \frac{a+2c_2}{3}$ , (6.13) and (6.14) are equal. Further, we have  $(\Pi_1^0 + \Pi_2^0) |_{c_1=c_2} = (\Pi_1^t + \Pi_2^t)$  and  $(\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{a+2c_2}{3}} > (\Pi_1^t + \Pi_2^t)$ . Also,  $(\Pi_1^0 + \Pi_2^0)$  is continuous and convex in  $c_1$  on the range  $[c_2, \frac{a+2c_2}{3}]$  with  $\frac{\partial(\Pi_1^0 + \Pi_2^0)}{\partial c_1} |_{c_1=c_2} < 0$  and it is positively sloped for  $c_1 \in [\frac{a+2c_2}{3}, \frac{a+c_2}{2}]$  (slope is zero at  $\frac{a+c_2}{2}$ ). This implies that  $\exists c_1 = c_1^*$  such that  $(\Pi_1^0 + \Pi_2^0) |_{c_1=c_1^*} = (\Pi_1^t + \Pi_2^t)$  and it can be shown that  $c_1^* = \frac{2a+11c_2}{13} < \hat{c}_1 < \frac{a+2c_2}{3}$ . This proves the result. ■

For sufficiently large cost differences, only technologically efficient firm (firm 2) hires a manager. But, hiring a manager is optimal for both the firms as long as they produce positive output. Here, unlike commitment through capacity installation, none can credibly show its intention to produce its Cournot output corresponding to actual marginal cost of production. This induces both firms to act more aggressively (when both firms produce positive outputs). Thus, either the industry will become a (restrictive) monopoly or profits will be lower in such a way that it reduces incentive for technology transfer relative to no-commitment equivalence model.

### 6.3.6 Positive cost of hiring a manager

Now we consider a situation where  $E_i > X_i$ , i.e.,  $Z_i > 0$  and assume that  $Z_1 = Z_2 = Z$ . When  $Z > 0$  then under the history of no technology transfer there are three possible equilibriums (0,0), (0,1) and (1,1) but under the history of technology transfer only possible equilibriums are (0,0) and (1,1) (see, Basu, 1995).

First we look at the equilibriums of the firms under the history of no technology transfer. We get that (0,0) will be equilibrium<sup>13</sup> iff

$$Z > \frac{(a - 2c_2 + c_1)^2}{72} \quad (6.16)$$

(0,1) will be equilibrium<sup>14</sup> iff

$$\frac{7(a - 3c_1 + 2c_2)^2}{400} < Z < \frac{(a - 2c_2 + c_1)^2}{72} \quad (6.17)$$

<sup>13</sup>(0,0) will be equilibrium provided  $\frac{(a-2c_1+c_2)^2}{72} > \frac{(a-2c_1+c_2)^2}{72} - Z$  and  $\frac{(a-2c_2+c_1)^2}{72} > \frac{(a-2c_2+c_1)^2}{72} - Z$ , i.e.,  $Z > \frac{(a-2c_1+c_2)^2}{72}$  and  $Z > \frac{(a-2c_2+c_1)^2}{72}$ . Both conditions hold for  $Z > \frac{(a-2c_2+c_1)^2}{72}$ .

<sup>14</sup>(0,1) will be equilibrium provided  $\frac{(a-3c_1+2c_2)^2}{16} > \frac{2(a-3c_1+2c_2)^2}{25} - Z$  and  $\frac{(a-2c_2+c_1)^2}{8} - Z > \frac{(a-2c_2+c_1)^2}{9}$ , i.e.,  $\frac{7(a-3c_1+2c_2)^2}{160} < Z < \frac{(a-2c_2+c_1)^2}{72}$ .

(1,1) will be equilibrium<sup>15</sup> iff

$$Z < \frac{7(a - 3c_1 + 2c_2)^2}{400} \quad (6.18)$$

From (6.17) it is clear that for (0,1) to be an equilibrium  $c_1$  must be sufficiently high than  $c_2$ ; in particular,  $c_1$  has to be greater than  $\underline{c}_1$  where  $\underline{c}_1 < \frac{a+2c_2}{3}$ . Further, from (6.18) we see that for  $c_1 > \frac{a+2c_2}{3}$ , (1,1) cannot be an equilibrium. Therefore, for  $c_1 > \frac{a+2c_2}{3}$ , firm 1 will never hire a manager, given that firm 2 hires a manager and firm 2 will actually hire a manager iff<sup>16</sup>

$$(c_1 - c_2)(a - c_1) - \frac{(a - 2c_2 + c_1)^2}{9} > Z \quad (6.19)$$

Since  $(c_1 - c_2)(a - c_1) > \frac{(a - 2c_2 + c_1)^2}{9}$ ,  $\forall c_1 \in [\frac{a+2c_2}{3}, \frac{a+c_2}{2}]$ ,  $\exists Z > 0$  such that (6.19) holds.

Now we consider the possible equilibriums under the history of technology transfer. Here both firms have marginal cost of production  $c_2$ . Now (0,0) will occur iff

$$Z > \frac{(a - c_2)^2}{72} \quad (6.20)$$

and (1,1) will be equilibrium iff

$$Z < \frac{7(a - c_2)^2}{400} \quad (6.21)$$

But (0,1) and (1,0) cannot be equilibriums.

**Lemma 6.3.1** (a) If the equilibrium is (0,0) under the history of both no technology transfer and technology transfer then technology transfer will be profitable iff  $c_1 < \frac{2a+3c_2}{5}$ .<sup>17</sup>

(b) Consider that  $c_1 < \frac{a+2c_2}{3}$ . Suppose the equilibrium is (0,1) under the history of no technology transfer and the equilibrium is (0,0) under the history of technology transfer. Then technology transfer is always profitable.

(c) Suppose the equilibrium is (0,1) under the history of no technology transfer and the equilibrium is (1,1) under the history of technology transfer. Then technology transfer is never profitable.

**Proof:** See Appendix A.4.

**Lemma 6.3.2** Suppose  $c_1 \in (c_2, \underline{c}_1]$  and  $z > \frac{7(a-c_2)^2}{400}$  then technology will be transferred.<sup>18</sup>

<sup>15</sup>(1,1) will be equilibrium provided  $\frac{2(a-3c_1+2c_2)^2}{25} - Z > \frac{(a-3c_1+2c_2)^2}{16}$  and  $\frac{2(a-3c_2+2c_1)^2}{25} - Z > \frac{(a-3c_2+2c_1)^2}{16}$ . Both the conditions hold for  $Z < \frac{7(a-3c_1+2c_2)^2}{400}$ .

<sup>16</sup>For,  $c_1 > \frac{a+2c_2}{3}$ , if firm 2 hires a manager it will choose  $\alpha$  in such a way that  $q_2 = (a - c_1)$ . Therefore, net profit of firm 2 will be  $(c_1 - c_2)(a - c_1) - Z$ . Here firm 2 will take this action provided  $(c_1 - c_2)(a - c_1) - Z > \frac{(a-2c_2+c_1)^2}{9}$   
 $\Rightarrow (c_1 - c_2)(a - c_1) - \frac{(a-2c_2+c_1)^2}{9} > Z$ .

<sup>17</sup>This is precisely the condition necessary for technology transfer to be profitable in Marjit (1990b).

<sup>18</sup>Actually for these  $c_1$ , it can be shown that technology transfer will be feasible for all values of  $Z$ . To show this one has to use some perfection concept as more than one Nash equilibrium arises for some values of  $Z$ . Since our purpose is to show that there exists some values of  $Z > 0$  such that technology transfer is profitable, we are considering only some values of  $Z$  rather than all possible values of  $Z$ .

**Proof:** Assume that  $c_1 \in (c_2, \underline{c}_1]$  and  $Z > \frac{7(a-c_2)^2}{400} > \frac{(a-2c_2+c_1)^2}{72} > \frac{(a-c_2)^2}{72}$ . Therefore, from (6.16) and (6.20) we see that the equilibrium will be (0,0) in both no technology transfer and technology transfer situations. Following Lemma 6.3.1(a) we can say that here technology transfer will be profitable as  $\underline{c}_1 < \frac{2a+3c_2}{5}$ . ■

**Lemma 6.3.3** *If  $c_1 \in [\underline{c}_1, \frac{a+2c_2}{3}]$  and  $z \in (\max\{\frac{7(a-3c_1+2c_2)^2}{400}, \frac{(a-c_2)^2}{72}\}, \min\{\frac{(a-2c_2+c_1)^2}{72}, \frac{7(a-c_2)^2}{400}\})$ , then technology will be transferred.*

**Proof:** See Appendix A.5.

**Lemma 6.3.4** *Suppose  $c_1 \in [\frac{a+2c_2}{3}, \frac{a+c_2}{2}]$  and  $z \in (\frac{(a-c_2)^2}{72}, (c_1 - c_2)(a - c_1) - \frac{(a-2c_2+c_1)^2}{9})$ . Then technology will be transferred  $\forall c_1 \in [\frac{a+2c_2}{3}, c'_1]$ , where,  $c'_1 = (a - c_2)(\sqrt{2} - 1) + c_2 < \frac{a+c_2}{2}$ .*

**Proof:** See Appendix A.6.

Combining Lemma 6.3.2, 6.3.3 and 6.3.4 we get the following Proposition.

**Proposition 6.3.2** *If  $Z > 0$ , then for all  $c_1 \in (c_2, c'_1)$ , where,  $\frac{a+c_2}{2} > c'_1 = (a - c_2)(\sqrt{2} - 1) + c_2 > \frac{2a+3c_2}{5} > \frac{a+2c_2}{3}$ ,  $\exists Z$  such that technology transfer is profitable.*

Proposition 6.3.2 shows that even if cost of hiring a manager is same for both the firms, the marginal costs of production and cost of hiring a manager may be such that it increases the possibility of technology transfer relative to other cases mentioned in this section. Here technology is transferred even for higher values of  $c_1$  relative to its no-commitment equivalence model (Marjit, 1990b).

