International Joint Ventures, Moral Hazards, and Technology Spillovers

Kar-yiu Wong
University of Washington

Wing-fai Leung
City University of Hong Kong

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Abstract

In this paper, we provide a theory to explain why a multinational corporation and a local firm choose to form an international joint venture (IJV) and why they decide to dissolve it sometime later. Our theory has two important features: moral hazard and technology spillovers. Because of moral hazard, a firm may not provide the right effort to make an IJV beneficial to both firms. When an IJV is formed, technology spillovers allow both firms to learn from each other. Under certain conditions, at least one of the firms learns sufficiently from the other firm and decides to break away from the joint venture.

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1 Introduction

There are many reasons why two firms (or more) choose to form a joint venture to produce a commodity. To increase the monopoly power is one reason often suggested. Another interesting reason is that a joint venture allows the partners to combine some of their advantages that are complementary to each other, including financial capital and technological knowledge.[1] Of all the forms of joint ventures, those formed by firms in different countries, which are commonly called international joint ventures (IJVs), receive special attention.

For an IJV, the difference between a multinational corporation (MNC) and a local firm is often emphasized. According to the ownership-location-internalization (OLI) literature, a MNC that chooses to supply to a foreign market not through export but through direct investment must possess some ownership advantages in order to overcome the obvious disadvantages of its unfamiliarity local cultures and systems.[2] We follow the approach of this literature, but focus instead on an option of a MNC that has not been covered in the OLI literature: the formation of an IJV with a local firm. Many studies have pointed out that in forming an IJV, a MNC contributes some of its ownership advantages while a local firm will make use of its knowledge and familiarity of the local market and domestic cultures and systems.[3]

One feature of IJVs that has captured the attention of many people is that the life of a typical IJV seems to be short, in fact much shorter than the life of a typical and comparable wholly-owned subsidiary of a MNC (Beamish, 1985; Franko, 1971; Kogut, 1988a and 1988b; Geringer and Hebert, 1991, and Li and Guisinger, 1991). In particular, Gomes-Casseres (1987) finds that although the liquidation of joint ventures is not very different from wholly-owned subsidiaries (WOSs), the sellout rate of joint ventures (to one of the partners or outsiders) is higher than WOSs. The paper is based on a sample of over 5000 subsidiaries (either joint ventured or wholly-owned) of U.S. MNCs established between 1900 and 1975.[4] The paper shows the share of

[1] See, for example, Beamish (1985), Benito and Gripsrud (1992), Blodgett (1991), Gomes-Casseres (1989), Hennart (1988), Kogut, (1988b), Lee and Beamish, (1995), Perlmutter and Heenan (1986), and Reynolds (1984).

[2] See Wong (1995, Chapter 13) for a recent survey of the literature.

[3] See, for example, Blodgett (1991), Kogut (1988b), Kogut and Singh (1988), and Leung (1998).

[4] Harvard Multinational Enterprise Project.

subsidiaries (of either form) that may be sold or liquidated by 1975, and any change in ownership structure (from joint ventured to wholly-owned or vice versa) between date of entry and the date of liquidation or sale, or between date of entry and 1975. On the whole, the termination rate of IJVs is about 30% while that of WOSs is only about 15%.[5] Chowdhury (1992) further breaks down the termination rates between joint ventures and WOSs into several periods instead of the lump-sum data in Gomes-Casseres (1987). His findings suggest that the average life of both IJVs and WOSs had consistently declined from 1951 to 1975. Leung (1997) applies the proportional hazard model to study the duration of IJVs and WOSs by using a different data set of U.S. MNCs. The results suggest that the IJVs have significant shorter life span than WOSs.

Why does the life of a typical IJV seem to be short? If a MNC and a local firm agree to form a joint venture in the first place, why would they want to dissolve it in the future? That the average life of IJVs is shorter than that of WOSs suggests that the structure of IJV may be part of the reason. In fact, since the two firms choose to dissolve a joint venture that they formed sometime ago implies that something must have happened after the formation of the joint venture.

The objective of this paper is to explain why two firms choose to form an international joint venture and decide to dissolve it later. There are several features of our model: moral hazard, cooperation costs, and technology spillovers. The presence of moral hazard means that one of the firms may choose to provide not sufficient effort to make an IJV attractive to the other firm.[6] The cooperation cost, as suggested by Leung (1998), is another factor

[5]Termination is called "instability" in Franko (1971) and Gomes-Casseres (1987). Following Franko (1971), there are three reasons why an international joint venture would terminate: (a) The joint venture is totally liquidated, i.e., the operation is terminated or all the assets are sold or scrapped; (b) The ownership changes even though the joint venture is still operating, e.g., the joint venture is sold to the local partner or a third party; (c) The foreign firm (i.e., the MNC) may buy out the joint venture from the local partner and create a wholly-owned subsidary. Gomes-Casseres (1987) points out that a wholly-owned subsidiary can terminate if it is liquidated or sold to local firms, or if the MNC sell part of the equity of the wholly-owned subsidary and change the venture form to a joint venture. The termination rate of international joint ventures is the number of joint ventures terminated as a percentage of the total number of joint ventures. The termination rate of wholly-owned subsidaries is defined in a similar way.

[6]For example, it was reported that Krohne, a German manufacturer of electromagnetic flow meters, complained that its China partner in a joint venture was not working hard

that may encourage firms to break away an existing IJV. If an IJV is formed, both firms may learn from each other through technology spillovers, and with such technology improvement one or both of the firms may choose to break away from the joint venture in the future. (See Benito and Gripsrud, 1992; and Parkhe, 1991, among others, for technology spillovers.)[7] An implication of the present theory is that an IJV can be formed and dissolved later even in the absence of uncertainty or imperfect information.

Sections 2 to 4 of this paper develop the model. For simplicity, we begin with a single-period model. Section 2 focuses on a single firm, whereas Section 3 turns to the case of duopoly, with a MNC and a local firm competing in a Cournot fashion. Section 4 examines the formation of a IJV. How the local firm chooses its effort in different cases is explained. Section 5 explains how the two firms decide between forming a joint venture and producing separately. Section 6 looks at a two-period model, which is used to explain technology spillover between the two firms when an IJV has been formed, and to analyze the conditions under which the firms would choose to break up the joint venture later. The last section concludes.

2 The Model: Single Firm and Single Period

We first introduce a one-period model, which will later be extended to two periods to analyze intertemporal choice. Consider a homogeneous product and its market in an economy called "home." The demand for the product in the market is described by $p = p(q)$, where p is the market price and q the demand. It is assumed that $p'(q) < 0$ and that p'' is either negative or not too positive, where a prime denotes a derivative.[8] The market is big enough to support the two firms to be introduced below.

There is a single home firm in the economy. Before the entry of the foreign firm, the home firm is a monopolist. Its cost of production includes two components: a variable cost that depends on the level of production,

enough. ("Enter in China: An Unconventional Approach," *Harvard Business Review*, March-April, 1997: 130–140.)

[7] In fact, technology spillover is often regarded as one major reasons for many developing countries to attract foreign investment and joint venture between local and foreign firms. See, for example, Miller et al. (1997).

[8] The latter assumption implies that the demand curve is concave or not too convex to the origin so that the marginal revenue curve is downward sloping.

cx, where c is a positive constant and x is the level of production, and a "fixed" cost which is independent of the level of output, f. This means that c is a constant marginal cost. The "fixed" cost of production, which is fixed in the production process, can indeed be changed by the firm by spending different levels of effort: Examples of "fixed" cost are the costs of establishing good relations with the suppliers of inputs (factor owners and suppliers of intermediate inputs, for example) and purchasers of its output (such as wholesalers and retailers), the costs of marketing and advertisement, and the costs of getting familiar with the local political, social, economic, and legal systems. If we denote the effort made by the firm by e, we can write the "fixed" cost of production as $f = f(e)$, which satisfies the following properties:

$$f(e) > 0, \ f'(e) < 0, \ f''(e) > 0. \tag{1}$$

Based on condition (1), the value of $-f'(e)$ can be illustrated by schedule FF in Figure 1. Note that $-f'(e)$ is positive, but declining.

