Firm Size, Synergy and Joint Ventures

Indrani Roy Chowdhury and Prabal Roy Chowdhury*

We develop a synergy based theory of joint venture formation. We find that an increase in firm size affects the incentive for joint venture formation. Furthermore, firm size also crucially affects the impact of market size on the incentive for joint venture formation. We also perform some interesting welfare analysis. (*JEL* Classification: F23, L13)

I. Introduction

Following the dramatic increase in the rate of joint venture formation (see Pekar and Allio 1994), there have been several studies that examine the question of joint venture formation at a theoretical level. These include, among others, D'Aspremont and Jacquemin (1988), Katz (1986), Marjit (1991), Roy Chowdhury (1995), Svejnar and Smith (1984), etc.

Most of these papers, however, deal with R&D oriented, rather than production oriented joint ventures. Furthermore, none of these take firm size into account. In this paper we make a modest beginning in both these respects and also derive some empirically testable implications of firm size on joint venture formation.

We develop a theory of joint venture formation that relies on synergy among partner firms. In joint ventures involving a multina-

*Ph.D Student, ITDD, CSDILE, School of International Studies, Jawaharlal Nehru University, New Delhi 110067, INDIA, (Tel) +91-11-6181160, (E-mail) indranirc@hotmail.com; Associate Professor, ITDD, CSDILE, School of International Studies, Jawaharlal Nehru University, New Delhi 110067, INDIA, (Tel) +91-11-6107676 (Ext. 2403), (E-mail) prabalrc@hotmail.com, respectively. We are indebted to an anonymous referee of this journal for very helpful comments. The responsibility for any errors that remain are, of course, ours alone.
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tional company (MNC) and a firm from a less developed country (LDC), it has often been observed that the MNC provides the superior technology, while the LDC firm provides a knowledge of local conditions, access to distribution channels, etc. (See Miller *et al.* (1996). Dymsza (1988) provides several case studies that support this viewpoint.) Thus, if a joint venture forms, then the partner firms can learn from each other, and the venture firm can produce much more efficiently compared to either one of the parent firms.

Moreover, we assume that joint venture formation involves some coordination costs. Indirect evidence that such costs are substantial is provided by Hergert and Morris (1988) who find that 81 per cent of all joint ventures studied by them involve two firms. Joint ventures involving three or more firms are quite rare. Such costs may arise out of the different cultures and objectives of the two parent firms. Kogut and Singh (1986) demonstrate that cultural distances among partner firms negatively affect the incentive for joint venture formation. Depending on whether the synergistic benefits outweigh the coordination costs or not, the firms either opt for a joint venture, or pursue Cournot competition.

We demonstrate that the impact of market size on the incentive for joint venture formation depends crucially on firm size, where firm size is identified with the capacity level. If firm size is small, then market size has no impact on the incentive for joint venture formation, whereas, if firm size is large, then market size has a positive impact on the incentive for joint venture formation. For firms of intermediate size, the result depends on the magnitude of the synergic effect. Market size has a positive impact if the synergic effect is large. Otherwise there is a negative impact. Moreover, we demonstrate that firm size is positively related to joint venture formation. We also relate these findings to the existing empirical literature on joint ventures.

Finally, turning to the welfare analysis we demonstrate that joint venture formation welfare dominates Cournot competition if and only if firm profit under joint venture formation exceeds that under Cournot competition.

II. The Model

The model comprises of two firms, one multinational (denoted firm 1) and the other domestic (denoted firm 2). The market demand function is given by

$$q = a - p, \tag{1}$$

where a is a parameter of market size.[1]

We consider a symmetric model with linear and identical cost functions. Thus under Cournot competition the cost function of the ith firm is given by

$$dq_i, \text{ for } q_i \leq \bar{q}, \tag{2}$$

where $\bar{q}$ represents the capacity level of both the firms.