One can think Marjit's (1990b) paper as a situation where cost of hiring a manager is so high that none hires a manager. On the other hand, Proposition 6.3.2 shows a situation where in case of no technology transfer, cost of hiring a manager restricts only one firm to hire a manager but it restricts along with the choice of license fee<sup>19</sup> both the firms to hire a manager in the post transfer situation. Hence Proposition 6.3.2 shows that technology transfer possibility may be more if cost of hiring a manager along with the choice of license fee acts as a restriction to hire a manager to both firms in post transfer situation but it acts as a restriction to hire a manager to only one firm in the pre-transfer situation relative to where cost of hiring a manager is such that it restricts hiring of manager to both firms in both pre and post transfer situation. Therefore, ceteris paribus, a less restrictive commitment cost may induce a higher likelihood of technology transfer. But if commitment cost is sufficiently reduced (eg., see section 6.3.5), then technology transfer possibility will be reduced relative to sufficiently higher commitment cost.

To show the importance of cost of hiring a manager now we mention an interesting possibility. It can be shown that if  $Z > 0$  then for same values of marginal cost of production of the technologically inefficient firm, i.e.,  $c_1$ , technology transfer will be profitable for some  $Z$  but

<sup>19</sup>Note that in this situation hiring of a manager by both firms may be a Nash equilibrium. But this equilibrium will not figure out with signaling through license fee.

it will not be profitable for some other values of  $Z$ . For example, one can consider the values of  $Z \in (\frac{7(a-3c_1+2c_2)^2}{400}, \frac{(a-c_2)^2}{72})$  and  $c_1 \in (\bar{c}_1, \frac{a+2c_2}{3}]$  where at  $\bar{c}_1$ ,  $\frac{7(a-3c_1+2c_2)^2}{400} = \frac{(a-c_2)^2}{72}$  and  $\bar{c}_1 > \underline{c}_1$ . Here technology transfer will not occur but in Lemma 6.3.3 we have shown the possibility of technology transfer for this values of  $c_1$  where the values of  $Z$  was different.

Now we summarize the findings of this section. The findings are as follows:

1. If only technologically efficient firm hires a manager then technology transfer will occur for  $c_1 < \frac{2a+9c_2}{11} (< \frac{2a+3c_2}{5})$ , where,  $\frac{2a+3c_2}{5}$  is the critical value for profitable technology transfer in its no-commitment equivalence model.
2. If only technologically inefficient firm hires a manager then technology transfer will occur for  $c_1 < \frac{a+2c_2}{3} (< \frac{2a+3c_2}{5})$ .
3. If cost of hiring a manager is zero then technology transfer is profitable for  $c_1 < \frac{2a+11c_2}{13} (< \frac{2a+3c_2}{5})$ .
4. If cost of hiring a manager is positive, then there always exists a cost of hiring a manager so that technology will transfer for  $c_1 < c'_1$ , where,  $c'_1 > \frac{2a+3c_2}{5}$ .

## 6.4 Conclusion

In this chapter we examine the possibility of technology transfer when firm(s) can pre-commit to an action before output choice that gives a firm strategic advantage over its competitor. This is shown in a duopoly where the licensor and licensee compete in a market and the licensee can 'imitate' or 'invent around' the licensed technology costlessly after getting it.

Assuming that the firm(s) pre-commit by capacity installation like Basu and Singh (1990) (section 6.2) we see that for relatively small market size, technology transfer possibility will be minimum when only technologically efficient firm can commit to the capacity and the possibility of technology transfer will be maximum when both firms simultaneously commit to capacity or when capacity commitment is not possible; but, for sufficiently large market size, the possibility of technology transfer will be maximum if only technologically inefficient firm commits in the first stage. In case of simultaneous capacity choice by both firms technology transfer possibility remains unchanged relative to where pre-commitment is not possible.

Section 6.3 considers pre-commitment by incentive delegation. If we consider an incumbent-entrant framework or a situation where both firms hire a manager in the pre and post transfer situation, then likelihood of technology transfer is less relative to where pre-commitment is not possible. Further, in this situation, technology transfer possibility will be lowest when both firms hire a manager. But with positive commitment cost, technology transfer may occur for a cost parameter but it does not occur in the model of no-commitment.

Therefore, the possibility of technology transfer depends on relative market size, form of commitment, commitment cost and on whether one or both firms commit. Whether relatively

large or small market size will increase or reduce the possibility of technology transfer too depends on the form of commitment and also on the commitment cost.

## Chapter 7

# Bilateral Agreements in Oligopoly<sup>1</sup>

### 7.1 Introduction

This chapter talks about bilateral technology transfer and horizontal merger in a multi-firm industry. In a technology transfer agreement a technologically advanced firm transfers its superior production knowledge to a technologically backward firm and charges an appropriate price for the transferred technology. Under merger the constituent firms lose their identities and the merged firm is concerned with the joint profit. Technology transfer directly generates efficiency in production and sometimes it increases concentration. Merger, on the other hand, directly increases concentration; it increases efficiency if it is associated with cost reduction.

In the literature of technology licensing, researchers have focused on situations where licensor and licensee compete in the same market. Papers in this area have been referred to the earlier chapter(s). These works, however, mainly focus on duopolistic industrial structure. Often, the immediate incentive for a technologically efficient firm to sell out the technology to its less efficient competitor is that it can leave the market after sale and both the firms can share larger collusive profits. But this may not be subgame perfect as the seller may enter the market after the deal. If monopoly outcome is not sustainable, will there be a technology transfer agreement? This question is addressed in Marjit (1990b). Assuming Cournot competition Marjit (1990b) shows that a technology transfer deal between these two asymmetric firms is profitable if the firms are close in terms of their initial technological knowledge and the technology transfer is not likely to occur if this knowledge gap is too large.<sup>2</sup> One purpose of this chapter is to study how the profitability of a bilateral technology licensing is influenced with the presence of other firm(s) competing in the product market. In other words, we want to examine how the qualitative results of Marjit (1990b) are influenced when there are other firms in the industry competing with the licensor and licensee in the product market. Hence, we consider the effect of competitiveness of an industry (measured by the number of firms competing in the product

---

<sup>1</sup>This chapter is based on Marjit, Kabiraj and Mukherjee (1996).

<sup>2</sup>This result is also in Katz and Shapiro (1985).

market) on the profitability of a technology transfer deal. Here, however, we are abstaining from the discussions on multilateral or more than one bilateral technology licensing deal. Following the literature of 'exogenous merger' (see Salant et al., 1983), one can call it as 'exogenous technology transfer'. There may be another reason for looking at the bilateral technology transfer deal. This technological asymmetry is more likely to occur between firms of different countries; in particular, between the firms of industrially developed and industrially backward countries. Thus, one may think of these technologically advanced and backward firms as firms of a developed and developing countries and the bilateral technology transfer may be the outcome of the government policy of the developing country. In fact, often the clause of 'exclusive licensing' prevents the advanced firm from transferring the same technology to many firms simultaneously.<sup>3</sup>

Let us consider the possibility of 'exogenous merger' in an oligopolistic industry. (eg., see, Salant et al., 1983, Perry and Porter, 1985, Deneckere and Davidson, 1985, Long and Voutsden, 1995, etc.). In particular, we consider a bilateral (exogenous) merger between a technologically efficient firm and a technologically inefficient firm and see how the merger would affect the private profitability of the merging firms. We compare the result with technology licensing and see which arrangement generates more profit. We focus on the role of number of firms in the industry and cost asymmetry. The analysis shows that a bilateral technology transfer will always be privately profitable provided the number of technologically advanced firm be at least two and here technology transfer is more profitable than bilateral merger. But, if there exists only one technologically advanced firm then a bilateral technology transfer will occur provided the difference in initial technology level of the licensor and licensee are not sufficiently large; further, for some cost parameters technology licensing is more profitable and for other cost parameters the opposite holds.<sup>4</sup>

The plan of this chapter is as follows. In the second section we describe the model and results. Concluding remarks are given in section three.

## 7.2 Model

We consider a  $(n + m)$  firm oligopoly industry with  $n$  number of (technologically) advanced firms and  $m$  number of (technologically) backward firms with  $n, m \geq 1$  and  $n + m \geq 2$ . The firms compete like Cournot oligopolists in a homogeneous product market.<sup>5</sup> The market demand function is assumed to be linear and the inverse market demand function is given by

$$p = a - \sum_{i=1}^{n+m} q_i, \quad a > 0 \quad (7.1)$$

<sup>3</sup>See Mookherjee (1995) on related issue.

<sup>4</sup>Like Salant et al., 1983, here we are looking at the profitability conditions but we are not claiming whether these arrangements will occur or not.

<sup>5</sup>Think of a situation where initially all firms have identical technologies but now for some reasons or other only a subset of these comes up with (non-drastic) cost-reducing technologies.



where,  $p$  is the price of the product and  $q_i$  is  $i$ th firm's output.

The production technology is represented by a constant marginal cost and there is no other cost of production. The marginal cost of production of each advanced firm is  $c_i$  and that of each backward firm is  $c$ ;  $c_i < c < a$ .

We discuss the possibility of bilateral technology transfer agreement as well as bilateral horizontal merger between one advanced and one backward firm. Let us denote  $a_i$  as the  $i$ th advanced firm and  $b_j$  as the  $j$ th backward firm,  $i = 1, \dots, n, j = 1, \dots, m$ . Without loss of generality we consider any such bilateral arrangement between  $a_1$  and  $b_1$ . Under technology transfer agreement we consider only the fixed fee contract when  $a_1$  transfers its superior technology  $c_i$  to  $b_1$  and charges a fixed fee, and after technology transfer the technology seller continues to compete.<sup>6</sup> But under bilateral merger the merging firms form a merged firm,  $M$ , giving up their identities for ever. It is obvious that the merged firm will possess the superior technology,  $c_i$ .

