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STRATEGIC OUTSOURCING WITH TECHNOLOGY TRANSFER

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Strategic Outsourcing with Technology Transfer

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Abstract: We analyze the outsourcing decision of a firm for a key input of a final good production to an independent input supplier even though the firm has an option of producing that key input in-house at a lower cost with a better technology. We find that for smaller technology gap with the independent input supplier the firm would outsource and for larger technology gap it would produce the input in-house for itself and for its rivals. The outsourcing occurs in order to take advantage of its sale of superior technology to the independent input supplier at a high payment although it involves a high price for the input to be acquired from the monopoly input supplier. Though the firm gains from strategic outsourcing, consumers' welfare as well as social welfare goes down.

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Strategic Outsourcing with Technology Transfer

Introduction

Outsourcing the production of key input is a widespread phenomenon in modern business. How the firms organize their production and whether they also sell the intermediate inputs to their rivals are very subtle and complex decisions that involve significant strategic considerations. The traditional firm theory would dictate that a firm confronted with the choice of in-house production versus outsourcing would typically depend on the cost consideration, and the firm would choose the least cost option.[1] However, in an imperfectly competitive market structure most decisions are based on complex strategic considerations and it is not surprising that a firm might outsource a key input from the outside supplier even though it can be produced cheaply in-house. In this paper we focus on such a scenario of outsourcing.

We analyze a setting in which there are two final good producers competing in Cournot quantities. There exists an independent input supplier who does not produce the final product. However, one of the final good producers, say firm 1, has a superior technology to produce the key input in-house and then it can also participate in the input market to compete with the independent input supplier to sell the input to its rival (say firm 2). Firm 2 does not have the requisite technology to produce the input in-house; so it has to depend on the input market to source its input. In this setting we analyze the decision of firm 1 between outsourcing the input from the independent input suppler or producing it in-house and also the decision to transfer the technology to the independent input supplier. We would show that firm 1 would outsource the key input if the gap between its input production technology and that of the independent supplier is small, and it would produce the input in-house and also supply to its rival when the technology gap is large. When the outsourcing is done, firm 1 buys the input

[1] Starting from Coase (1937), the modern theory of firm has mainly focused on the transaction costs involving asset specificity and incomplete contract and thus tried to explain the extent of integration (Williamson 1985, Grossman and Hart (1986); also see Gibbons (2005) for a nice survey on the theory of firm). Grossman and Helpman (2002) have studied the determinants of the equilibrium production mode (i.e., integration versus outsourcing) in industries where inputs are fully or partially specialized. However, we are concerned with the non-specific input.

from the monopoly input supplier at a price much higher than its in-house production cost. However, the advantage of outsourcing stems from softening of competition in the final goods market and this in turn accrues to firm 1 through a payment for the technology sold to the independent input supplier.

Our paper is very closely related to Arya et al (2008a). They have considered a similar framework like ours along with the possibility that the rival firm may be a potential entrant. They have shown that the decision to outsource to the same supplier rather than producing inputs internally, even when the outsourcing is more costly than internal production, is justified on the ground that it can reduce the incentive of the supplier to deliver inputs to the rival on favorable terms. In their model, the monopoly input supplier can price discriminate between incumbent and entrant firms and the prices are set sequentially and thus the outsourcing decision leads to the prospect of higher input prices for rival that might even deter potential rivals from entering the industry. Our paper is different from theirs on many counts. Among the main differences, first, in case of outsourcing in our model the monopoly input supplier does not price discriminate. It only quotes the monopoly price in the input market and the final good producers buy their inputs as per their demand at the quoted price. Second, in our case when firm 1, with having a superior technology of input production, decides to produce the input in-house, not only it produces for itself it can also participate in the input market and compete in prices with the outside input supplier. Given the possibility of input market participation we show that, unlike Arya et al (2008a), it is always profitable for firm 1 to participate in the input market and as a result the in-house input producing firm can never commit not to sell the input to its rival.[2] Third, we allow the possibility of technology transfer from firm 1 to the input supplier. Another closely related paper is by Chen (2011), which showed that the outsourcing decision of an incumbent might prevent the entry of a potential entrant as the incumbent can commit to an aggressive post entry competition. In his model the outsourcing has ambiguous welfare effect. There is no entry deterrence story in our model, and the final good market is always duopoly; it is the input market which becomes monopoly under outsourcing. Thus, our work complements the works of Arya et al (2008a) and Chen (2011).