Since making efforts is costly, we denote the cost of providing a level of effort e by $g = g(e)$, which has the following properties:

$$g(e) > 0, \ g'(e) > 0, \ g''(e) > 0. \tag{2}$$

The first derivative of the function, $g'(e)$, can be illustrated by a schedule like GG in Figure 1. Condition (2) implies that the schedule is rising.

For the sake of analysis, we assume that the home firm takes two stages to maximize its profit. First, it chooses the optimal effort, e, and pays a cost of $g(e)$. The effort then gives a certain "fixed" cost of production, $f(e)$. Second, it chooses the optimal output level, x.

We first describe the second stage. In this stage, both the effort e and the "fixed" cost $f(e)$ are taken as given. The firm chooses the output to maximize its nominal profit given by

$$\theta(x; e) = p(x)x - cx - f(e), \tag{3}$$

where the market equilibrium $q = x$ has been used. Note that the nominal profit does not include the cost of effort, which is paid for in stage 1. The first-order condition is[9]

$$p + p'x = c. \tag{4}$$

[9]Note that an interior solution is assumed because the case with no output is not interesting in the present paper. The second-order condition is assumed to hold.

Note that the first-order condition and thus the optimal output do not depend on the effort. That is because the effort is assumed to affect the "fixed" cost of production only.[10] Let us use a superscript "m" to represent the equilibrium value of a variable when the home firm is a monopolist; for example, x^m is the optimal output chosen by the firm and p^m is the resulting market price. The corresponding nominal profit of the firm is equal to

$$\theta(x^m; e) = p(x^m)x^m - cx^m - f(e). \tag{5}$$

In stage 1, the firm chooses the level of effort to maximize its net profit, which is the nominal profit minus the cost of effort:

$$\pi(e) = \theta(x^m, e) - g(e).$$

The first-order condition is

$$-f'(e) = g'(e), \tag{6}$$

where condition (5) has been used. Note that the output does not appear in condition (6), meaning that the optimal level of effort is independent of the output. Denote the optimal effort by e^m. The second-order condition is

$$-f''(e^m) - g''(e^m) < 0,$$

which is satisfied because of conditions (1) and (2).

Condition (6) and the optimal effort can be illustrated graphically. As explained earlier, schedules FF and GG in the diagram represent $-f'(e)$ and $g'(e)$, respectively. This means that the optimal effort is obtained from the intersecting point E between schedules FF and GG.

3 Rivalry between Two Firms

We now introduce a foreign firm to the above model. Suppose that there exists a foreign firm, which is capable of producing the same product in the local economy and suppling it to the local market. For simplicity, we assume that the foreign firm has no production in its own country.[11] For the time

[10] The result will be different if the effort affects the marginal cost. For simplicity, this case is not considered in the present paper.

[11] It may be due to, for example, prohibitive transport costs or a prohibitive tariff.

being, we consider the case of duopoly, with the foreign firm and the local firm produce and compete in a Cournot fashion. Variables of the foreign firm are distinguished by an asterisk. In particular, it is facing a constant marginal cost c^* and a "fixed" cost of production $f^*(e^*)$ after spending an effort of e^* and paying a cost of $g^*(e^*)$.

The two firms, however, have asymmetric positions. The foreign firm, being a newcomer in the local market, is in a disadvantageous position as compared with the home firm: it lacks good knowledge of the local political, economic, social, and legal systems, and, as compared with what a home firm has, usually has a less developed relationship with local suppliers and possibly wholesalers and retailers, and could have a cultural gap in the production process. Therefore a foreign firm producing in another country must have some ownership advantages such as a more advanced technology over the home firms. To capture these two features, we make the following assumptions:

(I) $f^*(e^{*d}) > f(e^d)$, where e^{*d} and e^d (to be determined later) are the efforts chosen by the foreign and local firms when competing in a Cournot way respectively; and

(II) $c^* < c$.

The first assumption is to capture the fact that the foreign firm is in a disadvantageous position in producing the good in the local economy, while the second assumption represents the superior technology the foreign firm has with respect to the home firm.

To analyze the present case of rivalry between the firms, we first have to find out how the entry of the foreign firm may affect the home firm's "fixed" cost. The answer is nothing, which means that the effort chosen by the home firm is not affected by the presence of the foreign firm. The reason, as shown by condition (6), is that the home firm's choice of effort is not affected by its output.

As in the previous section, the competition between both firms can be analyzed in two separate stages. In the first stage, they choose the level of efforts, thus fixing the "fixed" cost of production. They then compete in output. Let us analyze the second stage first. With the levels of effort chosen, their nominal profit can be written as follows:

$$\theta(x, x^*; e) = p(x + x^*)x - cx - f(e) \quad (7)$$

$$\theta^*(x, x^*; e^*) \quad = \quad p(x + x^*)x^* - c^*x^* - f^*(e^*). \tag{8}$$

Assuming Cournot competition, the first-order conditions of the firms are:[12]

$$p + p'x \quad = \quad c \tag{9}$$

$$p + p'x^* \quad = \quad c^*. \tag{10}$$

These are of course the reaction functions of the firms, which are illustrated by schedules HH and FF, respectively, in Figure 2. The intersecting point of the two schedules, N, is the Nash equilibrium. Let us denote the Nash equilibrium outputs of the home and foreign firms by x^d and x^{*d}, respectively. Based on assumption (II) and the assumption of a falling marginal revenue curve, the home firm, with a higher marginal cost, has a smaller market share. For a "stable" equilibrium, it is assumed that schedule HH is steeper than schedule FF in a region close to point N.[13] For a reason to be made clear later, let us treat the home firm's marginal cost c as a parameter and determine the output effects of a change in c. Differentiate (9) and (10) and rearrange the terms to give:

$$\begin{bmatrix} 2p' + p''x & p' + p''x \\ p' + p''x^* & 2p' + p''x^* \end{bmatrix} \begin{bmatrix} \mathrm{d}x \\ \mathrm{d}x^* \end{bmatrix} = \begin{bmatrix} \mathrm{d}c \\ 0 \end{bmatrix}. \tag{11}$$

Denote the determinant of the matrix by $D = (2p' + p''x)(2p' + p''x^*) - (p' + p''x)(p' + p''x^*) > 0$, where the sign comes from the "stability" condition. Solving (11), we have

$$\frac{\mathrm{d}x}{\mathrm{d}c} \quad = \quad \frac{2p' + p''x^*}{D} < 0 \tag{12}$$

$$\frac{\mathrm{d}x^*}{\mathrm{d}c} \quad = \quad -\frac{p' + p''x^*}{D} > 0, \tag{13}$$

where the sign comes from the assumption that p'' is either negative or sufficiently small in magnitude if positive. Conditions (12) and (13) imply that a drop in c will encourage the home firm's production but discourage that of the foreign firm. This result is also shown in Figure 2. From (11), a drop in c shifts the home firm's reaction curve to the right but the foreign firm's

[12] This paper ignores the uninteresting case in which one or both firms are not producing.

[13] See Wong (1995). The "stability" condition is satisfied if the demand curve is not too curved toward the origin.

reaction curve remains unchanged. The new Nash equilibrium point, N′, represents a higher output of the home firm but a lower output of the foreign firm.

Conditions (12) and (13) can be combined to give the effect on the total output:

$$\frac{\mathrm{d}(x + x^*)}{\mathrm{d}c} = \frac{p'}{D} < 0, \tag{14}$$

which means that a drop in c will encourage a larger aggregate output of the firms.

In the first stage, both firms choose the optimal levels of efforts to maximize their net profits

$$\begin{aligned} \pi(e) &= \theta(x^d, e) - g(e) \\ \pi^*(e^*) &= \theta^*(x^{*d}, e^*) - g^*(e^*). \end{aligned}$$

Based on (6), the effort chosen by each firm is independent of the output. Therefore, the first-order conditions are similar to (6). As we did earlier, we use the superscript "d" to represent the equilibrum value of a variable in the present case; for example, e^d and e^{*d} are the Nash equilibrim outputs chosen by the firms, with the corresponding costs of efforts given by $g^d \equiv g(e^d)$ and $g^{*d} \equiv g^*(e^{*d})$, and the profits of the firms given by $\theta^d \equiv \theta(x^d, e^d)$, $\theta^{*d} \equiv \theta^*(x^{*d}, e^{*d})$, $\pi^d \equiv \pi(e^d)$, and $\pi^{*d} \equiv \pi^*(e^{*d})$, respectively. Note that because the chosen effort is independent of the output level, the home firm chooses the same effort in the present duopoly case as in the previous monopoly case, i.e., $e^m = e^d$.