Let  $\Pi_r^s$  denotes the  $r$ th firm's payoff under state  $s$  where  $s = 0$  (initial),  $t$  (post technology transfer),  $M$  (merger);  $r = a_i, b_j, i = 1, \dots, n, j = 1, \dots, m$ . The sum of payoffs of firms  $a_1$  and  $b_1$  under  $s$  state will be denoted by  $\Pi_s$ , i.e.,  $\Pi_s = \Pi_{a_1}^s + \Pi_{b_1}^s, s = 0, t, M$ . Let us assume

$$c_i < c < \bar{c} \quad (7.2)$$

where  $\bar{c} = \frac{(a+nq)}{(n+1)}$ . Given the demand function (7.1), the above assumption ensures an initial oligopoly structure consisting of those  $(n+m)$  firms. Hence

$$\Pi_{a_1}^0 = \frac{(a - (m+1)c_i + mc)^2}{(n+m+1)^2} \text{ and } \Pi_{b_1}^0 = \frac{(a - (n+1)c + nc_i)^2}{(n+m+1)^2}$$

so that

$$\Pi_0 = \Pi_{a_1}^0 + \Pi_{b_1}^0 = \frac{(a - (m+1)c_i + mc)^2 + (a - (n+1)c + nc_i)^2}{(n+m+1)^2} \quad (7.3)$$

### Technology Transfer

First consider the possibility of a bilateral technology transfer deal. A technology transfer agreement between  $a_1$  and  $b_1$  is profitable under the fixed fee contract iff the sum of their post transfer payoffs is larger than that of pre-transfer situation, i.e.,

$$\Pi_{a_1}^t + \Pi_{b_1}^t > \Pi_{a_1}^0 + \Pi_{b_1}^0$$

or,

$$\Pi_t > \Pi_0.$$

Then given (7.1), we must have

$$\Pi_t = \begin{cases} \frac{2(a-mc+(m-1)c)^2}{(n+m+1)^2}, & \forall c \in [c_i, c^*] \\ \frac{2(a-c)^2}{(n+2)^2}, & \forall c \in [c^*, \bar{c}] \end{cases} \quad (7.4)$$

<sup>6</sup>This diverts attention to the situation where technology is costlessly imitable so that a royalty deal is not optimal (see Rockett, 1990).

where

$$c^* = \frac{(a + (n+1)c_l)}{(n+2)} < \bar{c} \quad (7.5)$$

$\Pi_t$  is convex and non-decreasing in  $c$  with  $\Pi_t$  strictly increasing over  $c \in [c_l, c^*)$  and constant for  $c \in [c^*, \bar{c}]$ . The results underlying (7.4) follow<sup>7</sup> from the fact that relative to the advanced technology, the backward technology is such that if it is above a critical level (i.e., if  $c \geq c^*$ ), in the post transfer situation all the firms competing with backward technologies cease to operate, and hence the last row of  $\Pi_t$  gives collaborating firms' joint profits under this situation. However, if the backward technology is not so much backward, all firms will survive and under that situation the expression in the first row of (7.4) is the joint profit of the collaborating firms. It is to be noted that  $c^*$  is independent of the number of backward firms. This means that the firms possessing backward technology above the critical level cease to operate together. This is so because given the aggregate output chosen by the firms possessing advanced technologies in the post transfer situation, each of the firms possessing backward technology faces a residual demand passing below their marginal cost of production. In other words, given that the backward firms have identical technologies, naturally when one such firm finds its operation unprofitable, to all other backward firms operation becomes unprofitable. Comparing (7.3) and (7.4) we have the following result.

**Proposition 7.2.1** (a) *Iff  $n = 1$ , then  $\exists c_t, c^* < c_t < \bar{c}$  such that  $\forall c \in (c_l, c_t)$  a technology transfer deal is profitable.*

(b) *For  $n \geq 2$ ,  $\forall c \in (c_l, \bar{c})$  a technology transfer deal is always profitable.*

An outline of the proof is left in the appendix (see Appendix B.1). We provide here an intuition of the result. Part (a) of Proposition 7.2.1 is the Marjit's (1990b) result extended to any number of backward firms. It tells that iff the asymmetry in costs between the advanced and the backward firm is low, a profitable technology transfer deal exists. With very high degree of cost asymmetry the low cost firm is a near-monopoly, and, therefore, technology transfer will create competitive pressures large enough to lead to a reduction of joint profits. When  $n = 1$ ,  $c_t$  always exists because for  $c$  close to  $\bar{c}$ , pre-transfer sum of payoffs of the firms  $a_1$  and  $b_1$  is almost monopoly payoff whereas in the post-transfer situation for  $c$  close to  $\bar{c}$  only collaborating firms operate and all other firms cease to operate. Hence for  $c$  close to  $\bar{c}$ ,  $\Pi_0$  will be above  $\Pi_t$ . When  $n \geq 2$ , at  $c$  close to  $\bar{c}$ , the backward firms taken together have near-zero profits. Therefore,  $\Pi_0$  is, in fact, the payoff of one firm in the symmetric  $n$ -firm (with marginal cost of production  $c_l$ ) industry. Under this situation transfer of  $c_t$  to any one of the backward firms mean that now in the industry there are  $(n+1)$  firms each with  $c_l$  technology. Then  $\Pi_t$  denotes the sum of two

<sup>7</sup>Define,  $c^* = \frac{(a + (n+1)c_l)}{(n+2)}$ . Then we have,

- (a)  $\forall c \in [c_l, c^*)$ ,  $\Pi_{a_1}^t = \Pi_{b_1}^t = \frac{(a - mc_l + (n-1)c_l^2)}{(n+m+1)^2}$  and  $\Pi_{b_j}^t = \frac{(a - (n+2)c_l + (n+1)c_l^2)}{(n+m+1)^2}$ ,  $j \neq 1$ .  
(b)  $\forall c \in [c^*, \bar{c}]$ ,  $\Pi_{a_1}^t = \Pi_{b_1}^t = \frac{(a - c_l)^2}{(n+2)^2}$ ,  $\Pi_{b_j}^t = 0$ ,  $j \neq 1$ .

such firms' payoff in the  $(n + 1)$ -firm industry. Following Salant et al. (1983)<sup>8</sup>, we must have  $\Pi_t > \Pi_0$ , and hence  $\Pi_0$  will be always below  $\Pi_t$  for all  $c > c_t$ . Thus it is important to note that the infeasible zone of technology transfer will just vanish if there is more than one advanced firm. The result is shown in Figure 7. It may be observed that breaking of the oligopoly structure into duopoly (of the collaborating firms) is necessary for not having a profitable technology deal in our model.

Figure 7

### Merger

Let us now consider the possibility of merger between  $a_1$  and  $b_1$ . We define a merger between  $a_1$  and  $b_1$  profitable iff  $\Pi_M > \Pi_0$ , where  $\Pi_M$  is the merged firm's payoff. Note that we are not concerned about the distribution of payoffs between them. Assuming  $n$  and  $m$  as the number of advanced and backward firms respectively, and merger occurring between  $a_1$  and  $b_1$ , we have

$$\Pi_M = \frac{(a - mc_t + (m - 1)c)^2}{(n + m)^2} \quad (7.6)$$

$\Pi_M = \frac{(a - c_t)^2}{(n + m)^2}$  at  $c = c_t$  and  $\Pi_M = \frac{(a - c)^2}{(n + 1)^2}$  at  $c = \bar{c}$ . It is convex and increasing in  $c$  if  $m \geq 2$  but constant at  $\Pi_M(\bar{c})$  if  $m = 1$ .

**Proposition 7.2.2** *Suppose,  $n, m \geq 1$  and  $(n + m) > 2$ . Then  $\exists c_m$  such that  $\forall c \in (c_m, \bar{c})$  merger between firms  $a_1$  and  $b_1$  is profitable.<sup>9</sup>*

Proof is again left in the Appendix (see Appendix B.2). It states that if the asymmetry in costs between the advanced and the backward firm is not high, merger is not profitable but for high cost asymmetry, bilateral merger is profitable.

In our framework merger increases concentration by dropping one inefficient firm. In a two firm framework (whether firms are symmetric or not) with homogeneous goods, merger is always profitable as merger results in monopoly. But with more than two symmetric firms in the industry, bilateral merger is not profitable (see Salant et al., 1983), because any effort to concentrate market power through merger by reducing output of the merged firm is frustrated by the induced expansion of the rivals outside the merger. So for near-symmetry (between advanced and backward firms) merger will create strong induced expansion of output for the firms outside merger. This negative effect dominates the concentration effect and merger becomes unprofitable. Only if cost reduction is sufficiently high, merger becomes profitable for the constituent firms (see Perry and Porter, 1985 and Long and Voutsden, 1995).

<sup>8</sup>Salant et al. (1983) show that with linear demand and constant average cost of production one firm's payoff in an  $(n + 1)$ -firm industry is larger than the sum of two firms' payoff in a  $n$ -firm industry.

<sup>9</sup>For  $(n + m) = 2$  merger is always profitable.

We are now in a position to study the relative profitability of the two bilateral agreements, viz., technology transfer and merger. If initially there is only one advanced firm and one backward firm, merger trivially dominates technology transfer, because the former results in monopoly whereas the latter gives symmetric duopoly. Against this, if the number of advanced firms is at least two, technology transfer strictly dominates merger in terms of profitability whatever be the number of backward firms. This is in fact the case when technology transfer is always profitable and merger, although profitable only for a high cost asymmetry between the negotiating firms, generates strictly less profit than technology transfer to them. The most interesting is the case where the number of advanced firm is exactly one. Figure 8 shows the case for  $n = 1, m \geq 2$ .

Figure 8

Given Proposition 7.2.1 (a), Proposition 7.2.2 and  $c_m < c_t^{10}$ , we can deduce the following result:

**Corollary 7.2.1** (a)  $\forall c \in (c_t, c_m)$ , only technology transfer is profitable.  
 (b)  $\forall c \in (c_m, c_t)$ , both technology transfer and merger are profitable.  
 (c)  $\forall c \in (c_t, \bar{c})$ , only merger is profitable.

It is also evident that which arrangement generates larger profits to the negotiating partners depends on the initial level of  $c$ . For relatively low cost asymmetry technology transfer dominates merger in profitability and for a relatively high cost asymmetry, merger dominates technology transfer. To be more precise,  $\exists \hat{c}, c_m < \hat{c} < c_t$  such that  $\Pi_t \geq \Pi_m$  according as  $c \leq \hat{c}$ .