We assume that this constant marginal cost d consists of two components. For the first firm $d = a_1 + b_1$, and for the second firm $d = a_2 + b_2$, where a_i represents the technological component and b_i represents the local knowledge component. Given that firm 1 is the technologically advanced MNC and firm 2 is the LDC firm with local knowledge, it is natural to assume that $a_1 < a_2$, and $b_1 > b_2$.

In case of joint venture formation there is a synergic effect and the marginal cost of the joint venture $c = a_1 + b_2 < d$. Thus the difference between the two marginal costs $(d - c)$, is an index of this synergic effect. Moreover, the total capacity of the joint venture firm is $2\bar{q}$. Thus the cost function under a joint venture is given by

$$cq, \text{ where } q \leq 2\bar{q}. \tag{3}$$

Furthermore, we assume that forming a joint venture involves an exogenous coordination cost of T.

Depending on the expected profits the firm can either form a joint venture, or pursue Cournot competition. First consider the case where the firms opt for a joint venture. We assume that the joint venture profits are equally shared between the parent firms. Since we consider a completely symmetric model, most bargaining solutions would yield a equal profit sharing rule. Thus this assumption is quite natural. Clearly, the profit function of the partner firms under a joint venture

$$J = \frac{q(a-q) - cq - T}{2}, \text{ where } q \leq 2\bar{q}. \tag{4}$$

Let the unconstrained profit maximising output be $\hat{q}$, where $\hat{q} =$

[1]In an earlier version of this paper we consider a model where the demand function is of the form $p = a - f(q)$.

$(a-c)/2$. Thus if $\hat{q} \leq 2\bar{q}$, then the equilibrium output level is $\hat{q}$, otherwise it is $2\bar{q}$. Hence the equilibrium profit level of both the firms

$$\hat{J} = \begin{cases} \dfrac{(a-c)^2}{8} - \dfrac{T}{2}, & \text{if } \hat{q} \leq 2\bar{q}, \\ \bar{q}(a-2\bar{q}) - c\bar{q} - \dfrac{T}{2}, & \text{otherwise.} \end{cases} \tag{5}$$

We then consider the case where the two firms opt for Cournot competition. Clearly, the profit level of the ith firm

$$P_i = q_i\{a-(q_1+q_2)\} - dq_i, \text{ where } q_i \leq \bar{q}. \tag{6}$$

A standard reaction function approach yields that the unique unconstrained Cournot equilibrium output $q^* = (a-d)/3$. In order to keep the analysis interesting we assume that $\bar{q} < \max\ \{\hat{q}/2,\ q^*\}$. Hence the equilibrium profit level

$$\bar{P} = \begin{cases} \bar{q}(a-2\bar{q}) - d\bar{q}, & \text{if } \bar{q} \leq q^*, \\ \dfrac{(a-d)^2}{9}, & \text{otherwise.} \end{cases} \tag{7}$$

Clearly, if $\hat{J} \geq \bar{P}$, then the firms opt for a joint venture, otherwise Cournot competition ensues. Define $I = \hat{J} - \bar{P}$, where I denotes the incentive for joint venture formation. Observe that

$$I = \begin{cases} \dfrac{(a-c)^2}{8} - \dfrac{T}{2} - \bar{q}(a-2\bar{q}) + d\bar{q}\ , & \text{if } \hat{q} \leq 2\bar{q} \leq 2q^*, \\ \bar{q}(a-2\bar{q}) - c\bar{q} - \dfrac{T}{2} - \dfrac{(a-d)^2}{9}, & \text{if } 2q^* \leq 2\bar{q} \leq \hat{q}, \\ (d-c)\bar{q} - \dfrac{T}{2}, & \text{if } \bar{q} < \min\left\{ \dfrac{\hat{q}}{2},\ q^* \right\}. \end{cases} \tag{8}$$

We then examine the impact of a change in the demand parameter a on the incentive for joint venture formation. It is easy to see that

$$\frac{dI}{da} = \begin{cases} \dfrac{(a-c)}{4} - \bar{q},\ , & \text{if } \hat{q} \leq 2\bar{q} \leq 2q^*, \\ \bar{q} - \dfrac{2(a-d)}{9}, & \text{if } 2q^* \leq 2\bar{q} \leq \hat{q}, \\ 0, & \text{if } \bar{q} < \min\left\{ \dfrac{\hat{q}}{2},\ q^* \right\}. \end{cases} \tag{9}$$

Proposition 1 follows straightaway from equation (9) above.