As explained earlier, the disadvantageous position of the foreign firm is represented by a higher "fixed" cost of production, i,e., $f^*(e^{*d}) > f(e^d)$.

4 A Joint Venture of the Firms

In this section, we consider an alternative option for the foreign firm to produce the good in the local economy: forming a joint venture with the home firm. It is formed under the following conditions:

1. In the presence of a joint venture, both firms would not produce separately.

2. The joint venture will have a marginal cost of c^* and a "fixed" cost of production $f(e) + \phi$, where $\phi > 0$ and e is to be chosen by the home firm.

3. The joint venture chooses an output, X, to maximize the following nominal profit:

$$\Theta(X; e) = p(X)X - c^*X - f(e) - \phi. \tag{15}$$

4. The home firm receives a fraction s, $0 \leq s \leq 1$, of the resulting profit, and the foreign firm receives the rest. The determination of s will be explained later.

Let us explain these assumptions. Assumption 1 is a normal phenomenon. One reason is that both firms are willing to stop producing separately as a goodwill gesture of cooperation. Assumption 2 represents the basis for the two firms to cooperate in the present paper: the joint venture uses the foreign firm's advanced technology, in terms of a lower marginal cost, the home firm's better knowledge of the domestic market, leading to a lower "fixed" cost from effort. The variable ϕ refers to the cost of cooperation, which includes the costs of coordination, communication, and possibly friction between the firms. For simplicity, we assume that ϕ is given exogenously. Assumption 3 seems to be a natural one, but it has two implications. First, the level of effort has yet to be determined. This is left to the home firm to choose. Second, the cost of effort, $g(e)$, has not been included in the nominal profit of the joint venture. These two implications require further explanation.

Since effort is a variable difficult to quantify, measure, and verify, the present model involves moral hazard by the home firm.[14] Even if both firms sign an agreement that requires the home firm to spend so much time on lowering the fixed cost, it is difficult to determine or verify in court how much effort the home firm has actually spent and what the cost of the effort is. In the present model with perfect information and no uncertainty, the foreign firm can determine how much effort the home firm will choose to

[14]Note that we assume that only the local firm is responsible for the "fixed" cost, and thus moral hazard occurs in that firm only. Double moral hazard exists when both firms supply effort, but it is not needed for the results in the present paper.

spend under the present conditions.[15] It is just that it is difficult to require the home firm to choose a particular level of effort or to verify that the home firm has chosen an effort different from the one stated in an agreement.[16] The foreign firm knows well functions $f(e)$ and $g(e)$, but it is difficult to verify in court what effort the home firm has spent.

Based on the above assumptions and description, we consider the following three-stage game when a joint venture is formed. In the first stage, the home firm chooses the optimal level of effort. This in turn determines the "fixed" cost of production, $f(e)$. In the second stage, both firms decide how to share the nominal profit of the joint venture, and in the last stage, they choose an output to maximize the nominal profit of the joint venture. In each stage, each firm is aware of what they will choose in later stages.

We first examine the third stage. The joint venture chooses x to maximize the profit defined by (15). The first-order condition is

$$p + p'X = c^*. \tag{16}$$

Note that this condition is similar to the first-order condition (4) for the home firm when it is a monopolist because in both cases there is only one single supplier. Let the optimal output be denoted by X^v, where the superscript "v" represents a variable in the presence of this joint venture. Furthermore, in both cases, the optimal output is independent of the level of effort chosen by the home firm. There is a difference between the two cases, however, because the marginal cost of the joint venture is lower than that of the home firm, as stated in assumption (II). Thus (16) yields a higher output and a higher profit than (4) does. Denote the resulting nominal profit of the joint venture by $\hat{\Theta}(e)$:

$$\hat{\Theta}(e) \equiv \Theta(X^v; e) = p(X^v)X^v - c^*X^v - f(e) - \phi. \tag{17}$$

[15]In the moral hazard literature, uncertainty is usually assumed. Effort is what an agent spends on improving the probability of a good state. By observing what state is going to happen, it is difficult to verify what effort an agent has chosen. However, if the preferences of the agent are known publicly, other agents know what the amount of effort the agent will choose. In the present paper, we avoid assuming uncertainty because we want to simplify our analysis and because including uncertainty will not change the results qualitatively. See Bruce and Wong (1995) for a relevant model of moral hazard and insurance.

[16]In the present model without uncertainty, the agreement between the two firms may include a requirement concerning the level of fixed cost, which is measurable and requires a certain effort made by the local firm. We do not consider this option in the present paper because it is not the focus here. Rather, we want to examine how moral hazard may affect the formation of a joint venture.

Note that even though the optimal output of the joint venture is not a function of the effort chosen by the home firm, $\hat{\Theta}(e)$ is.

In the second stage, the two firms share the nominal profit in a Nash bargaining game. In such a game, we assume that the alternative to a joint venture is a duopolistic situation as described above. In the latter situation, the local and foreign firms will receive nominal profits equal to θ^d and θ^{*d}, respectively. As a result, the home firm's share of the profit of the IJV, s, is chosen to solve the following problem:

$$\max_s \left[s\hat{\Theta}(e) - \theta^d\right]\left[(1-s)\hat{\Theta}(e) - \theta^{*d}\right]. \tag{18}$$

The first-order condition is equal to

$$s\hat{\Theta}(e) = \frac{\hat{\Theta}(e) - \theta^{*d} + \theta^d}{2}. \tag{19}$$

Note that the left-hand side of (19) is the portion of the joint venture's nominal profit the home firm receives, based on the effort chosen by the home firm. Denote the share that satisfies (19) by $s(e)$, which is a function of the home firm's effort.

In the first stage of the game, the home firm chooses its effort to maximize its net profit. Its problem is

$$\max_e \ \pi(e) = s(e)\hat{\Theta}(e) - g(e). \tag{20}$$

Making use of (19), (20) reduces to

$$\max_e \ \pi(e) = \frac{\hat{\Theta}(e) - \theta^{*d} + \theta^d}{2} - g(e). \tag{21}$$

Using condition (17), the first-order condition is equal to

$$-\frac{1}{2}f'(e) = g'(e). \tag{22}$$

The optimal effort can be illustrated in Figure 1. Schedule F′F′ is constructed so that vertically it is half way between schedule FF and the horizontal axis. The equilibrium point is the intersecting point E′ between schedules F′F′ and GG. A comparison between points E and E′ shows that with the formation of the joint venture, the home firm chooses to spend less effort,

e^v, which results in a higher "fixed" cost of production $f(e^v)$, as compared with what it does when it produces alone or as a duopolist, e^d. Denote the resulting profit of the joint venture by $\Theta^v \equiv \hat{\Theta}(e^v)$. Therefore the nominal profits of the home and foreign firms are respectively equal to

$$s\Theta^v = \frac{\Theta^v - \theta^{*d} + \theta^d}{2} \tag{23}$$

$$(1-s)\,\Theta^v = \frac{\Theta^v + \theta^{*d} - \theta^d}{2}. \tag{24}$$

The net profit of the home firm is $\pi^v = s\Theta^v - g(e^v)$. Because the foreign firm does not have to spend any effort in forming the joint venture, its nominal profit is the same as its net profit, i.e., $\pi^{*v} = (1-s)\,\Theta^v$.

5 Choosing between Joint Venture and Separate Production

After explaining how a joint venture can be formed, the next question is whether the firms prefer to have a joint venture, or to produce the good separately as duopolists. Each firm chooses the option that produces a higher profit. Let us denote the outcome joint venture by V and the outcome of separate production by D. We then say that $V \succ D$ if *both* firms prefer a joint venture with each other to separate production, and that $D \succ V$ if at least one firm prefers separate production to a joint venture.

We first analyze the home firm.