From Corollary 7.2.1 we see that for  $n = 1$  and  $m \geq 2$  sometime technology transfer dominates merger and sometime merger dominates technology transfer. In the context of this analysis one might be interested to see the effects on merger and technology transfer of an increase in the number of backward firms. The change of  $m$  will affect both the initial and post-merger and/or post-transfer payoffs of firms. This will ultimately affect the crucial parameters like  $c_m$  and  $c_t$ . Thus for this case we can have the following proposition.

**Proposition 7.2.3** Consider  $n = 1$ . As the number of inefficient firms ( $m$ ) goes up, the region of  $c$  over which technology transfer is feasible increases but the feasible region of merger gets reduced.

Proof is given in Appendix B.3. Starting with  $n = 1$  and  $m \geq 2$  if, however, we increase  $n$ , then the result is that technology transfer will strictly dominate merger for any cost asymmetry. To explain the result in Proposition 7.2.3, we note that the critical value of  $c$  after which the market will be duopoly in post-transfer situation is independent of  $m$ . But with an increase in

<sup>10</sup>This is because  $\Pi_M|_{c=c'} > \Pi_0|_{c=c'} \Rightarrow c_m < c' < c_t$ .

$m$ , the sum of pre-transfer payoffs of two collaborating firms gets reduced. So, it increases the incentive for technology transfer. In case of merger, as the number of inefficient firms increase, it increases the external effect on the outputs of the 'outside' merged firm more than that of concentration effect. This reduces the incentive for merger.

### 7.3 Conclusion

In this chapter we have discussed the profitability of technology transfer and merger between two asymmetric firms in a multi-firm oligopoly industry. In particular, we have shown that if initially there are more than one advanced firm, a profitable technology transfer deal between one advanced firm and one backward firm always exists. However, if there is only one advanced firm, a bilateral technology transfer deal exists iff the degree of technological asymmetry is below certain critical level. Profitable bilateral merger, on the other hand, requires that the technological gap between the firms must be above some critical level. We have also compared the profitability of these two arrangements. Technology transfer generates larger profits than merger if the number of advanced firm is at least two. When we have initially one advanced firm but more than one backward firm, technology transfer will dominate merger only for low cost asymmetry; otherwise merger will dominate technology transfer. If, however, there is just one advanced firm and one backward firm, then merger necessarily dominates technology transfer. Our results show that initial industry structure (that defines number of advanced and backward firms) and the technological difference among the firms are key factors determining the profitability of bilateral agreements.

## Chapter 8

# Summary and Future Extension

This dissertation has focused on some aspects related to international joint ventures and technology transfer. We summarize the results below.

Chapter 2 considers a situation where the MNC perceives higher return from its technology relative to the local firm and/or the MNC has lower opportunity cost of investment. We find that the JV may be a better option than other modes of entry when there exists project specific local inputs and difficulty in getting payments ex post.

In chapter 3 we consider a situation where the technology seller has private information about the quality of its technology and it faces imitation threats whenever it licenses its technology. We have shown that in this situation JV may be a better entry strategy relative to technology licensing and, in fact, JV invites relatively better technology in the project.

Government policy uncertainty and threat of entry from a domestic firm coupled with the private information and imitation threat mentioned above may encourage a local firm to go for a JV even if this JV does not give any immediate benefit. The possibility of future expected gain may induce the local firm to go for a JV. Chapter 4 theorizes this issue.

Chapter 5 explains whether a committed or non-committed government (tax) policy is welfare improving. In this respect, it shows that higher bargaining power of the MNC and the flexibility of technology choice in the project by the MNC is likely to create higher domestic welfare under committed government policy compared to non-committed government policy.

Chapters 6 and 7 are devoted explicitly to the problems on technology licensing. In chapter 6, we consider the profitability of technology licensing in a Cournot duopoly where licensor and licensee compete in the same market. In this framework, we see the effect of pre-commitment by one or both the firms on the profitability of technology licensing. We prove that the identity of the player who commits and the form of commitment have significance in this respect.

Chapter 7 focuses on the profitability of bilateral technology transfer and horizontal merger. In a Cournot oligopoly, we explain how the profitability of bilateral technology transfer and horizontal merger will be affected due to the presence of other competitors in the output market. We find that whether technology licensing or horizontal merger will be more profitable depend

on the number of firms existing in the product market as well as on the technology differences between these firms.

The above works of this dissertation may be extended in several directions. In a JV agreement, bargaining power is an important issue. The bargaining power not only affects the present profitability of the firm but may affect the future course of the project. Researchers should devote more attention on this issue and explain how the performance of a JV is affected by the different strengths of the parents. Again, the relations of the parents and/or the structure of industry change over time. So, we need to devote more attention to the dynamic aspects of JVs. In the recent years, while JV activities have been encouraged, it is observed that most of the JVs are operating only for few years after which break-down occurs. Hence, formation and breakdown of JVs point to an important dynamic phenomenon which is yet to receive sufficient attention from the researchers.

Secondly, while considering JV in a developing economy, one has to understand the role and importance of financial institutions in the formation of JV, which in turn, may have important consequences on the capital structure and also on the domestic welfare. The researchers may also look at the importance of control, scale economies, parental size, availability of local assistance, technology desirability in different markets, etc., while taking about JVs.

Joint ventures in the intermediate goods is another important feature in today's world. The literature, however, is yet to grow. It is likely that researchers will tempt to fill up the gap.

Sometimes the choice of capital structure gives a firm strategic advantage in the product market (see Brander and Lewis, 1986). So, one can do a similar analysis like chapter 6 to see the effects of licensing possibility on the strategic choice of capital structure of the firm(s). Often firms face uncertainty in the market demand while taking their costly investment decision but this uncertainty may be resolved before their output decision (eg., provision of facilities in restaurants). In this uncertain world, one can see the profitability and implications of licensing on the capacity choice. Another possible extension is to look at the technology licensing when the firms have asymmetric information about their rival(s).

In Chapter 7 we have discussed the profitability of bilateral merger and technology transfer in an oligopoly industry. It is possible to extend the work and provide a comparative welfare analysis. It is also worth to study the possibility of multilateral deal or more than one bilateral deals.

These issues and the related aspects will feature in our future research.

# Appendix A

## A. 1 Proof of Lemma 6.2.1

Given  $c_1$  and  $c_2$ , firm 2 will choose

$$r_2 = \frac{a - 2c_2 + c_1}{4} \quad (\text{A. 1})$$

From (A.1) we see  $r_2 > 0$ . But  $r_2 < c_2$  iff

$$c_1 < 6c_2 - a \quad (\text{A. 2})$$

Otherwise,  $r_2 = c_2$ . With  $r_2$  given by (A.1) and assuming less than  $c_2$ , we have

$$q_1 = \frac{a - 3c_1 + 2c_2}{4} \text{ and } q_2 = \frac{a - 2c_2 + c_1}{2} \quad (\text{A. 3})$$

From (A.3), we see that  $q_1 \geq 0$  iff

$$c_1 \leq \frac{a + 2c_2}{3} \quad (\text{A. 4})$$

Therefore, if firm 2 can choose  $r_2$  as given by (A.1) then firm 1 will not produce for  $c_1 \geq \frac{a+2c_2}{3}$ . Now,  $\forall c_1 \in (c_2, \frac{a+2c_2}{3}]$ , optimal  $r_2$  given by (A.1) will satisfy the constraint  $r_2 \leq c_2$  provided (if equality, only at  $c_1 = \frac{a+2c_2}{3}$ )

$$6c_2 - a \geq \frac{a + 2c_2}{3} \Rightarrow a \leq 4c_2 \quad (\text{A. 5})$$

So, with the satisfaction of (A.5), only firm 2 produces positive output  $\forall c_1 \geq \frac{a+2c_2}{3}$  and becomes a (restricted) monopoly.

From the reaction function of firm 1, we get that for  $q_2 = (a - c_1)$ , firm 1's optimal output is zero. While firm 1 producing zero output, firm 2 has no incentive to increase its output from  $(a - c_1)$  as here this amount is greater than its unrestricted monopoly output and an increase in output here implies a fall in the industry profit, i.e., the profit of firm 2. Thus the result holds. ■

## A. 2 Proof of Proposition 6.2.1

(a) From (6.2), (6.3) and (6.4) we see that  $(\Pi_1^0 + \Pi_2^0) |_{c_1=c_2} = (\Pi_1^t + \Pi_2^t)$ ,  $(\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{a+2c_2}{3}} > (\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{a+2c_2}{3}}$ . Further,  $(\Pi_1^0 + \Pi_2^0)$  is convex in  $c_1$ , continuous on  $[c_2, \frac{a+2c_2}{3}]$  and



$\frac{\partial(\Pi_1^0 + \Pi_2^0)}{\partial c_1} |_{c_1=c_2} < 0$ . This implies that  $\exists c_1 = \hat{c}_1$  so that  $(\Pi_1^0 + \Pi_2^0) |_{\hat{c}_1} = (\Pi_1^1 + \Pi_2^1)$ . This means that for  $c_1 \geq \hat{c}_1$ ,  $(\Pi_1^0 + \Pi_2^0) \geq (\Pi_1^1 + \Pi_2^1)$ . This proves the result.

(b) From (6.6) and (6.7) we see that  $(\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{2}{3}} > (\Pi_1^1 + \Pi_2^1)$ . Further, from (6.6) it is clear that  $\frac{\partial(\Pi_1^0 + \Pi_2^0)}{\partial c_1} > 0$ ,  $\forall c_1 \in [\frac{a}{2}, \frac{a+c_2}{2})$ . Therefore,  $\forall c_1 \in [\frac{a}{2}, \frac{a+c_2}{2})$ , technology will never be transferred.