***Proposition* 1**

(i) If firm size is small, i.e. if $\bar{q}<\min\{\hat{q}/2,\ q^*\}$, then market size has no impact on, I, the incentive for joint venture formation.

(ii) Suppose firms are intermediate in size, i.e. $\bar{q}\geq\min\{\hat{q}/2,\ q^*\}$. If $\hat{q}\leq 2\bar{q}\leq 2q^*$, then I is decreasing in market size, whereas if $2q^*\leq 2\bar{q}\leq\hat{q}$, then I is increasing in market size.

Consider Proposition 1 (ii). Obviously, if the synergic effect is small then $\hat{q}$ is likely to be less than $2q^*$, whereas if the synergic effect is large then $\hat{q}$ is likely to be greater than $2q^*$. Thus, if firm size is intermediate, then market size is likely to have a positive impact on joint venture formation if the synergic effect is large. If the synergic effect is small, the impact is likely to be negative. Thus Proposition 1 (ii) may provide a way of determining whether, in a particular industry, joint ventures are motivated by the rent dissipation effect alone, or by the synergic effect also.

We then examine a model where there are no capacity constraints. We can mimic the earlier argument to show that in this case

$$\frac{dI}{da}=\frac{a-c}{4}-\frac{2(a-d)}{9}. \tag{10}$$

Proposition 2 now follows from equation (10) above.

***Proposition* 2**

The incentive for joint venture formation is increasing in the level of demand if and only if $\hat{q}>4q^*/3$.

In fact it is easy to see that a joint venture forms if and only if

$$9(a-c)^2-8(a-d)^2\geq 36T. \tag{11}$$

Define $X(a)=9(a-c)^2-8(a-d)^2$. Observe that $X'(a)=2(a-9c+8d)$, which is positive for all $a>d$. Thus the left hand side of equation (11) is increasing (without bounds) in a. Next define a^* as that value of a such that $9(a-c)^2-8(a-d)^2=36T$. Clearly, equation (11) is satisfied for all $a\geq a^*$. Hence the firms opt for a joint venture if and only if the demand level is large enough, i.e. $a\geq a^*$.

We then examine the impact of a change in the capacity level, $\bar{q}$, on the incentive for joint venture formation. Observe that

$$\frac{dI}{d\bar{q}} = \begin{cases} -(a-4\bar{q}-d), & \text{if } \hat{q} \le 2\bar{q} \le 2q^*, \\ a-4\bar{q}-c, & \text{if } 2q^* \le 2\bar{q} \le \hat{q}, \\ (d-c), & \text{if } \bar{q} < \min\left\{ \dfrac{\hat{q}}{2},\ q^* \right\}. \end{cases} \tag{12}$$

Obviously, for $\bar{q} < \min\{\hat{q}/2,\ q^*\}$, I is increasing in $\bar{q}$. In this case the incentive for joint venture formation is $(d-c)\bar{q}$, which is the synergic effect multiplied by firm size. Clearly, greater the firm size, greater the output level over which the synergic effect can operate, hence the result.

We then consider the case where $\hat{q} \le 2\bar{q} \le 2q^*$. To begin with observe that $(a-4\bar{q}-d)$ is decreasing in $\bar{q}$. Next notice that if $\bar{q} = \hat{q}/2$, then $(a-4\bar{q}-d) = (a-2\hat{q}-d)$. This from the joint venture profit maximising condition is negative, since $d > c$. Thus, for all $\bar{q} \ge \hat{q}/2$, $-(a-4\bar{q}-d)$ is positive. The intuition is simple. An increase in capacity level increases Cournot equilibrium output. Hence rent dissipation under Cournot competition increases, making joint ventures more attractive.