5.1 The Home Firm

The home firm prefers a joint venture over a duopoly production if and only if it gets a higher net profit:

$$s\Theta^v - g^v > \pi^d = \theta^d - g^d. \tag{25}$$

Making use of condition (23) and rearranging terms, (25) reduces to:

$$\Theta^v > \theta^d + \theta^{*d} - 2(g^d - g^v). \tag{26}$$

Consider the following condition:

$$\Theta^v > \theta^d + \theta^{*d}. \tag{A}$$

Condition (A) means that the net profit of the joint venture is higher than the total net profits of the firms when producing separately. From (22), we know that $g^d > g^v$. Thus condition (A) implies (26).

5.2 The Foreign Firm

The foreign firm prefers a joint venture if and only if its profit share is larger than the net profit under duopoly competition:

$$(1-s)\Theta^v > \pi^{*d} = \theta^{*d} - g^{*d}. \tag{27}$$

Making use of condition (24), (27) reduces to

$$\Theta^v > \theta^d + \theta^{*d} - 2g^{*d}. \tag{28}$$

It is easy to see that condition (A) implies (28).

A joint venture will be formed if and only if both firms prefer the joint venture to separate production. Thus we have the following proposition:

Proposition 1 *(a) $V \succ D$ if and only if conditions (26) and (28) are satisfied. (b) $V \succ D$ if condition (A) is satisfied.*

Since condition (A) is a sufficient condition for the formation of a joint venture, let us analyze it more carefully. It states that the nominal profit of the joint venture is greater than the sum of the nominal profits of the firms when producing separately as Cournot duopolists. Using the definitions of these nominal profits, we have

$$\begin{aligned}
\Theta^v - \theta^d - \theta^{*d} &= [p(X^v)X^v - c^*X^v - f(e^v) - \phi] - \left[p(q^d)x^d - cx^d - f(e^d)\right] \\
&\quad - \left[p(q^d)x^{*d} - c^*x^{*d} - f^*(e^{*d})\right] \\
&= \left[p(X^v)X^v - c^*X^v - f(e^d)\right] - \left[p(q^d)x^d - c^*x^d - f(e^d)\right] \\
&\quad - \left[p(q^d)x^{*d} - c^*x^{*d} - f(e^d)\right] + (c - c^*)x^d \\
&\quad + \left[f^*(e^{*d}) - f(e^d)\right] + \left[f(e^d) - f(e^v)\right] - \phi. \qquad (29)
\end{aligned}$$

Let us analyze condition (29). The individual terms on its RHS have the following signs:

(a) $\Big[p(X^v)X^v - c^*X^v - f(e^d)\Big] - \Big[p(q^d)x^d - c^*x^d - f(e^d)\Big]$
$- \Big[p(q^d)x^{*d} - c^*x^{*d} - f(e^d)\Big] > 0;$

(b) $(c - c^*)x^d > 0;$

(c) $\Big[f^*(e^{*d}) - f(e^d)\Big] > 0$; and

(d) $\Big[f(e^d) - f(e^v)\Big] < 0.$

The term in (a) represents the difference between the maximum profit when two identical firms produce jointly and the sum of their profits when they produce non-cooperatively, which is positive because a joint venture can better exploit the monopoly power. The signs of the terms in (b) and (c) are due to assumptions II and I, respectively. The term in (d) is negative due to the moral hazard problem as explained before. As a result, condition (A) is not necessarily satisfied.

Proposition 2 *If the cooperation cost is sufficiently small, the home firm always prefers an IJV to separate production. If the cooperation cost is sufficiently small and if the drop in the home firm's effort will be sufficiently small, then condition (A) is satisfied and* $V \succ D$.

Proof. To see the first statement, assume that the home firm chooses the same effort e^m when cooperating with the foreign, as it does as a monopolist (or duopolist). Then the joint profit of both firms must be higher because both firms act as a single monopolist and because both firms have complementary technologies. So the home firm must get a higher profit. If the home firm chooses the effort it supplies optimally, its profit will be higher, or not lower. To see the second statement, note that under the given conditions term (d) and ϕ in (29) are sufficiently small, and the RHS is positive, implying condition (A). By Proposition 1, $V \succ D$. ■

Proposition 3 $V \succ D$ *if (i) condition (28) is satisfied and (ii)* $g^{*d} < (g^d - g^v)$.

Proof. Conditions (i) and (ii) imply condition (26). So both firms prefer an IJV. ■

6 Technology Spillover and Break-Up of A Joint Venture

So far, we have been focusing on a one-period model. Although the joint venture makes use of the advantages of both firms, the technology of each firm remains unchanged. We now turn to a two-period model to analyze why in some cases a joint venture is formed but breaks up in the future.

We assume that in each of the two periods, the firms have the option of forming a joint venture under the conditions described above (V), and that of producing separately as duopolists (D). To represent different outcomes in these two periods, we use a duplet (i, j), where i, $j = V$, D. In general, there are altogether four possible outcomes: (V, V), (V, D), (D, V), and (D, D).

The main feature of the present two-period model is that when the firms form a joint venture, both are able to learn from each other. This leads to a change in the technology they use in the second period, thus affecting their choice between a joint venture and separate production.

We now analyze more carefully the decision making of the firms. First, let us be more explicit about how firms learn from each other. Recalling that the home firm is more efficient in terms of the "fixed" cost of production but less efficient in terms of the marginal cost, we make the following simple assumptions:

(i) In the first period, both firms have the technology described in previous sections.

(ii) In the second period, the home firm has a marginal cost equal to δc^*, and the foreign firm faces a "fixed" cost function of $\delta^* f(e)$ and has to pay an effort cost of $\delta^* g(e)$ if it spends an effort of e^*, where $1 < \delta < c/c^*$ and $1 < \delta^* < [f^*(e) + g^*(e)]/[f(e) + g(e)]$ for all relevent values of e.

(iii) Learning is free.

Assumption (ii) means that the home firm learns from the foreign firm through a joint venture, and is able to reduce its marginal cost although the marginal cost is still greater than that of the foreign firm. Similarly, the foreign firm reduces its "fixed" cost of production although the latter is greater than what the home firm has. The foreign firm learns not only how to change its "fixed" cost but also the cost of its effort. Assumption (iii) is made to simplify our analysis.

Before we analyze the two-period model, let us examine how the technology spillovers may affect the two firms. Suppose that after one period of cooperation in the form of a joint venture, both firms now want to compete as Cournot duopolists. This case can easily be compared with the one described in Section 3, except that the firms' technologies are different than before. Our main focus is how the profits may change after the firms have learned from each other.

We can again conceptually assume that the firms compete in two separate stages: In stage one, they choose the level of effort, and then in stage two they compete in a Cournot way. Our analysis is simplified by the fact that the effort they choose is independent of the output. We thus can immediately get the following results: (a) Since the home firm maintains the same "fixed" cost of production and the same effort cost function as before, the home firm chooses the same effort as before, i.e., e^d. (b) Since the foreign firm learns from the home firm in terms of the latter's "fixed" cost and effort cost, the first-order condition of an optimal effort as expressed in (6) also applies to the foreign firm. This means that the foreign firm will also choose the same effort as the home firm, e^d.

As a result, the marginal cost and fixed cost of the home firm in the present case are δc^* ($< c$) and $f(e^d)$ respectively, and those of the foreign firm are c^* and $\delta^* f(e^d)$ $\left(< f^*(e^d)\right)$. The Nash equilibrium can be derived using the technique described in Section 3 and can be compared with the Cournot equilibrium before the technology spillover. Because the marginal cost of the foreign firm is unchanged, its reaction function will remain the same as before, which is illustrated by FF in Figure 2. For the home firm, the reduction in marginal cost will encourage it to produce more for each production level of the foreign firm, meaning that its new reaction curve, such as H′H′ in Figure 2, is on the right of the original reaction curve, HH. Schedule H′H′ cuts schedule FF at the new Nash equilibrium point N′. Using a tilde and a superscript "d" to represent variables after technology spillover, let us denote the new equilibrium output of the home firm by $\tilde{x}^d$ and that of the foreign firm by $\tilde{x}^{*d}$. Comparing the new and initial Nash equilibrium points, we get $\tilde{x}^d > x^d$ and $\tilde{x}^{*d} < x^{*d}$. This confirms conditions (12) and (13).