From (6.5) we find that  $(\Pi_1^0 + \Pi_2^0)$  is continuous and convex in  $c_1$  on the range  $[c_2, \frac{a}{2}]$ . Also,  $(\Pi_1^0 + \Pi_2^0) |_{c_1=c_2} = (\Pi_1^1 + \Pi_2^1)$ . Further, (6.5) and (6.7) shows that

$$(\Pi_1^1 + \Pi_2^1) \geq (\Pi_1^0 + \Pi_2^0) \text{ iff } \frac{2a - 2c_2}{5} \geq c_1.$$

(c) Assume that  $4c_2 < a \leq 5c_2$ . Therefore, (6.4) remains same; but pre-transfer industry profit will be changed  $\forall c_1 > 6c_2 - a$ . If the relation between  $a$  and marginal costs of production are such that  $c_1 > 6c_2 - a$  for  $c_1 > \hat{c}_1$ , then also Proposition 6.2.1(a) holds. But for  $c_1 > 6c_2 - a$  and  $c_1 < \hat{c}_1$ , then one has to compare (6.5) and (6.6) with (6.4). However, even in this situation technology will be transferred provided  $c_1$  is less than a critical value, say,  $\hat{c}_1$ , which is less than  $\frac{a+2c_2}{3} < \frac{2a+3c_2}{5}$ . ■

### A. 3 Proof of Proposition 6.2.2

(a) From (6.8) and (6.9) we see that  $(\Pi_1^0 + \Pi_2^0)$  is convex and continuous in  $c_1 \in [c_2, \frac{a+c_2}{2}]$ . Also we have  $(\Pi_1^0 + \Pi_2^0) |_{c_1=c_2} = (\Pi_1^1 + \Pi_2^1)$ ,  $(\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{a+c_2}{2}} > (\Pi_1^1 + \Pi_2^1)$  and  $(\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{a+2c_2}{3}} = (\Pi_1^1 + \Pi_2^1)$ . Further,  $\frac{\partial(\Pi_1^0 + \Pi_2^0)}{\partial c_1} |_{c_1=c_2} < 0$ . This means that  $\forall c_1 \in (c_2, \frac{a+2c_2}{3})$ , technology transfer is profitable.

(b) From (6.10) we see that  $(\Pi_1^0 + \Pi_2^0)$  is negatively sloped with respect to  $c_1$ ,  $\forall c_1 \in [c_2, \frac{a+c_2}{6}]$  with  $(\Pi_1^0 + \Pi_2^0) |_{c_1=c_2} = (\Pi_1^1 + \Pi_2^1)$  and  $(\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{a+c_2}{6}} < (\Pi_1^1 + \Pi_2^1)$ . Further, for  $c_1 \geq \frac{a+c_2}{6}$ , we have  $(\Pi_1^0 + \Pi_2^0)$  is convex and continuous  $\forall c_1 \in [\frac{a+c_2}{6}, \frac{a+c_2}{2}]$  with  $(\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{a+c_2}{2}} > (\Pi_1^1 + \Pi_2^1)$ . This implies  $\exists c_1 = c_1^0 \in (c_2, \frac{a+c_2}{2})$  so that  $\forall c_1 \in (c_2, c_1^0)$  technology will be transferred. Also, we see that  $(\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{a+2c_2}{3}} < (\Pi_1^1 + \Pi_2^1)$  and

$$\begin{aligned} (\Pi_1^0 + \Pi_2^0) |_{c_1=\frac{a+2c_2}{3}} &\geq (\Pi_1^1 + \Pi_2^1) \text{ as (compare (6.7) and (6.8))} \\ &0 \geq 53a^2 + 53c_2^2 - 506ac_2 \end{aligned} \quad (\text{A. 6})$$

RHS of (A.6) is increasing in  $a$  for  $a > 5c_2$ . At  $a \rightarrow 5c_2$ , we get RHS  $< 0$ . This implies that  $c_1^0 < \frac{2a+3c_2}{5}$ . But  $\exists a$  such that RHS  $> 0$  which in turn implies that  $c_1^0 > \frac{2a+3c_2}{5}$ . For example, at  $a = 6c_2$ , RHS  $< 0$  but for  $a = 10c_2$ , RHS  $> 0$ . ■

### A. 4 Proof of Lemma 6.3.1

(a) Suppose the equilibrium is (0,0) under both the history of no technology transfer and technology transfer. Now technology transfer will be profitable iff the technology transfer industry

<sup>1</sup>Since the procedure is similar to cases (a) and (b) of this Proposition, we are not doing it again.

profit is higher than no technology transfer industry profit, i.e.,  $\Pi_1(c_2, c_2; 0, 0) + \Pi_2(c_2, c_2; 0, 0) > \Pi_1(c_1, c_2; 0, 0) + \Pi_2(c_1, c_2; 0, 0)$ . This implies that for technology transfer to be profitable we need,

$$\frac{2(a - c_2)^2}{9} > \frac{(a - 2c_1 + c_2)^2}{9} + \frac{(a - 2c_2 + c_1)^2}{9}$$

$$\Rightarrow c_1 < \frac{2a + 3c_2}{5}.$$

(b) Suppose,  $c_1 < \frac{a+2c_2}{3}$ . Assume that pre-transfer equilibrium is (0,1) and post-transfer equilibrium is (0,0). Now technology transfer will be profitable provided

$$\Pi_1(c_2, c_2; 0, 0) + \Pi_2(c_2, c_2; 0, 0) > \Pi_1(c_1, c_2; 0, 1) + \Pi_2(c_1, c_2; 0, 1), \text{ i.e., } \frac{2(a - c_2)^2}{9} > k - Z$$

where,  $k = \frac{(a-3c_1+2c_2)^2}{16} + \frac{(a-2c_2+c_1)^2}{8}$ . Note that  $k|_{c_1=c_2} = \frac{3(a-c_2)^2}{16} < \frac{2(a-c_2)^2}{9}$  and  $k|_{c_1=\frac{a+2c_2}{3}} = \frac{2(a-c_2)^2}{9}$ . Further, we get that  $k$  is continuous and convex in  $c_1$  on the cost range  $[c_2, \frac{a+2c_2}{3}]$  and  $\frac{\partial k}{\partial c_1}|_{c_1=c_2} < 0$ . This implies that  $\forall c_1 \in (c_2, \frac{a+2c_2}{3})$ , technology transfer is profitable.

(c) Suppose pre-transfer equilibrium is (0,1) and post-transfer equilibrium is (1,1). In the pre-transfer situation industry profit is given by

$$\frac{(a - 3c_1 + 2c_2)^2}{16} + \frac{(a - 2c_2 + c_1)^2}{8} - Z, \text{ for } c_1 \leq \frac{a + 2c_2}{3}$$

$$(c_1 - c_2)(a - c_1) - Z, \text{ for } c_1 \geq \frac{a + 2c_2}{3}.$$

The post-transfer industry profit is given by

$$\frac{4(a - c_2)^2}{25} - 2Z.$$

First assume,  $c_1 \leq \frac{a+2c_2}{3}$ . Denote  $g = \frac{(a-3c_1+2c_2)^2}{16} + \frac{(a-2c_2+c_1)^2}{8}$  which is continuous and convex on the range  $[c_2, \frac{a+2c_2}{3}]$  with  $\frac{\partial g}{\partial c_1}|_{c_1=c_2} < 0$ . Further,  $g|_{c_1=c_2} = \frac{3(a-c_2)^2}{16} > \frac{4(a-c_2)^2}{25}$ ,  $g|_{c_1=\frac{a+2c_2}{3}} = \frac{2(a-c_2)^2}{9} > \frac{4(a-c_2)^2}{25}$  and  $g|_{\min c_1 = \frac{a+10c_2}{11}} > \frac{4(a-c_2)^2}{25}$ . Therefore,  $\forall c_1 \in [c_2, \frac{a+2c_2}{3}]$ ,  $g > \frac{4(a-c_2)^2}{25} - Z$ .

Now assume  $c_1 \geq \frac{a+2c_2}{3}$ . Here denote  $h = (c_1 - c_2)(a - c_1)$  which is positively sloped on the range  $[\frac{a+2c_2}{3}, \frac{a+c_2}{2}]$  and  $h|_{c_1=\frac{a+2c_2}{3}} > \frac{4(a-c_2)^2}{25}$ .

This proves the result that in this situation technology transfer is never profitable. ■

## A. 5 Proof of Lemma 6.3.3

Assume that  $c_1 \in (\underline{c}_1, \frac{a+2c_2}{3}]$  and  $Z \in (\max\{\frac{7(a-3c_1+2c_2)^2}{400}, \frac{(a-c_2)^2}{72}\}, \min\{\frac{(a-2c_2+c_1)^2}{72}, \frac{7(a-c_2)^2}{400}\})$ . Therefore, under the history of no technology transfer the equilibrium will be (0,1) (see (6.17) in the text) but there are two Nash equilibriums (0,0) and (1,1) under the history of technology transfer as  $Z > \frac{(a-c_2)^2}{72}$  and  $Z < \frac{7(a-c_2)^2}{400}$ . Now from Lemma 6.3.1(b) we can say that technology transfer will be profitable iff the post technology transfer equilibrium is (0,0). So, if one can get (0,0) as the Nash equilibrium after perfection and can eliminate (1,1) as the post technology

transfer then technology transfer will take place. Here we use the concept of 'forward induction' (see, Van Damme, 1989) to get the perfect equilibrium. The reason is as follows. Suppose firm 2 charges an up-front fixed fee,  $f$ , as the price of technology so that its payoff between no technology transfer and technology transfer with a (0,1) equilibrium is same<sup>2</sup>, i.e.,

$$\begin{aligned} \frac{(a - 2c_2 + c_1)^2}{8} - Z &= \frac{(a - c_2)^2}{8} - Z + f \\ \Rightarrow f &= \frac{(a - 2c_2 + c_1)^2}{8} - \frac{(a - c_2)^2}{8} > 0 \end{aligned} \quad (\text{A. 7})$$