[2] Arya et al (2008) do not consider the possibility of technology transfer and the firm with the input production facility would not outsource when its own cost of production is lower than the independent input supplier.

Related literature

With the liberalization of trade and openness in most part of the world, international outsourcing has assumed great significance. There is a sharp rise in outsourcing activities in recent decades (Hummels *et al.*, 1998; Feenstra and Hanson, 1999). Given its empirical prevalence, both inside an economy and in international context, there exists a large body of literature attempting to analyze the topic from various dimensions. Here we focus on the most relevant ones.

The benefit of strategic outsourcing in terms of raising rivals costs is illustrated in Salop and Scheffman (1983, 1987). In a model with Cournot competition in both upstream and downstream, Schrader and Martin (1998) focus on the advantage of excessive outsourcing in order to reduce the market supply to rival downstream producers. In the presence of economies of scale Shy and Stenbacka (2003) have analyzed the strategic incentives of oligopoly firms in outsourcing the production of inputs. By outsourcing inputs a firm can avoid the investment in fixed cost for its in-house production, all the more so if one's rivals have already gone to an outsider and created the scale economies there. Buehler and Haucap (2006) show outsourcing that increases production costs can be mutually profitable for downstream producers when it softens the competition in the final goods market. Even when the rival is doing in-house production, outsourcing orders with the rival will only enhance its economies of scale and lower its costs, making it a more formidable competitor in the final goods market (Yutian Chen and Dubey, 2009). Arya et al. (2008b) was concerned with the price versus quantity competition when the production of key inputs is outsourced to a vertically integrated retail competitor with upstream market power. They find that Bertrand competition can lead to higher prices, higher industry profit, lower consumer surplus, and lower welfare than Cournot competition. Chen et al (2011) have introduced another aspect of strategic competition where the input-seeking firm fully reveals its plans to the vertically integrated rival by placing the amount of order that it intends to become the Stackelberg leader in the final product market. It is the rival who, seeing through this ploy, refuses to play the role of the input provider and drives the firm to outsource elsewhere. It is shown that under some circumstances the vertically integrated firm would like to be Stackelberg follower and supply the input to its rival.

Towards the end we must mention that though our model is posed in the context of a standard vertical structure model of industrial organization,[3] our model is equally applicable in the context of international outsourcing. The firms can be from different countries competing in the world market. Using our model one can investigate different policy options for different countries, which is beyond the scope of this paper. However, in Section 5 we have discussed an immediate application of our model in the context of international outsourcing. It is argued that trade liberalization leading to outsourcing may be detrimental for any developed country which typically outsource inputs from developing countries.[4]

The rest of the paper is presented according to the following scheme. Section 2 provides the framework of our analysis and elaborates the game. We undertake the analysis in Section 3. Section 4 presents the welfare results. In section 5 we highlight the significance and robustness of our model. Then in section 6 we conclude the paper.

2.1 The Framework

There are three firms. Firm 1 and 2 produce a homogeneous final good. Final good production requires a non-specific key input. Firm 1 has access to a technology for producing the key input whereas firm 2 cannot produce the key input for itself. Firm 3 can produce the key input and sell in the input market but it cannot produce the final good. Firm 1 has a technology for input production, which is superior to that of firm 3. Firm 1 and 2 compete in quantities in the final good market. The final good production technology converts one unit of input into one unit of output. We assume for simplicity that no other inputs are required for production of final good, and the production of final good does not involve any other cost

[3] Among others, Mukherjee and Ray (2007) and Van Long (2005) discuss the issues of outsourcing in the scenario of R&D and technology spillovers.