How are the profits of the two firms affected by the technology spillovers? Let us consider first the home firm. Because the effort it chooses is independent of output level and thus is not affected by the spillover effect, the change in its net profit is equal to:

$$\begin{aligned}\tilde{\pi}^d - \pi^d &= [\tilde{p}^d\tilde{x}^d - \delta c^*\tilde{x}^d - f^d - g^d] - [p^d x^d - cx^d - f^d - g^d] \\ &= [(\tilde{p}^d\tilde{x}^d - c\tilde{x}^d - f^d) - (p^d x^d - cx^d - f^d)] + (c - \delta c^*)\tilde{x}^d \\ &> 0, \qquad (30)\end{aligned}$$

where the sign is due to the following factors:

(a) $[(\tilde{p}^d\tilde{x}^d - c\tilde{x}^d - f^d) - (p^d x^d - cx^d - f^d)] > 0$, because of a drop in the output of its rival; and

(b) $(c - \delta c^*)\tilde{x}^d > 0$, because of the spillover effect.

We now turn to the foreign firm. The change in its profit is equal to

$$\begin{aligned}\tilde{\pi}^{*d} - \pi^{*d} &= [\tilde{p}^d\tilde{x}^{*d} - c^*\tilde{x}^{*d} - \tilde{f}^{*d} - \tilde{g}^{*d}] - [p^d x^{*d} - c^* x^{*d} - f^{*d} - g^{*d}] \\ &= (\tilde{p}^d\tilde{x}^{*d} - c^*\tilde{x}^{*d}) - (p^d x^{*d} - c^* x^{*d}) \\ &\quad + (-\tilde{f}^{*d} - \tilde{g}^{*d}) - (-f^{*d} - g^{*d}), \qquad (31)\end{aligned}$$

where $\tilde{f}^{*d} = \delta^* f(e^d)$ and $\tilde{g}^{*d} = \delta^* g(e^d)$. In analyzing (31), note that we have

$$\begin{aligned}& (-\tilde{f}^{*d} - \tilde{g}^{*d}) - (-f^{*d} - g^{*d}) \\ =\ & [-\delta^* f(e^d) - \delta^* g(e^d)] - [-f^*(e^{*d}) - g^*(e^{*d})] \\ =\ & \{[-\delta^* f(e^d) - \delta^* g(e^d)] - [-\delta^* f(e^{*d}) - \delta^* g(e^{*d})]\} \\ & + \{[-\delta^* f(e^{*d}) - \delta^* g(e^{*d})] - [-f^*(e^{*d}) - g^*(e^{*d})]\}.\end{aligned}$$

To determine the sign of the change in profit given in (31), let us note the following factors:

(a) $(\tilde{p}^d\tilde{x}^{*d} - c^*\tilde{x}^{*d}) - (p^d x^{*d} - c^* x^{*d}) < 0$, because of an increase in the home firm's output;

(b) $\{[-\delta^* f(e^d) - \delta^* g(e^d)] - [-\delta^* f(e^{*d}) - \delta^* g(e^{*d})]\} > 0$, due to profit maximization after the spillover; and

(c) $\{[-\delta^* f(e^{*d}) - \delta^* g(e^{*d})] - [-f^*(e^{*d}) - g^*(e^{*d})]\} > 0$, due to technology spillover.

Combining these factors together, we note that the sign of the change in profit given by (31) is ambiguous.

We now turn to the case in which the two firms choose to produce separately as duopolists in period 1. In this case, there is no technology transfer, meaning that technologies of the firms remain the same in period 2. This means that (D, V) will not be an outcome in the present model. The reason is that if $D \succ V$ in period 1, then the firm(s) that prefers separate production will still prefer separate production in period 2. Thus we are left with three possible outcomes.

In the present two-period model, denote the sum of the discounted profits of the home firm by W_{ij} and that of the foreign firms by W^*_{ij}, where $i = d, v$ for the duopolist or joint venture outcome in period 1, respectively, and $j = d$, v for those in period 2, respectively. Also denote the discount rates of the home and foreign firms by ρ and ρ^*, respectively. Therefore the two-period profits of the firms in the following three cases are:

1. outcome (D, D):

$$W_{dd} = (1+\rho)\pi^d \tag{32}$$

$$W^*_{dd} = (1+\rho^*)\pi^{*d}. \tag{33}$$

2. outcome (V, V):

$$W_{vv} = (1+\rho)\pi^v \tag{34}$$

$$W^*_{vv} = (1+\rho^*)\pi^{*v}. \tag{35}$$

3. outcome (V, D):

$$W_{vd} = \pi^v + \rho\tilde{\pi}^d \tag{36}$$

$$W^*_{vd} = \pi^{*v} + \rho^*\tilde{\pi}^{*d}. \tag{37}$$

It should be noted that if the firms form a joint venture in period 1, and if in period 2 the joint venture stays, the technology spillover will have no impacts on the firms' profits because the joint venture will still be using the marginal cost supplied by the foreign firm and the "fixed" cost supplied by the home firm. Let us now compare these three outcomes. Our comparison can be divided into three parts:

6.1 $(V,\, V)$ versus $(D,\, D)$

Conditions (32) and (33) indicate that the two-period profit of each firm is directly proportional to its profit in one period. Therefore $(V,\, V) \succ (D,\, D)$ if and only if $V \succ D$. See Propositions 1 and 2.

The options of the home firm can be illustrated in Figure 3, where the horizontal axis represents its (current value) net profit in period 1, π_1, and the vertical axis stands for its net profit in period 2, π_2. Different combinations of π_1 and π_2 that yield the same two-period profit of the home firm, $W_{dd} = \pi_1 + \rho\pi_2$, for various values of W_{dd} can be represented by parallel iso-profit lines with a slope of $-1/\rho$. Line AB is an iso-profit line passing through the point $(\pi^d,\, \pi^d)$. This line stands for the two-period profit with outcome $(D,\, D)$. The net profits of the home firm under outcome (V, V) can be represented by a point on the 45°-line OHK. Therefore the home firm prefers $(V,\, V)$ to $(D,\, D)$ if and only if its net profits under outcome $(V,\, V)$ is on the line segment HK above H.

The choice of the foreign firm can be illustrated in the same way. Figure 4 represents the firm's period-1 net profit π_1^* (horizontal axis) and period-2 net profit π_2^* (vertical axis). CD is the iso-profit line with a slope of $-1/\rho^*$ and passing through point F $(\pi^{*d},\, \pi^{*d})$. OFG is the 45°-line from the origin. So the foreign firm prefers $(V,\, V)$ to $(D,\, D)$ if and only if its net profits under outcome $(V,\, V)$ is on the line segment FG above F.

6.2 $(V,\, D)$ versus $(D,\, D)$

The question now is, if the firms are going to produce separately as duopolists in the second period, does it make any sense to form a joint venture in the first period? To answer this question, let us recall that in the presence of a joint venture, both firms learn from each other and are able to reduce their costs. However, the two firms are affected differently by the technology spillovers. As explained earlier, the joint venture allows the home firm to achieve a higher profit in the second period, but the foreign firm may be hurt by the joint venture. The impacts of the joint venture have to be taken into account when comparing between these two outcomes.

The profits of the home firm when a joint venture is formed in the first period can be represented by a point in Figure 3, $(\pi^v,\, \tilde{\pi}^d)$. As explained earlier, $\tilde{\pi}^d > \pi^d$. Three possible points representing possible profits of the home firm are shown in the diagram, L, M, and N, all of which depict a higher second-period profit than π^d. Point L represents a lower two-period profit for the home firm than under (D, D). Thus (V, D) is dominated by (D, D). At point N, the home firm gets a higher profit in each of the period under the outcome (V, D), and thus prefers it to the outcome (D, D). Point M shows an interesting case. This point means that the formation of a joint venture lowers the current value of the home firm's profit, $\pi^v < \pi^d$. However, because point M is above line AB, the home firm is able to gain enough in the second period through learning from the foreign firm to compensate for the drop in its profit in the first period. We call this type of cooperation with the foreign firm a *strategic cooperation*. The shaded region labeled SC (and also called region b) in Figure 3 represents possible profits with which a strategic cooperation with the foreign firm is preferred by the home firm.