Therefore, this amount of  $f$  gives a signal to firm 1 that firm 2 does not want to hire a manager in the technology transfer situation as this will not give firm 2 more payoff relative to its no technology transfer payoff.<sup>3</sup> So, firm 2 will not hire a manager, if it transfers its technology and seeing this firm 1 will not hire a manager also as  $Z > \frac{(a - c_2)^2}{72}$ . However, firm 2 will actually transfer its technology with this  $f$  given in (A.7) and it will be accepted by firm 1 iff this gives both parties at least their payoff from no technology transfer. First consider the participation constraint of firm 2, i.e., firm 2 will be better off under technology transfer equilibrium iff

$$\begin{aligned} \frac{(a - c_2)^2}{9} + f &> \frac{(a - 2c_2 + c_1)^2}{8} - Z \\ \text{or, } Z &> \frac{(a - c_2)^2}{72} \end{aligned} \quad (\text{A. 8})$$

and this holds. Again it is easy to show that here firm 2 choose  $f$  in such a way that it will be accepted by firm 1 because firm 2 can always choose  $f$  less than the amount specified in (A.7) so far it satisfies its participation constraint with equality. As industry profit increases here relative to no technology transfer, this process will satisfy both parties participation constraints. ■

## A. 6 Proof of Lemma 6.3.4

Consider the values of  $c_1 \in [\frac{a+2c_2}{3}, \frac{a+c_2}{2}]$  and assume that  $Z \in (\frac{(a-c_2)^2}{72}, (c_1 - c_2)(a - c_1) - \frac{(a-2c_2+c_1)^2}{9})$ . However, for  $Z$  belongs to this range we need this to be non-empty, i.e.,  $(c_1 - c_2)(a - c_1) - \frac{(a-2c_2+c_1)^2}{9} - \frac{(a-c_2)^2}{72} = P$  (say)  $> 0$ . We see that  $P|_{c_1 = \frac{a+2c_2}{3}} > 0$  but  $P|_{c_1 = \frac{a+c_2}{2}} < 0$  and  $P$  is continuous in  $c_1$  on  $[\frac{a+2c_2}{3}, \frac{a+c_2}{2}]$ . So,  $\exists \tilde{c}_1 = \frac{9a+11c_2}{20} > \frac{a+2c_2}{3}$  such that  $\forall c_1 \in [\frac{a+2c_2}{3}, \frac{9a+11c_2}{20}]$ , we have non-empty interval.

Now we see that for these values of  $c_1$  and  $Z$ , the equilibrium will be (0,1) under no technology transfer but the equilibrium will be (0,0) and/or (1,1) under technology transfer. However, like Lemma 6.3.3, we can eliminate (1,1) as an equilibrium when we have two Nash equilibriums (0,0) and (1,1) in the technology transfer situation.

<sup>2</sup>Actually firm 2 charges  $f - \delta$ ,  $\delta > 0$  and very small.

<sup>3</sup>If the equilibrium is (1,1) after technology transfer then this amount of  $f$  will make firm 2 worse-off relative to no technology transfer.

Now consider the profitability of technology transfer for  $c_1 \in (\frac{a+2c_2}{3}, \frac{9a+11c_2}{20})$ . For technology transfer to be profitable we need to increase industry profit under technology transfer vis-a-vis that of no technology transfer, i.e.,

$$\frac{2(a-c_2)^2}{9} > (c_1 - c_2)(a - c_1) - Z \quad (\text{A. 9})$$

If (A.9) is satisfied at maximum  $Z = (c_1 - c_2)(a - c_1) - \frac{(a-2c_2+c_1)^2}{9}$ , for all  $c_1 \in [\frac{a+2c_2}{3}, \frac{9a+11c_2}{20}]$ , then  $\exists$  some  $Z$  for any  $c_1$  in this range that will make technology transfer profitable. So  $M > 0$  is the sufficient condition where,

$$M = \frac{2(a-c_2)^2}{9} - \frac{(a-2c_2+c_1)^2}{9} \quad (\text{A. 10})$$

We have  $M|_{c_1=\frac{a+2c_2}{3}} > 0$ ,  $M|_{c_1=\frac{9a+11c_2}{20}} < 0$  and  $\frac{\partial M}{\partial c_1} < 0$ . Therefore,  $\exists$  some  $Z$  such that technology transfer will be profitable for  $c_1 \in (\frac{a+2c_2}{3}, c'_1)$ , where at  $c'_1$ ,  $\frac{2(a-c_2)^2}{9} = \frac{(a-2c_2+c_1)^2}{9}$ , which implies that

$$c'_1 = (a - c_2)(\sqrt{2} - 1) + c_2.$$

This proves the result. ■

# Appendix B

## B.1 Proof of Proposition 7.2.1

From (7.3) and (7.4), for  $c \in [c_l, c^*]$  we get that  $(\Pi_t - \Pi_0)$  is quadratic in  $c$  with  $(\Pi_t - \Pi_0)|_{c=c_l} = 0$ ,  $(\Pi_t - \Pi_0)|_{c=c^*} > 0$  and  $\frac{\partial(\Pi_t - \Pi_0)}{\partial c}|_{c=c_l} > 0$ . Therefore, we can say that  $\forall c \in [c_l, c^*]$ ,  $(\Pi_t - \Pi_0) > 0$ .

For  $c \in [c^*, \bar{c}]$ ,  $\Pi_t$  is constant. Just we have seen that  $(\Pi_t - \Pi_0) > 0$  at  $c = c^*$ . Further from (7.3) and (7.4), we see that  $(\Pi_t - \Pi_0)|_{c=\bar{c}} > 0$  iff  $n > 1$ ; but for  $n = 1$ ,  $\Pi_t < \Pi_0$  at  $c = \bar{c}$ . Also,  $\Pi_0$  is quadratic, convex and continuous in  $c$ . Thus, we can conclude that iff  $n = 1$ , then  $\exists c_l, c^* < c_t < \bar{c}$  such that  $\Pi_t > \Pi_0$  for  $c \in (c_l, c_t)$ . This proves part (a).

But for  $n \geq 2$ ,  $\Pi_t > \Pi_0$  for all admissible values of  $c$ . This proves part (b). ■

## B.2 Proof of Proposition 7.2.2

Consider  $n, m \geq 1$  and  $(n + m) > 2$ . From (7.3) and (7.6) we get that  $(\Pi_M - \Pi_0)$  is quadratic in  $c$  with  $(\Pi_M - \Pi_0)|_{c=c_l} < 0$ ,  $(\Pi_M - \Pi_0)|_{c=\bar{c}} = 0$ . Therefore, we have  $\bar{c}$  as one root of the quadratic equation  $\Pi_M - \Pi_0 = 0$ . Then it can be easily shown (from the property of quadratic equation) that another root of the equation  $\Pi_t - \Pi_0 = 0$  is at  $c_m = \frac{(a-c_l)((n+m-2)(n+m)-1)}{(n-1)(n+m)^2 + (2n+2m+1)(n+2m-1)} + c_l$  and  $c_l < c_m < \bar{c}$ . This proves the result. ■

## B.3 Proof of Proposition 7.2.3

Directly from the expression of  $c_m$  (with  $n = 1$ ) we can see that  $\frac{\partial c_m}{\partial m} > 0$ , i.e., with an increase in  $m$ , the feasible region of merger shrinks.

Now to see the effect of an increase in  $m$  on  $c_t$  we note the following. As  $m$  increases,  $\Pi_t$  shifts downward (i.e.,  $\frac{\partial \Pi_t}{\partial m} < 0$ ) for  $c \in [c_l, c^*]$  and remains unaffected for  $c \in [c^*, \bar{c}]$ . But  $\Pi_0$  also shifts downward for all  $c < \bar{c}$ , and at  $\bar{c}$ ,  $\Pi_0$  is independent of  $m$ . Hence as  $m$  increases,  $\Pi_0$  curve gradually intersects the horizontal portion of  $\Pi_t$  to the right. Hence  $\frac{\partial c_t}{\partial m} > 0$  and proves the result. ■

# References

1. Abdalla, A.E.A., 1992, 'Distortions to Capital Mobility : The Case of Joint Ventures', *Economics Letters* 38 : 443 - 49.
2. Aghion, P. and J. Tirole, 1994, 'The Management of Innovation', *Quarterly Journal of Economics* 109: 1185 - 1209.
3. Aizenman, J., 1992, 'Trade Reforms, Credibility and Development', *Journal of Development Economics* 39: 163 - 87.
4. Al-Saadon, Y. and S.P. Das, 1996, 'Host-country Policy, Transfer Pricing and Ownership Distribution in International Joint Venture : A Theoretical Analysis', *International Journal of Industrial Organization* 14 : 345 - 64.
5. Bagchi, A. K., 1987, 'Public Intervention and Industrial Restructuring in China, India and Republic of Korea', *ARTEP, ILO, New Delhi*.
6. Basu, K., 1993, 'Lectures in Industrial Organization Theory', *Oxford UK and Cambridge USA, Blackwell*.
7. Basu, K., 1995, 'Stackelberg Equilibrium in Oligopoly: An Explanation Based on Managerial Incentive', *Economics Letters* 49: 459 - 64.
8. Basu, K., A. Ghosh and T. Ray, 1997, 'The Babu and the Boxwallah: Managerial Incentives and Government Intervention in a Developing Economy', *Review of Development Economics* 1: 71 - 80.
9. Basu, K. and N. Singh, 1985, 'Commitment and Entry-Deterrence in a Model of Duopoly', *Economics Letters* 18: 265 - 69.
10. Basu, K. and N. Singh, 1990, 'Entry Deterrence in a Stackelberg Perfect Equilibrium', *International Economic Review* 31: 61 - 71.
11. Beamish, P., 1988, 'Multinational Joint Ventures in Developing Countries', *New York, Routledge*.