Finally, consider the case where $2q^* \le 2\bar{q} \le \hat{q}$. From the joint venture profit maximising condition it follows that if $\bar{q} = \hat{q}/2$, then $a-4\bar{q}-c = 0$. Since $a-4\bar{q}-c$ is decreasing in $\bar{q}$, it follows that $a-4\bar{q}-c$ is positive for all $\bar{q}$ in this range. In this case an increase in the capacity level allows the joint venture output to increase, coming closer to the monopolistic output. So joint venture profit increases.

***Proposition* 3**

The incentive to form a joint venture is increasing in firm size.

Finally, we allow for the fact that the coordination cost T may depend on firm size.[2] Let us formalise this by writing that $T = t\bar{q}$. It is easy to see that in this case

$$I = \begin{cases} \dfrac{(a-c)^2}{8} - \dfrac{t\bar{q}}{2} - \bar{q}(a-2\bar{q}) + d\bar{q}, & \text{if } \hat{q} \le 2\bar{q} \le 2q^*, \\ \bar{q}(a-2\bar{q}) - c\bar{q} - \dfrac{t\bar{q}}{2} - \dfrac{(a-d)^2}{9}, & \text{if } 2q^* \le 2\bar{q} \le \hat{q}, \\ (d-c)\bar{q} - \dfrac{t\bar{q}}{2}, & \text{if } \bar{q} < \min\left\{ \dfrac{\hat{q}}{2},\ q^* \right\}. \end{cases} \tag{13}$$

Clearly, equations (9) and (10) will not be affected and hence

[2]We are indebted to the referee for raising this point.

both Propositions 1 and 2 go through unchanged. Equation (12) will, however, be affected. In particular, in this case

$$\frac{dI}{d\bar{q}} = \begin{cases} -(a-4\bar{q}-d)-t, & \text{if } \hat{q} \leq 2\bar{q} \leq 2q^*, \\ a-4\bar{q}-c-t, & \text{if } 2q^* \leq 2\bar{q} \leq \hat{q}, \\ (d-c)-t, & \text{if } \bar{q} < \min\left\{\dfrac{\hat{q}}{2}, q^*\right\}. \end{cases} \tag{14}$$

Notice that for $t \leq 0$, Proposition 3 will not be affected. Clearly, however, if t is positive and large, then the result in Proposition 3 may be overturned. This leads us to the question whether in general we can expect t to be positive or negative. Note that if the firms are large then we can expect that coordination problems would be larger. This would tend to make t positive. Whereas, larger firms are also likely to have better communication systems and infrastructure. This would tend to make t negative. Which of these effects dominate is an empirical question.

We then relate our work to the empirical literature on joint ventures. It is interesting that there are some empirical studies that corroborate our finding that firm size has a positive impact on the incentive for joint venture formation. For example, in a study of 275 U.S. joint ventures, Boyle (1968) found that large firms are more likely to opt for joint venture formation compared to smaller firms. Of course, Boyle's study is for U.S. joint ventures. Moreover, it is not clear whether synergistic effects were important in the joint ventures examined by Boyle (1968). Thus an empirical study of this fact for synergy based joint ventures seems warranted.

We also show that the impact of a change in the demand level on joint venture formation can, depending on firm size and the synergic effect, be either positive or negative. Hladik (1985), however, found that the relationship between market size and joint venture formation is unambiguously positive. Notice though, that Hladik (1985) examined R&D oriented joint ventures, so that the two sets of results are not directly comparable. Again a study of this question in a LDC context, taking firm size carefully into account, appears to be called for.