We now turn to the foreign firm. Figure 4 represents the profit of the firm in each period under the outcome (D, D), π^{*d}, and the iso-profit line CD. The profits of the firm under the outcome (V, D) can also be represented in the figure. Following the analysis above, we can argue that the firm prefers (V, D) to (D, D) if and only if the point for the profits under (V, D) is above line CD.

Two regions in Figure 4 deserve more analysis. Region labeled SC (also labeled region b), which is shaded, represents the profits of the foreign firm with which it prefers (V, D) to (D, D) even though it gets a profit from a joint venture in period 1 less than what it gets if it produces separately. This is what we call *strategic cooperation*. Another region of interest is labeled SN (also labeled region f) and is shaded. In this region, the foreign firm receives a profit in period 1 from a joint venture higher than that it produces separately as a duopolist. However, forming a joint venture causes a big drop in the profit in period 2 when both firms compete in separate production as compared with what it can get in the same period should there be no cooperation. The cooperation in period 1 is thus too costly to the foreign firm, which then prefers not to cooperate. We call this case *strategic noncooperation*.

6.3 (V, V) versus (V, D)

We now turn to another case: both firms cooperate in period 1 but in period 2 they have the option of continuing the cooperation or breaking up the joint venture. For this case, the choice boils down to what the firms can get in period 2 in these two options: joint venture and duopolistic production. Such comparison has been done earlier, except that the two frms have improved their technologies. For example, in period 2 the home firm chooses to keep the joint venture if and only if the following condition holds:

$$\pi^v > \tilde{\pi}^d, \tag{38}$$

or, applying condition (26), if and only if

$$\Theta^v > \tilde{\theta}^d + \tilde{\theta}^{*d} - 2(\tilde{g}^d - g^v). \tag{39}$$

The decision criterion for the home firm can also be illustrated in Figure 3. Note that its net profits in the two periods under outcome (V, V) are represented by a point on line OHK. Therefore condition (38) means that the net profits (π^v, $\tilde{\pi}^d$) under outcome (V, D) are depicted by a point below line OHK.

Similarly, in period 2 the foreign firm prefers to keep the joint venture if and only if

$$\pi^{*v} > \tilde{\pi}^{*d}, \tag{40}$$

or, applying condition (28), if and only if

$$\Theta^v > \tilde{\theta}^d + \tilde{\theta}^{*d} - 2\tilde{g}^{*d}. \tag{41}$$

Using the same argument as for the home firm, we can conclude that the foreign firm chooses to keep the joint venture if its net profits (π^{*v}, $\tilde{\pi}^{*d}$) under outcome (V, D) is represented by a point below line OFG in Figure 4.

6.4 The Optimal Choice

So far we have been comparing only any two of the outcomes. We now consider these three options together. We first consider the home firm, and summarize its decisions by the following rules:

(i) The home firm prefers (V, V) to (D, D) if and only if (π^v, π^v) is on line segment HK and above H.

(ii) The home firm prefers (V, D) to (D, D) if and only if (π^v, $\tilde{\pi}^d$) is above AB.

(iii) The home firm prefers (V, V) to (V, D) if and only if $(\pi^v, \tilde{\pi}^d)$ is below OHK.

In Figure 3, we identify four regions a, b, c, and d, and try to determine how the decision of the home firm will be affected if $(\pi^v, \tilde{\pi}^d)$ is represented by a point in one of these regions. Note that we neglect the area below a horizontal line passing through point H, because if a joint venture is formed in period 1, the profit of the home firm in period 2 will be higher than π^d through technology spillover. Based on the three points in the above summary, we can make the following conclusion concerning the choice of the firm:

(a) The home firm will choose (V, D) if $(\pi^v, \tilde{\pi}^d)$ is in region b or c. To see why, note that in one of these regions, $(\pi^v, \tilde{\pi}^d)$ is above AB and OHK. So by rules (ii) and (iii), (V, D) dominates. Note that region b is the region of strategic cooperation.

(b) The home firm will choose (V, V) if $(\pi^v, \tilde{\pi}^d)$ is in region d. In this case, (π^v, π^v) is on line segment HK and above H and $(\pi^v, \tilde{\pi}^d)$ is below OHK. The result follows from rules (i) and (iii).

(c) The home firm will choose (D, D) if $(\pi^v, \tilde{\pi}^d)$ is in region a. In this case, (π^v, π^v) is not on line segment HK and $(\pi^v, \tilde{\pi}^d)$ is below AB. The result follows from rules (i) and (ii).

The above results mean that if $(\pi^v, \tilde{\pi}^d)$ is in region b, c, or d, the home firm prefers to have a joint venture in period 1. If it is in region b or c, then the firm prefers to break away from the joint venture in period 2.

We can now turn to the foreign firm. Rules similiar to rules (i) to (iii) given above can be stated for the firm in its decision. The decision criterion can also be stated in terms of the location of the net profit point $(\pi^{*v}, \tilde{\pi}^{*d})$. One difference between these two firms is that with duopolistic production in period 2 the foreign firm may experience a drop in its net profit if a joint venture is formed in period 1. As a result, the region below a horizontal line through point F cannot be excluded for a point representing $(\pi^{*v}, \tilde{\pi}^{*d})$. In Figure 4, regions a to h can be identified.

(a) The foreign firm will choose (V, D) if (π^{*v}, $\tilde{\pi}^{*d}$) is in region b or c. In one of these regions, (π^{*v}, $\tilde{\pi}^{*d}$) is above CD and OFG. Note that region b is the region of strategic cooperation.

(b) The foreign firm will choose (V, V) if (π^{*v}, $\tilde{\pi}^{*d}$) is in region d or e. (π^{*v}, π^{*v}) is on line segment FG and above F and (π^{*v}, $\tilde{\pi}^{*d}$) is below OFG.

(c) The foreign firm will choose (D, D) if (π^{*v}, $\tilde{\pi}^{*d}$) is in regions a, f, g or h. In this case, (π^{*v}, π^{*v}) is not on line segment FG and (π^{*v}, $\tilde{\pi}^{*d}$) is below CD. Note that region f is the region of strategic non-cooperation. This means that in this region, the foreign firm will not choose to have a joint venture and then a break up in period 2, but it will prefer to maintain separate production throughout the two periods.

Let us now bring both firms together and find out the actual outcome in different cases. The following rules can be used to determine the outcome:

1. If both firms prefer the same outcome, that outcome will happen.
2. If any one of the firms prefers (D, D), a joint venture will not be formed, and (D, D) must be the outcome.
3. If a firm prefers (V, V) while the other firm wants (V, D), then (V, V) will not be formed and the former firm will choose between (V, D) and (D, D). Such decision of the former firm will dominate and it will become the actual outcome.

Using the above the rules, the outcomes are given in Table 1.

Table 1: Outcomes in Different Cases:

H / F	(V, V)	(V, D)	(D, D)
(V, V)	(V, V)	?	(D, D)
(V, D)	(V, D)	(V, D)	(D, D)
(D, D)	(D, D)	(D, D)	(D, D)

Note: ? means that the outcome is (V, D) if $(\pi^{*v}, \tilde{\pi}^{*d})$ is in region e in Figure 4, or is (D, D) if $(\pi^{*v}, \tilde{\pi}^{*d})$ is in region f.

In Table 1, the columns show different options the home firm prefers while the rows give those of the foreign firm. The contents of the table can be constructed based on rules (1) to (3). Note that if the foreign firm prefers (V, V) while the home firm wants (V, D), the foreign firm is left with the options of (V, D) and (D, D). What it chooses depends on the location of $(\pi^{*v}, \tilde{\pi}^{*d})$ in Figure 4. If, on the other hand, the home firm prefers (V, V) while the foreign firm wants (V, D), the home firm will choose (V, D) from the remaining options because if a joint venture is formed in period 1, it can have a higher profit when producing as a duopolist in period 2 than what it can have in the same period if no joint venture is formed.