12. Bhandari, B., 1997, 'Losing Control', *Business World*, **25 December, 1996 - 7 January, 1997**: 34 - 39.
13. Bhandari, L., 1996, 'International Technology Transfer: Control, Contracts and Learning Between Firms', *Ph.D. dissertation*, Boston University.
14. Brander, J. A. and B. J. Spencer, 1985, 'Export Subsidies and International Market Share Rivalry', *Journal of International Economics* **18**:83 - 100.
15. Brander, J. A. and T. R. Lewis, 1986, 'Oligopoly and Financial Structure: The Limited-liability Effect', *The American Economic Review* **76**: 956 - 70.
16. Bresnahan, T and S. Salop, 1986, 'Quantifying the Competitive Effects of Production Joint Ventures', *International Journal of Industrial Organization* **4** : 155 - 75.
17. Broll, U. and S. Marjit, 1995, 'Joint Venture under Uncertainty', *Current Policies and Economics in Europe* **November Issue**.
18. Buffie, E., 1995, 'Trade Liberalization, Credibility and Self-fulfilling Failures', *Journal of International Economics* **38**: 51 - 73.
19. Caves, R. E., 1996, 'Multinational Enterprise and Economic Analysis', *London, Cambridge University Press*.
20. Chan, R. and M. Hoy, 1991, 'East-West Joint Ventures and Buyback Contracts', *Journal of International Economics* **30** : 330 - 43.
21. Choi, C.J. and D. Maldoom, 1992, 'A Simple Model of Buybacks', *Economics Letters* **40**: 77 - 82.
22. Darrough, M. N. and N. M. Stoughton, 1989, 'A Bargaining Approach to Profit Sharing in Joint Ventures', *Journal of Business* **62**: 237 - 70.
23. Das, S. P., 1995, 'On the Choice of International Joint Venture: The Role of Policy Moral Hazard', *The Journal of Policy Reform*, forthcoming.
24. Das, S.P., 1996, 'Direct Foreign Investment versus Licensing', *Mimeo*, Indian Statistical Institute, Delhi.
25. Dasgupta, S. and Z. Tao, 1995, 'Contractual Incompleteness, Ownership Rights and Equity Joint Ventures', *Mimeo*, Hong Kong University of Science and Technology, Hong Kong.
26. Deneckere, R. and C. Davidson, 1985, 'Incentives to Form Coalitions with Bertrand Competition', *RAND Journal of Economics* **16**: 473 - 86.

27. Dixit, A., 1980, 'The Role of Investment in Entry Deterrence', *The Economic Journal* **90**: 95 - 106.
28. Economic and Political Weekly (EPW) - Special Issue, 1985.
29. Either, W. J., 1986, 'The Multinational Firm', *Quarterly Journal of Economics* **101**: 805 - 33.
30. Eswaran, M., 1993, 'Cross-licensing of Competing Patents as a Facilitating Device', *Canadian Journal of Economics* **27**: 689 - 708.
31. Falvey, R.E. and H.O. Fried, 1986, 'National Ownership Requirements and Transfer Pricing', *Journal of Development Economics* **24** : 249 - 54.
32. Fershtman, C. and K. L. Judd, 1987, 'Equilibrium Incentives in Oligopoly', *The American Economic Review* **77**: 927 - 40.
33. Gabszewicz, J. J. and S. Poddar, 1997, 'Demand Fluctuations and Capacity Utilization under Duopoly', *Economic Theory* **10**: 131 - 46.
34. Gallini, N. T. and B. D. Wright, 1990, 'Technology Transfer under Asymmetric Information', *RAND Journal of Economics* **21**: 147 - 60.
35. Gallini, N.T., 1984, 'Deterrence by Market Sharing: A Strategic Incentive for Licensing', *The American Economic Review* **74**: 931 - 41.
36. Gallini, N.T. and R.A. Winter, 1985, 'Licensing in the Theory of Innovation', *Bell Journal of Economics* **16**: 237 - 52.
37. Gangopadhyay, S. and I. Gang, 1993, 'Government Policy for Foreign Direct Investment', in B.Dutta et al., ed., *Theoretical Issues in Development Economics (Oxford University Press)* : 209 - 20.
38. Grossman, S. J. and O. D. Hart, 1986, 'The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration', *Journal of Political Economy* **94**: 691 - 719.
39. Gupta, S. P. and R. L. Chawla, 1995, 'Prospects of Foreign Direct Investment in India in Post Liberalization Era', *Indian Council for Research on International Economic Relations, New Delhi, India*.
40. Harvey, C. R., 1995, 'The Risk Exposure of Emerging Equity Markets', *The World Bank Economic Review* **9**: 19 - 50.
41. Hladik, K., 1985, 'International Joint Ventures: An Analysis of U.S. Foreign Business Partnership' *Lexington, Massachusetts: Lexington Book*.



42. Horstmann, I. J. and J. R. Markusen, 1987a, 'Strategic Investments and the Developments of Multinationals', *International Economic Review* **28**: 109 - 21.
43. Horstmann, I. J. and J. R. Markusen, 1987b, 'Licensing versus Direct Investment: A Model of Internalization by the Multinational Enterprises', *Canadian Journal of Economics* **20**: 464 - 81.
44. Kabiraj, T., 1990, 'Market Size and the Desired Technology Level', *Artha Shastra* **9**: 41 - 47.
45. Kabiraj, T., 1993, 'Some Aspects of Technology Transfer - Theory and Policy', *Ph.D. Dissertation, Jadavpur University*.
46. Kabiraj, T., 1994, 'Technology and Price in a Leadership Structure: A Geometric approach', *Journal of Quantitative Economics* **10**: 171 - 79.
47. Kabiraj, T. and M. Chaudhuri, 1996, 'An Input Joint Venture : Some New Results', *Mimeo*, Indian Statistical Institute, Calcutta.
48. Kabiraj, T. and S. Marjit, 1992a, 'To Transfer or Not to Transfer the best Technology Under Threat of Entry - The Case of Price Competition', in B. Dutta et al., ed., *Game Theory and Economic Applications*, Berlin: Springer - Verlag: 356 - 68.
49. Kabiraj, T. and S. Marjit, 1992b, 'Technology and Price in a Non-cooperative Framework', *International Review of Economics and Finance* **1**: 371 - 78.
50. Kabiraj, T. and S. Marjit, 1993, 'International Technology Transfer Under Potential Threat of Entry - A Cournot-Nash Framework', *Journal of Development Economics* **42**: 75 - 88.
51. Kamien, M. I. and I. Zang, 1990, 'The Limits of Monopolization Through Acquisition', *Quarterly Journal of Economics* **105**: 465 - 500.
52. Kamien, M.I., 1992, 'Patent Licensing', *Handbook of Game Theory with Economic Applications* **1**: 331 - 54.
53. Katz, M. and C. Shapiro, 1985, 'On the Licensing of Innovation', *RAND Journal of Economics* **16**: 504 - 20.
54. Killing, J.P., 1983, 'Strategies for Joint Venture Success', *Praeger Publishers, New York*.
55. Korbin, S. J., 1988, 'Ownership of American Manufacturing Subsidiaries in Developing Countries', *Managerial International Review Special Issue*: 73 - 84.
56. Kwoka, John Jr. E., 1992, 'The Output and Profit Effects of Horizontal Joint Ventures', *Journal of Industrial Economics* **40**: 325 - 38.

57. Lee, F.C. and O. Shy, 1992, 'A Welfare Evaluation of Technology Transfer to Joint Ventures in the Developing Countries', *The International Trade Journal* 7: 205 - 20.
58. Lee, S., 1990, 'International Equity Markets and Trade Policy', *Journal of International Economics* 29: 173 - 84.
59. Lin, P., 1996, 'Fixed-fee Licensing of Innovations and Collusion', *The Journal of Industrial Economics* XLIV: 443 - 49.
60. Long, N. V. and N. Vousden, 1995, 'The Effects of Trade Liberalization on Cost Reducing Mergers', *Review of International Economics* 3: 141 - 55.
61. Mansfield, E., 1994, 'Intellectual Property Rights, Foreign Direct Investment and Technology Transfer', *Discussion Paper No. 19*, International Finance Corporation, The World Bank, Washington, D.C.
62. Marin, D. and M. Schnitzer, 1995, 'Tying Trade Flows: A Theory of Countertrade with Evidence', *The American Economic Review* 85: 1047 - 64.
63. Marjit, S., 1990a, 'Rationalizing Public-Private Joint Venture in an Open Economy', *Journal of Development Economics* 33 : 377 - 83.
64. Marjit, S., 1990b, 'On a Non-cooperative Theory of Technology Transfer', *Economics Letters* 33: 293 - 98.
65. Marjit, S., 1994, 'Verification and Adverse Selection - A Case for Corruption in Public Procurement', *Mimeo*, Indian Statistical Institute.
66. Marjit, S., 1998, 'Equity and Joint Ventures', in G. Gupta et al., ed., *Issues in Development Economics*, Orient Longman, forthcoming.
67. Marjit, S., A. Mukherjee and T. Kabiraj, 1997a, 'International Joint Venture and the Technology of the Future - The Role of Uncertainty', *Mimeo*, Indian Statistical Institute, Calcutta, India.
68. Marjit, S., A. Mukherjee and T. Kabiraj, 1997b, 'International Joint Ventures in Developing Countries - A Survey of Analytical Issues', *Mimeo*, Indian Statistical Institute, Calcutta.
69. Marjit, S., T. Kabiraj and A. Mukherjee, 1996, 'Bilateral Agreements in a Multi-firm Industry - Technology Transfer and Horizontal Merger', *Pacific Economic Review*, forthcoming.
70. Marjit, S., U. Broll and I. Mallick, 1995, 'A Theory of Overseas Joint Venture', *Economics Letters* 47 : 367 - 70.