[4] There is a considerable literature on international outsourcing. Among others, see Antràs and Helpman, 2006, McLaren (2000), Grossman and Helpman (2003, 2005) etc. Pack and Saggi (2004) are concerned with the international outsourcing under vertical technology transfer from the developed country firms to less developed country firms; they find that there is benefit of technology transfer even though technology might be diffused to other firms and might change the market structure.

except the cost of this key input. The unit cost of producing one unit of input by firm 1 and 3 are respectively c_1 and c_2; $0 \leq c_1 < c_2$. The superior technology of firm 1 can be licensed or the patent for that technology can be sold without incurring any additional cost.

2.2 The Game

Stage 1: firm 1 decides whether to sell the patent for its superior technology or to license the technology to the independent input supplier (firm 3). The independent input supplier either accepts or rejects the offer. We consider that in either case of technology sale or licensing, only fixed payment from firm 3 to firm 1 would be made. Firm 1's option of neither selling the patent nor licensing the technology, can be thought of as making an unacceptable offer by firm 1 to firm 3.

Stage 2: In case firm 1 has sold the patent in the first stage, then both the final good producers buy the required amount of input at the prevailing price in the input market from the monopoly input supplier. Whereas if the technology is not sold and firm 1 decides to produce the input in-house, then only firm 2 buys input from the input market and firm 1 competes with firm 3 to sell input to firm 2. We assume that input market competition takes place in prices.

Stage 3: The final good producers compete in Cournot quantities in the final good market.

Let us elaborate the game and the outcomes a little more. First the distinction between patent sale and licensing should be made clear. In stage 1, suppose firm 1 sells out the patent of the input producing technology. Thereafter it has to buy input from the input market. As a result input market will be monopoly of the independent input supplier. In other words, technology sale agreement strips firm 1 the right to use the technology and it has to buy input from the input market. This is tantamount to choosing the option of outsourcing the input from the independent input supplier. In case of technology licensing, firm 1 has the option of using the technology for its in-house production as well as producing for the input market. Then under licensing the input market will have two firms competing to supply inputs to firm 2. We make an assumption that firm 1 cannot commit to firm 3 in the licensing contract that it will not participate in the input market. We also show that it is always tempting for firm 1 to sell input in the market when it is undertaking the in-house production. Thus, given the positive

incentive to breach such a contract of non participation in the input market, such commitment, even if written in the contract, has no value. When the contract is breached, the government would not be willing to enforce such a contract in the court of law as it is anti-competitive. We show that in such circumstances of non-commitment the technology licensing will not occur.

An alternative way to motivate the problem is that firm 1 shuts down the production facility of the input once the technology sale is agreed upon at a fixed price. By this way it is committing to outsource the input from the input supplier. And the other option of licensing in the given game may be thought of as no licensing action by firm 1. Our basic purpose is to show that firm 1, despite having a better technology (lower cost of input production), might choose outsourcing rather than in-house production of the input and this strategic outsourcing makes firm 1 better off. In case of outsourcing, firm 1 pays the same price for the input as its rival pays, however that price is much higher than the in-house cost of input production. The advantage of outsourcing comes from the sale of superior technology at a high price.

3.1 Analysis of Benchmark Case

The benchmark case presumes that firm 1 undertakes in-house production but without entering into the input market competition with firm 3. In other words, the benchmark case presents the scenario that firm 1 having the cost advantage in input production, just produces input for itself as a vertically integrated firm, and it neither sells the patent of the technology nor does it license the technology to firm 3, and also it does not sell the input to firm 2. Thus, firm 2 buys input from firm 3, who is a monopoly supplier of the input in the input market. Clearly, firm 1 gets inputs at the cost price c_1 per unit, but firm 2 pays w_2 for inputs per unit charged by firm 3. The market demand for the final good is assumed to be linear. This is, in inverse form, given by the equation

$$P = a - Q = a - (q_1 + q_2), a > \text{c} \qquad (1)$$

where P is the price of the product and q_i is the supply of the i-th firm, $i = 1, 2$.