7 Concluding Remarks

In this paper, we provided a theory to explain why a MNC and a local firm choose to form an IJV and why they decide to dissolve it sometime later. Our theory has two important features: moral hazard and technology spillover. The presence of moral hazard means that an IJV may not be beneficial to both firms, and so there are cases in which at least one of the firms prefers not to have a joint venture. Technology spillover means that in the presence of a joint venture the firms learn from each other and are able to improve their technology. It is the technology spillover that is the key in our theory to the formation of an IJV and its breakup in the future.

In this paper, we introduced the concepts of *strategic cooperation* and *strategic noncooperation*. Strategic cooperation exists if one of the firms is willing to sacrifice in the short run in forming a joint venture if the joint venture can bring a bigger future gain. Strategic noncooperation, on the other hand, is the case when a firm chooses not to form a joint venture even though it will bring a short-term benefit. This paper shows that the usual one-period analysis of joint ventures may give misleading results.

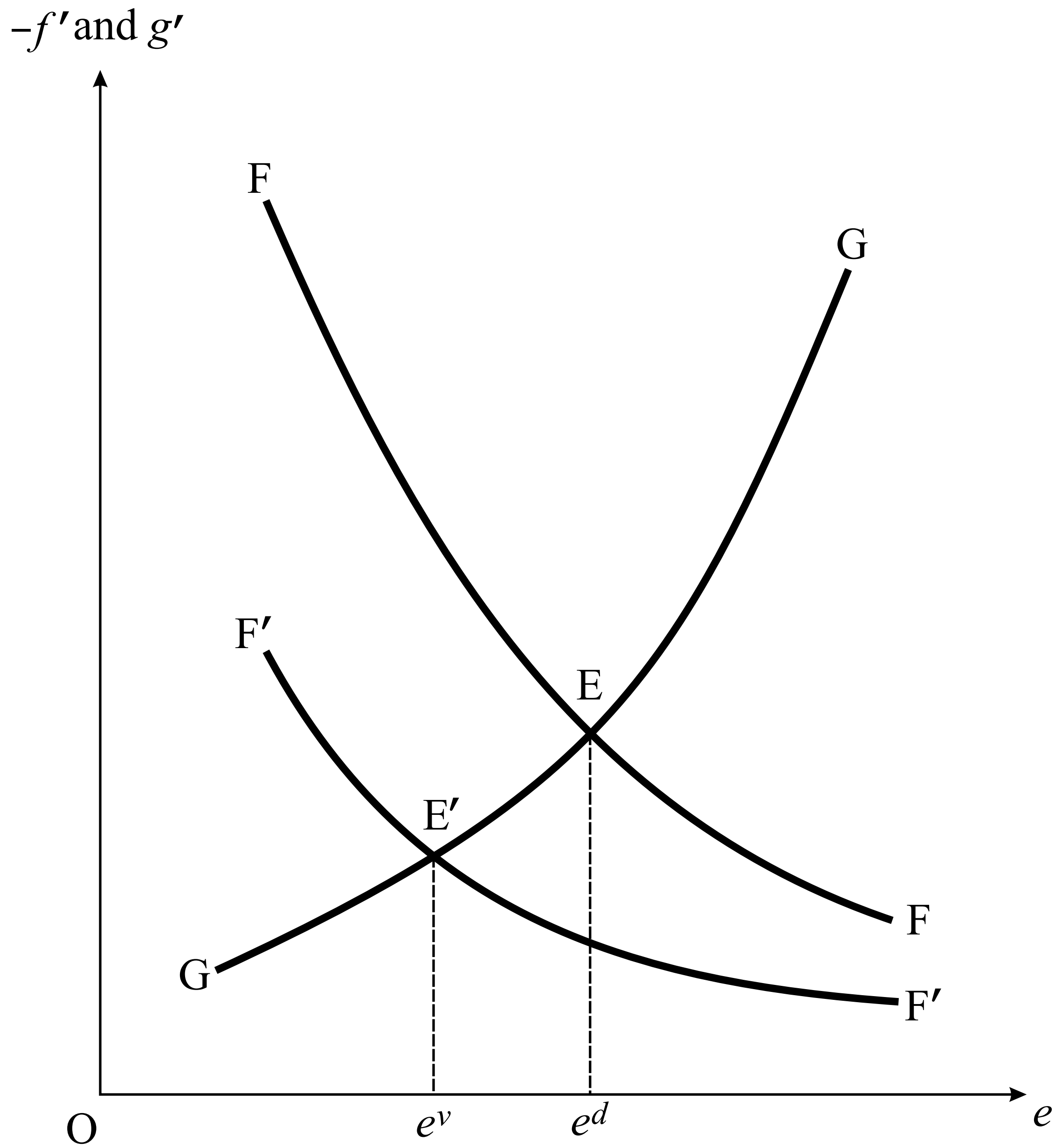

Figure 1

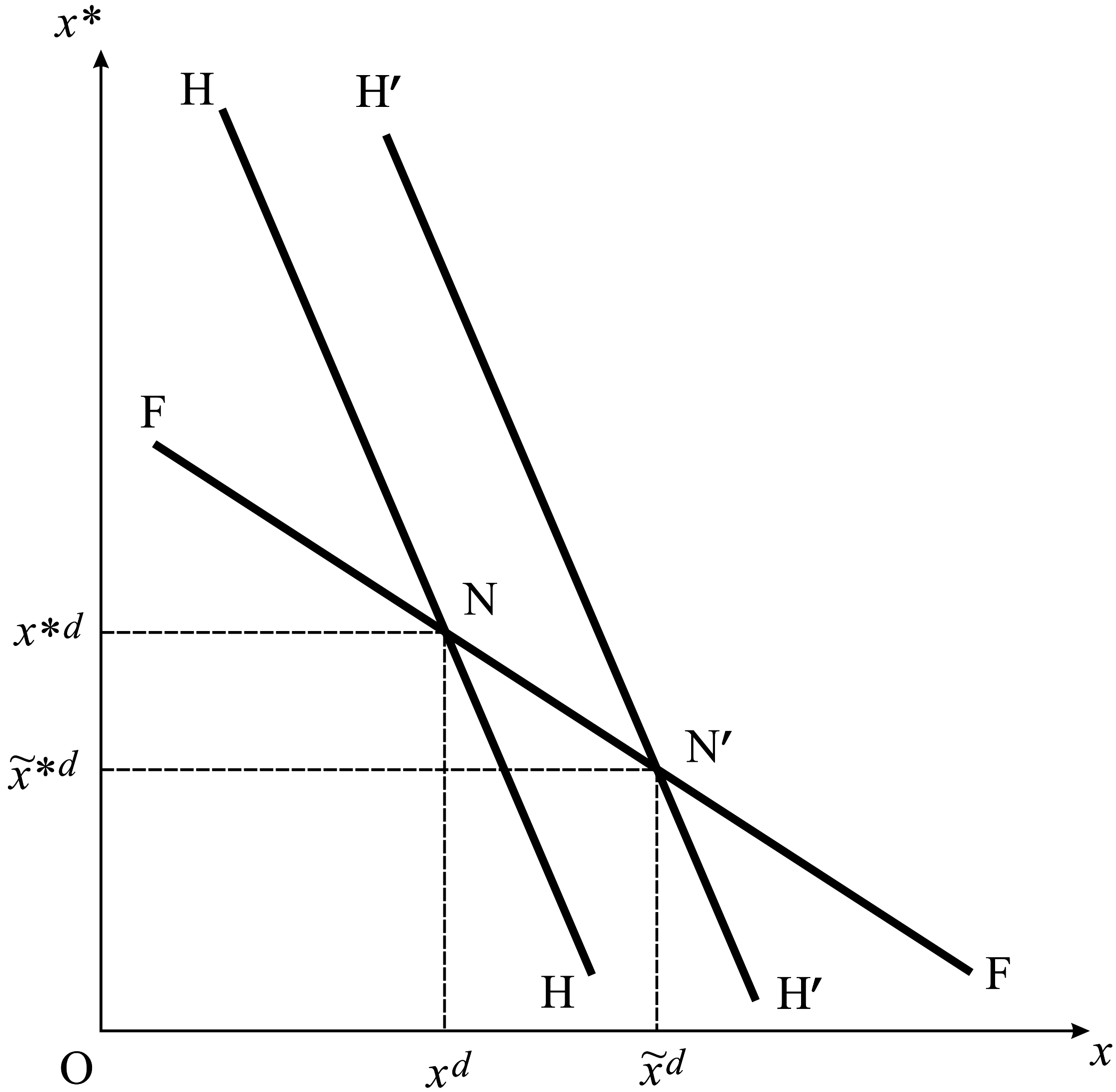

Figure 2

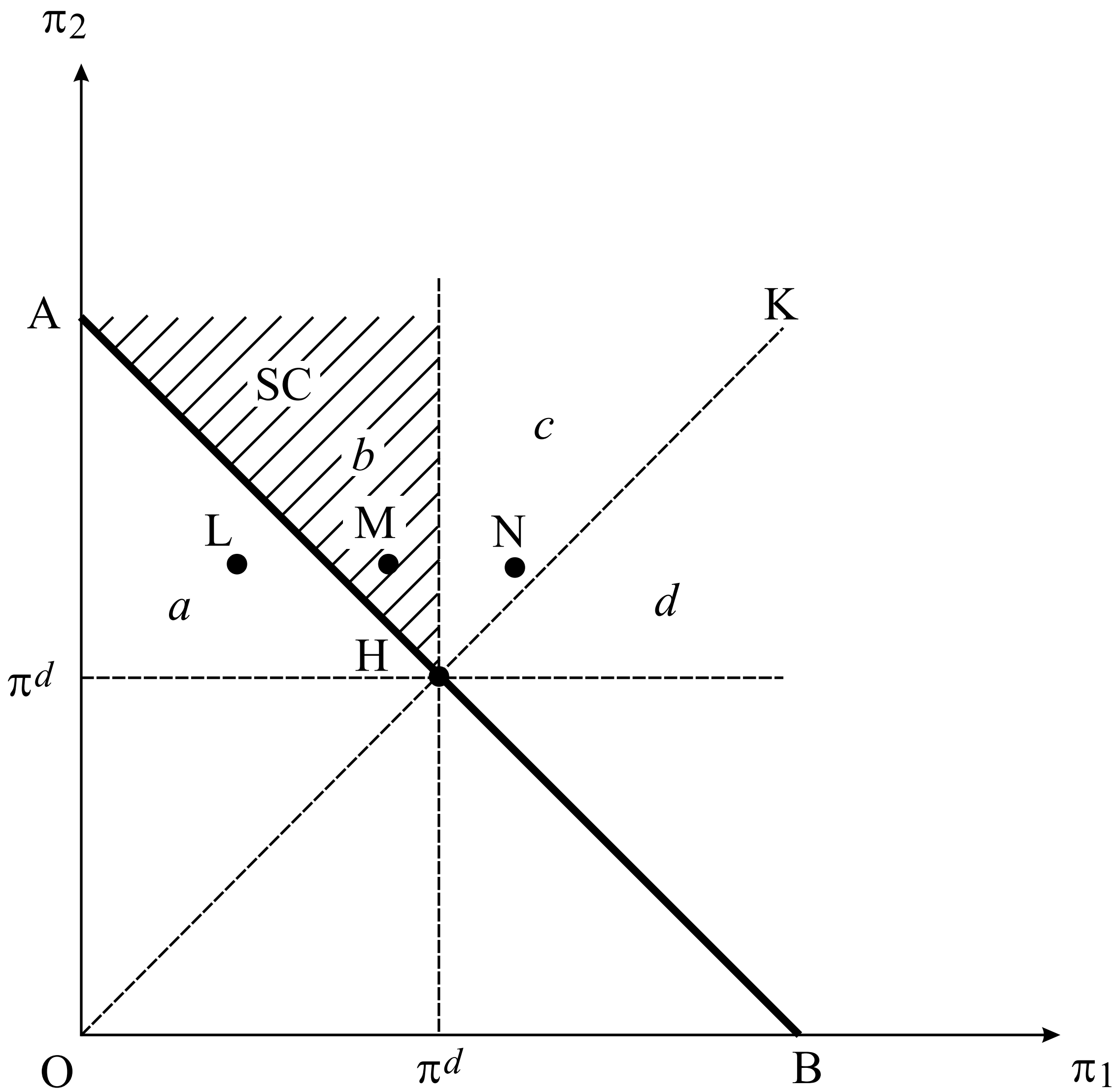

Figure 3

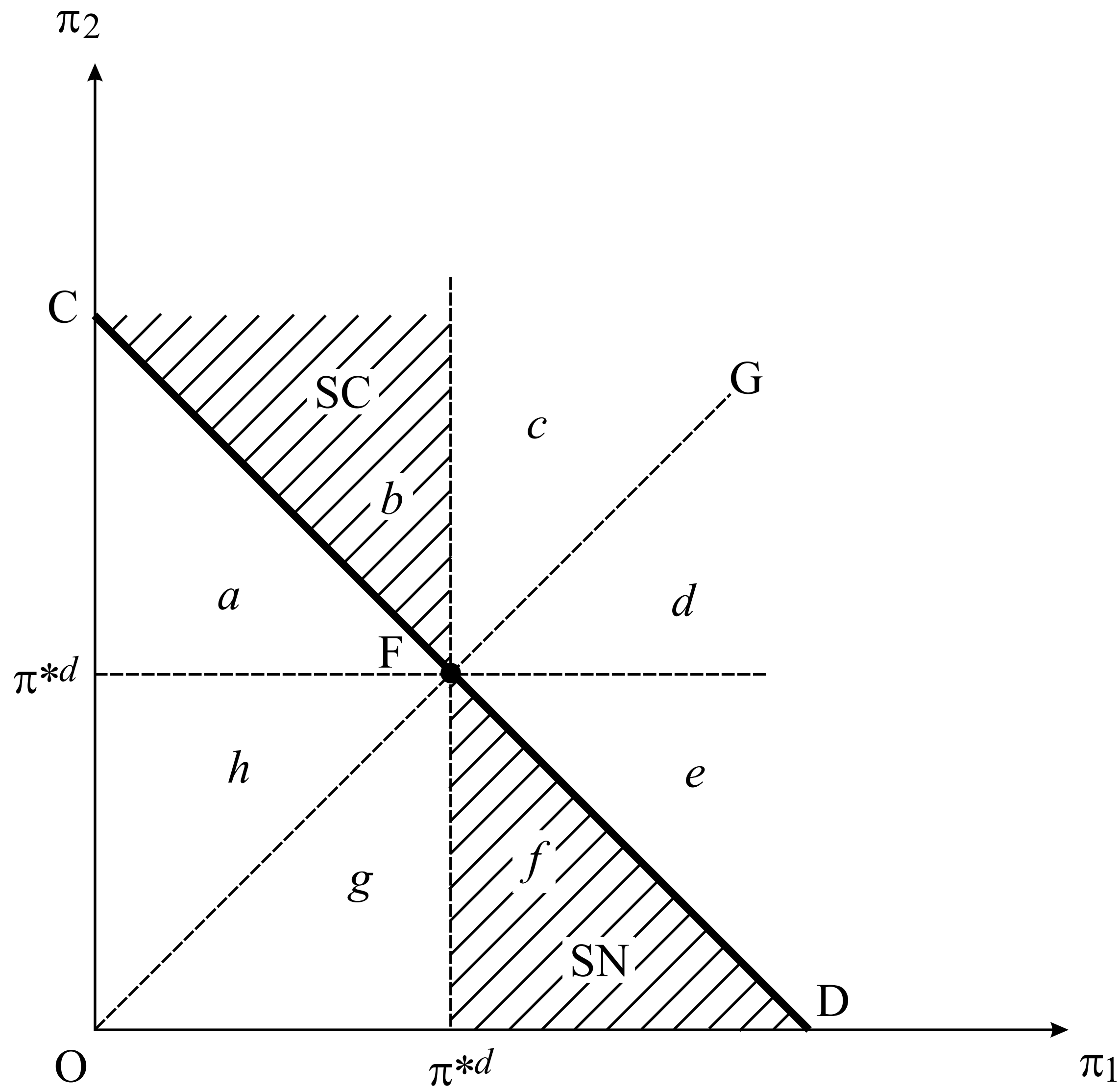

Figure 4

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