71. Marjit, S., Y-k. Ng, U. Broll and B. Moitra, 1994, 'Resolving the Credibility Problem of an Honest Government: A Case for Foreign Investment Subsidy', *Mimeo*, Jadavpur University.
72. Marjit, S. and A. Mukherjee, 1995, 'Technology Transfer under Asymmetric Information: The Role of Equity Participation', Paper presented at the *International Conference on Game Theory and Economic Applications*, Bangalore, 1996.
73. Marjit, S. and A. Mukherjee, 1998, 'Technology Collaboration and Foreign Equity Participation: A Theoretical Analysis', *Review of International Economics*, 6: 142 - 50.
74. Marjit, S. and H. Beladi, 1996, 'Tariff Jumping and Joint Ventures', *Mimeo*, University of Dayton.
75. Marjit, S. and N. Singh, 1995, 'Technology and Indian Industry', in D. Mookherjee, ed., *Indian Industry - Policies and Performance*, Delhi: Oxford University Press: 191 - 235.
76. Marjit, S. and U. Broll, 1997, 'Missing Markets: Foreign Investment and the Role of Joint Ventures', *Mimeo*, University of Munich.
77. Markusen, J.R., 1995, 'The Boundaries of Multinational Enterprises and the Theory of International Trade', *Journal of Economic Perspectives* 9: 169 - 89.
78. Milgrom, P. and J. Roberts, 1986, 'Price and Advertising Signals of Product Quality', *Journal of Political Economy* 94: 796 - 821.
79. Miller, R.R., J.D. Glen, F.Z. Jaspersen and Y. Karmokolias, 1996, 'International Joint Ventures in Developing Countries - Happy Marriages?', *Discussion Paper, No. 29*, International Finance Corporation.
80. Mookherjee, D., 1995, 'Introduction', in D. Mookherjee, ed., *Indian Industry - Policies and Performance*, Delhi: Oxford University Press.
81. Mukherjee, A., 1997a, 'Technology Transfer with Commitment', *Mimeo*, Indian Statistical Institute, Calcutta.
82. Mukherjee, A., 1997b, 'Host-Country Policy - Commitment or No-Commitment: A Theoretical Analysis', Paper presented at the *UGC-National Conference on Contemporary Issues in Economic Theory and Policy*, organized by Burdwan University, 1997.
83. Myerson, R., 1979, 'Incentive Compatibility and the Bargaining Problem', *Econometrica* 47: 61 - 73.

84. Myrdal, G., 1981, 'The Transfer of Technology to Underdeveloped Countries', in T. J. Kuehn and A. L. Porter, ed., *Science, Technology and National Policy*, Cornell University Press.
85. Nye, W., 1992, 'Can a Joint Venture Lessen Competition more than a Merger?', *Economics Letters* 40 : 487 - 89.
86. Pack, H. and K. Saggi, 1997, 'Inflows of Foreign Technology and Indigenous Technological Development', *Review of Development Economics* 1: 81 - 98.
87. Perry, M. K. and R. H. Porter, 1985, 'Oligopoly and the Incentives for Horizontal Merger', *The American Economic Review* 75: 219 - 27.
88. Purkayastha, D., 1993, 'Firm-Specific Advantages, Multinational Joint Ventures and Host-Country Tariff Policy', *Southern Economic Journal* 60 : 89 - 95.
89. Qiu, L.D. and Z. Tao, 1995, 'Policy Towards International R&D Cooperation', *Mimeo*, Department of Economics, Hong Kong University of Science and Technology.
90. Reinganum, J.F., 1989, 'The timing of Innovation: Research, Development and Diffusion', in *Handbook of Industrial Economics* 1: 849 - 908.
91. Rockett, K., 1990, 'The Quality of Licensed Technology', *International Journal of International Organization* 8: 559 - 74.
92. Rodrik, D., 1989, 'Promises, Promises: Credible Policy Reform via Signalling', *The Economic Journal* 99: 756 - 72.
93. Rugman, A. M., 1981, 'Inside the Multinationals: The Economics of Internal Markets', London, Croom Helm, and New York: Columbia University Press.
94. Rugman, A. M., 1986, 'New Theories of the Multinational Enterprise: An Assessment of Internalization Theory', *Bulletin of Economic Research* 38: 101 - 18.
95. Salant, S. W., S. Switzer and R. Reynolds, 1983, 'Losses from Horizontal Merger: The Effects of an Exogenous Change in Industry Structure on Cournot-Nash Equilibrium', *Quarterly Journal of Economics* 98: 185 - 99.
96. Saqib, M., 1995, 'An Overview of the Economic Policy and FDI in India with Special Reference to the USA', in: S.P.Gupta et al., ed., *Prospects of Foreign Direct Investment in India in Post Liberalisation Era (Indian Council For Research On International Economic Relations)*, 81 - 99.
97. Singh, N., 1992, 'Multinationals, Technology and Government Policy', in K. Basu and P. Nayak, ed., *Development Policy and Economic Theory*, Delhi, Oxford University Press.

98. Singh, N. and P. Bardhan, 1991, 'Government Policy Towards Joint Ventures with Multi-national Rivalry', *Mimeo*, University of California, Santa Cruz.
99. Spence, A. M., 1977, 'Entry Capacity, Investment and Oligopolistic Pricing', *Bell Journal of Economics* 8: 534 - 44.
100. Spencer, B. J. and J. A. Brander, 1983, 'International R&D Rivalry and Industrial Strategy', *Review of Economic studies* L(3): 707 - 22.
101. Spencer, B.J. and R.S. Raubitschek, 1996, 'High-Cost Domestic Joint Ventures and International Competition: Do Domestic Firms Gain', *International Economic Review* 37: 315 - 40.
102. Svejnar, J. and S.C. Smith, 1984, 'The Economics of Joint Venture in Less Developed Countries', *Quarterly Journal of Economics* 119 : 149 - 67.
103. Tang M.J. and C.M.J. Yu, 1990, 'Foreign Market Entry: Production-Related Strategies', *Management Science* 36: 476 - 89.
104. Teece, D. J., 1977, 'Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-how', *The Economic Journal* 87: 242 - 61.
105. Teece, D. J., 1981, 'The Market for Know-how and the Efficient International Transfer of Technology', *ANNALS, AAPSS* November: 81 - 95.
106. Tirole, J., 1986, 'Hierarchies and Bureaucracies: On the Role of Collusion in Organizations', *Journal of Law, Economics and Organizations* 2: 181 - 214.
107. Tirole, J., 1989, 'The Theory of Industrial Organization', *The MIT Press*.
108. Tomlinson, J.W.C., 1970, 'The Joint Venture Process in International Business : India and Pakistan', *The MIT Press, Cambridge, Massachusetts*.
109. Van Damme, E., 1989, 'Stable Equilibria and Forward Induction', *Journal of Economic Theory* 48: 476 - 96.
110. Williamson, R. W., 1981, 'The Modern Corporation: Origins, Evolution, Attributes', *Journal of Economic Literature* 19: 1537 - 68.

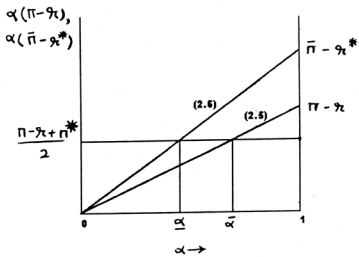


Figure 1

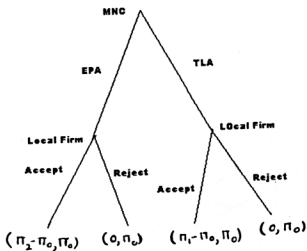


Figure 2

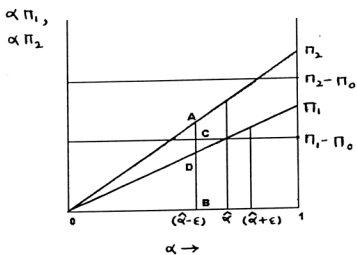
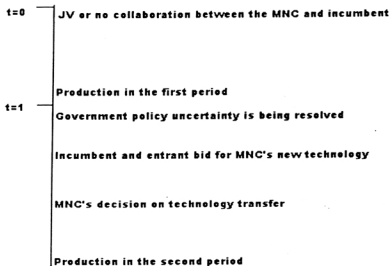


Figure 3





**Figure 4**

**Decision on technology transfer**

**Commitment by incumbent**

**Production by the firms**

**Figure 5**

**Decision on technology transfer**

**Commitment by both firms**

**Production by the firms**

**Figure 6**

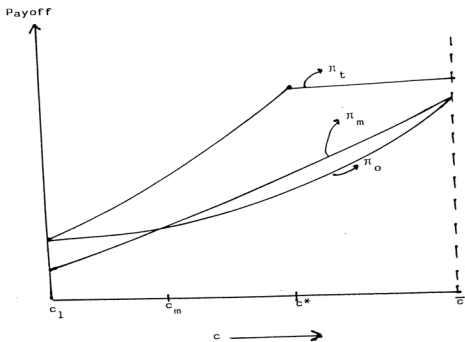


Figure 7

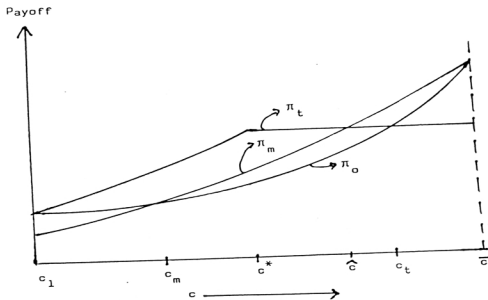


Figure 8

|                                             | Small Market Size<br>( $a \leq 4c_2$ ) | Medium Market Size<br>( $4c_2 < a \leq 5c_2$ ) | Large Market Size<br>( $a > 5c_2$ ) |
|---------------------------------------------|----------------------------------------|------------------------------------------------|-------------------------------------|
| Technologically Efficient<br>Firm Commits   | $\hat{c}_1 (< (a+2c_2)/3)$             | $\check{c}_1 (< (a+2c_2)/3)$                   | $\tilde{c}_1 (< (2a+3c_2)/5)$       |
| Technologically Inefficient<br>Firm Commits | $\check{c}_1 (= (a+2c_2)/3)$           | $\check{c}_1 (= (a+2c_2)/3)$                   | $c_1^o (\geq (2a+3c_2)/5)$          |

Table 1

# INDIAN STATISTICAL INSTITUTE LIBRARY

## Processing slip

Source.....P/E/G date 23.12.05 Acc. no. T163

Author Mukherjee Arijit

Title International Joint Ventures and technology transfer in developing economies

### CHECKING :

Call no.

1 In library/earlier ed./later ed. ☐

2 Earlier volumes/nos. of the series in lib. ☐

3 New title ☒

Suggested/Approved by

Note :

~~23~~ 23.12.05  
Signature & date

### CLASSIFICATION :

Class no.....x-ref.....

Scrutiny report :

Signature & date

Class no.....x-ref.....

Note :

Signature & date

### CATALOGUING :

1 Main Card ☐

2 Supp. Cards ( Subject/Title/Series/Added entries/Shelf List ) [ Total no. of cards ].....

3 Mechanical processing completed on.....

4 Cards filed ☐

Note :

Signature & date