So for any w_2, output stage equilibrium quantities are

$$q_1 = \frac{a - 2c_1 + w_2}{3} \text{ and } q_2 = \frac{a - 2w_2 + c_1}{3}, \quad (2)$$

and the corresponding payoffs are

$$\pi_1 = \frac{(a - 2c_1 + w_2)^2}{9} \text{ and } \pi_2 = \frac{(a - 2w_2 + c_1)^2}{9}. \quad (3)$$

In the input market firm 3's demand comes only from firm 2 and thus its problem is :

$$\max_{w_2} \pi_3 = (w_2 - c_2)q_2 = (w_2 - c_2)(a - 2w_2 + c_1)/3.$$

This yields the optimal w_2 as

$$w_2^0 = \frac{a + c_1 + 2c_2}{4} \quad (4)$$

The corresponding equilibrium quantities and profits are:

$$q_1^0 = \frac{5a - 7c_1 + 2c_2}{12} \text{ and } q_2^0 = \frac{a - 2c_2 + c_1}{6} \quad (5)$$

$$\pi_1^0 = \frac{(5a - 7c_1 + 2c_2)^2}{144} \text{ and } \pi_2^0 = \frac{(a - 2c_2 + c_1)^2}{36} \quad (6)$$

$$\text{and} \quad \pi_3^0 = \frac{(a - 2c_2 + c_1)^2}{24}$$

We assume that both firms are active by producing positive output in the output market. Thus, we have the restriction that,

(A1) $$c_2 < \frac{a + c_1}{2} \equiv \bar{c}$$

The benchmark case has ignored all other strategic considerations of firm 1 except its participation in the final good market as a Cournot player. We would now gradually introduce such considerations below.

3.2 In-house production with input market competition

Let us introduce the possibility that firm 1, while produces inputs for itself, can also compete in the input market with firm 3 to supply input to firm 2. The competition in the input market is Bertrand price competition. Then under competition firm 1 gets inputs at price c_1 per unit from its upstream division, firm 2 buys inputs at a price $w = \min\{w_1, w_2\}$ per unit, where w_i is the input price quoted by firm $i; i = 1, 3$. Bertrand competition will lead to $w_i = c_2$. To avoid the open set problem in Bertrand competition we assume that firm with the lower cost matches the price quoted by the higher cost firm and get the entire demand in the market.[5] Thus, firm 1 charges the limiting price c_2, and supplies inputs to firm 2. The equilibrium payoffs in this subgame are:

$$\tilde{\pi}_1 = \frac{(a - 2c_1 + c_2)^2}{9} + (c_2 - c_1)\frac{(a - 2c_2 + c_1)}{3} \qquad (7)$$

$$\tilde{\pi}_2 = \frac{(a - 2c_2 + c_1)^2}{9} \quad \text{and} \quad \tilde{\pi}_3 = 0 \qquad (8)$$

By comparing with the benchmark situation it is clear that input market competition leads to lower price of input for firm 2, which makes firm 2 a stronger rival in the final good market. This reduces firm 1's profit earning from the final good market. Since input supply to firm 2 is done by firm 1, it earns some extra profit from input sales. The net overall benefit of input market participation can go either way. Thus, it is quite possible that firm 1 may not like to participate in the input market and does better by simply undertaking the in-house production for itself. In the following subsection we first provide that comparison of payoffs in case it is possible for firm 1 to commit someway that it would not enter the input market. Then in Lemma 1 we argue that such a commitment of non participation is not credible in the given game.

[5] Note that under asymmetric cost Bertrand competition there exists another possibility that the cost efficient firm charging monopoly price could be an equilibrium if the monopoly price is below the cost of the inefficient rival firm. This possibility is ruled out due to the parameter restrictions considered here.