III. Welfare Analysis

Finally, turning to welfare analysis we examine the conditions under which joint venture formation welfare dominates Cournot competition, and vice versa.[3] Given that joint venture formation leads to a monopoly outcome, this question is of interest for anti-trust policies.

Under the assumption that the whole of MNC profits are repatriated, domestic welfare is the sum of consumers' surplus and the profit of the domestic firm.[4] Given that demand functions are linear, consumers' surplus is obviously $q^2/2$, where q is the aggregate output level.

We begin by calculating the welfare level under various different parameter configurations. Let W_J represent the welfare level under a joint venture, and let W_C represent the welfare level under Cournot competition.

***Case* 1:** $\hat{q} \leq 2\bar{q} \leq 2q^*$. Clearly in this case

$$W_J = \frac{(a-c)^2}{8} - \frac{T}{2} + \frac{(a-c)^2}{8} = \frac{(a-c)^2}{4} - \frac{T}{2}, \tag{15}$$

$$W_C = \bar{q}(a-2\bar{q}) - d\bar{q} + 2\bar{q}^{\,2} = \bar{q}(a-d). \tag{16}$$

Notice that in equation (15), in the R.H.S., the term $(a-c)^2/8 - T/2$ represents the profit of the domestic firm (under a joint venture) and the term $(a-c)^2/8$ represents consumers' surplus. Similarly in equation (16), in the R.H.S., the term $\bar{q}(a-2\bar{q}) - d\bar{q}$ represents the profit of the domestic firm (under Cournot competition) and the last term represents consumers' surplus.

***Case* 2:** $2q^* \leq 2\bar{q} \leq \hat{q}$. In this case

$$W_J = \bar{q}(a-2\bar{q}) - c\bar{q} - \frac{T}{2} + 2\bar{q}^{\,2} = \bar{q}(a-c) - \frac{T}{2}, \tag{17}$$

$$W_C = \frac{(a-c)^2}{9} + \frac{2(a-c)^2}{9} = \frac{(a-c)^2}{3}. \tag{18}$$

***Case* 3:**

$\bar{q} < \min\left\{ \frac{\hat{q}}{2},\ q^* \right\}.$ Clearly,

[3]We are indebted to the referee for inspiring us to work on this section.

[4]We can instead assume that the MNC repatriates a fixed share of its profits. This does not affect the results qualitatively.

$$W_J = \bar{q}(a-c) - \frac{T}{2}, \tag{19}$$

$$W_C = \bar{q}(a-d). \tag{20}$$

The next proposition is the main result of this section.

***Proposition* 4**

Suppose that the firms prefer joint venture formation (Cournot competition) to Cournot competition (joint venture formation). Then joint venture formation (Cournot competition) welfare dominates Cournot competition (joint venture formation).

The proof has been relegated to the Appendix.

It is interesting that the private incentive for joint venture formation always dominates the social incentive. The intuition for this result has to do with the relationship between profitability, the output level and consumers' surplus. Suppose that joint venture formation is more profitable compared to Cournot competition. This implies that the output level under joint venture is quite large. If, in fact, the output level under joint venture exceeds that under Cournot competition then we are through, since this implies that consumers' surplus under joint venture formation is greater than that under Cournot competition. However, even if the output level under joint venture is less than that under Cournot competition, the difference between the two output levels cannot be too large. (Otherwise, the profit level under joint venture would be less compared to that under Cournot competition.) This implies that the profit effect dominates the consumers' surplus effect, and hence joint venture formation welfare dominates Cournot competition. The intuition for the case where Cournot competition is more profitable is similar.

Thus what this proposition shows is that if joint venture formation is best for the firms, then it is also best for the economy as a whole. Thus there seems to be little justification for anti-trust interventions in this case.

Let us then examine the impact of a change in the demand parameter on welfare levels. Clearly, if the chosen institutional form is capacity constrained then, even with an increase in a, the output level and hence consumers' surplus remains the same. However, firm profits would increase and thus welfare increases.

Otherwise, an increase in a increases both firms profits, as well as consumers' surplus, and hence welfare increases.

Next, we turn to the effect of a change in the capacity level. It is easy to see that if the chosen institutional form is capacity constrained then an increase in $\bar{q}$ increases welfare, otherwise there is no impact on the level of welfare.

Finally, we ask the question as to what extent do our results depend on the assumption that the joint venture is between an MNC and a domestic firm. In particular, are the results affected if we assume that both the firms are domestic?

Notice that the analysis in section II does not *formally* depend on the assumption that one firm is an MNC and the other is a domestic firm. All we require for the analysis is that there be some synergic effect between two firms. (Of course, there may be other sources of the synergic effect if both the firms are domestic.) Hence given the synergic effect all the results in this section go through.

The effect on the welfare analysis is not so transparent though. The main difference is that now the aggregate welfare includes the profit of *both* the firms, while in section III we were only considering the profit of one of the firms (the domestic firm). However, some simple manipulations demonstrate that even in this case Proposition 4 goes through.[5]

Thus even if we assume that both the firms are domestic, all our results go through.

IV. Conclusion

In this paper we develop a synergy based theory of joint venture formation. We examine how the interaction between synergy, firm size and market size affects the incentive for joint venture formation. We also find some interesting welfare results. In particular we find that whatever institutional form dominates in terms of payoff, also dominates in terms of welfare.

[5]The calculations are available from the authors on request.

Appendix

***Proof of Proposition* 4:** We consider the three cases separately.

***Case* 1:** $\hat{q} \leq 2\bar{q} \leq 2q^*$.
First suppose that the firms prefer Cournot competition to joint venture formation. Then the profit of the domestic firm would be higher under Cournot competition. Moreover, since the output under Cournot competition, $2\bar{q} \geq \hat{q}$, the output under a joint venture, consumers' surplus would be higher under Cournot competition as well. Thus in this case $W_C \geq W_J$.

Next consider the case where the firms prefer joint venture formation to Cournot competition. Hence,

$$\frac{(a-c)^2}{8} - \frac{T}{2} \geq \bar{q}(a-d) - 2\bar{q}^2, \tag{A1}$$

$$\begin{aligned} \text{or, } W_J = \frac{(a-c)^2}{8} - \frac{T}{2} + \frac{\hat{q}^2}{2} &\geq \bar{q}(a-d) - (2\bar{q}^2 - \frac{\hat{q}^2}{2}) \\ &\geq \bar{q}(a-d) = W_C, \end{aligned} \tag{A2}$$

where the last inequality follows since in this case $2\bar{q} \geq \hat{q}$.

***Case* 2:** $2q^* \leq 2\bar{q} \leq \hat{q}$.
First assume that the firms prefer joint venture formation to Cournot competition. In that case the profit of the domestic firm is greater under joint venture formation. Furthermore, since $2\bar{q} \geq 2q^*$, consumers' surplus under joint venture formation is also greater than that under Cournot competition. Hence $W_J \geq W_C$.

Next consider the case where the firms prefer Cournot competition to joint venture formation. Thus

$$\frac{(a-d)^2}{9} > \bar{q}(a-c) - \frac{T}{2} - 2\bar{q}^2, \tag{A3}$$

$$\begin{aligned} \text{or, } W_C = \frac{(a-d)^2}{9} + 2q^{*2} &> \bar{q}(a-c) - \frac{T}{2} - (2\bar{q}^2 - 2q^{*2}) \\ &\geq \bar{q}(a-c) - \frac{T}{2} = W_J, \end{aligned} \tag{A4}$$

where recall that $\bar{q} \geq q^*$.

***Case* 3:**

$$\bar{q} \leq \min\left\{\frac{\hat{q}}{2},\ q^*\right\}.$$

Clearly, the aggregate output is the same under joint venture formation and Cournot competition, and hence so is consumers' surplus. Thus whatever institutional form dominates in terms of profits, also dominates in terms of welfare.

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