3.3 Input market competition and the problem of commitment

Suppose firm 1 can commit not to enter the input market. Firm 1 would then like to commit *not* to enter into input market competition if and only if $\pi_1^0 > \tilde{\pi}_1$. We can rewrite the expressions as follows:

$$\pi_1^0 = \frac{(5a - 7c_1 + 2c_2)^2}{144} = \frac{1}{144}[5a' + 2\delta]^2 \quad \text{and}$$

$$\tilde{\pi}_1 = \frac{(a - 2c_1 + c_2)^2}{9} + (c_2 - c_1)(a - 2c_2 + c_1)/3 = \frac{1}{9}[a' + \delta]^2 + \frac{\delta}{3}[a' - 2\delta]$$

where,

$$a' = (a - c_1) \quad and \quad \delta = (c_2 - c_1)$$

Now given assumption (A1), that is, $a' > 2\delta$, $\pi_1^0 > \tilde{\pi}_1$ if and only if,

$$[5a' + 2\delta]^2 > 16[a' + \delta]^2 + 48\delta[a' - 2\delta]$$

$$\Rightarrow 9a' > 42\delta$$

$$\Rightarrow c_2 < \frac{3a + 11c_1}{14} \equiv \tilde{c} \qquad (9)$$

Check that $c_1 < \tilde{c} < \bar{c}$. Therefore, when it is possible, firm 1 will commit not to compete in the input market with firm 3 $\forall c_2 \in [c_1, \tilde{c}]$. If $c_2 \in (\tilde{c}, \bar{c})$, it is better for firm 1 to compete in the input market with firm 3.

Proposition 1: *In case it is possible for firm 1 to commit not to enter into a competition in the input market with the independent input supplier, it would do so for all* $c_2 \in [c_1, \tilde{c}]$. *And for* $c_2 \in (\tilde{c}, \bar{c})$ *firm 1 would like to participate in the input market competition.*

Though firm 1 would prefer not to participate in the input market competition for small technology gap, but it cannot credibly commit to do so. The following lemma proves that. Note that until now we have analyzed different scenarios where firm 1 neither license the technology nor does it sell the technology.

Lemma 1: *No equilibrium is possible where firm 1 commits to stay out of the input market competition when it produces the input in-house for itself.*

Proof: Suppose there exists an equilibrium where firm 1 does not compete in the input market but it produces in-house. Now consider the following deviation. Given any choice of $w_2 > c_1$ by firm 3, firm 1 has incentive to enter the input market by matching w_2, thereby it can supply the entire demand of firm 2. This does not change the outcome of the final good market but by matching the price quoted by firm 3 it can always increase its payoff from selling input to its rival. Thus, firm 1 can retain its market operated payoff π_1^0 from the final good market, and get an additional profit from the input market by entering into the input market competition. Hence, the lemma is proved.

Therefore, commitment is *not* possible and so only possible outcome under the possibility of in-house production will be that both firm 1 and 3 compete to supply inputs to firm 2. Given the cost advantage of firm 1 in input production, firm 3 will receive zero profit in equilibrium.

Until now we were concerned with the outcome that would occur without technology sale or licensing. In view of Lemma 1 then the only possible equilibrium would be where no such deviation exists and that is characterized by the input market price equal c_2, and firm 1 supplies the input and get its payoff given by (7). It follows from proposition 1 that due to the problem of commitment (described in lemma 1) firm 1 actually does weakly worse. Now we turn to the analysis of technology licensing and outsourcing and show that outsourcing solves this commitment problem and does better for firm 1 for some parameter range.

In the context of our game, first note that there would not be any technology licensing. Suppose, on the contrary, firm 3 accepts an offer of technology licensing transfer at stage 1 of the game against a fixed fee. Then, given the no-commitment to participate in the input market, firm 1 has always the incentive to undercut and the Bertrand competition in the input market would lead to the price of input equal to c_1. As a result the optimal fixed fee will be zero here. Given this prospect of licensing, firm 1 does better by not licensing the technology but participating in the input market. Thus, we have

Proposition 2: *Technology licensing will not occur in equilibrium.*

3.4 Outsourcing decision

Suppose that firm 1, as an alternative to in-house input production, decides to sell its patent of the superior input production technology to firm 3. In case of sale firm 1 cannot undertake production because it does not have the necessary right to do so. *Thus patent sale acts as a credible commitment not to produce inputs by itself, which essentially means that firm 1 would outsource the input from the input market where firm 3 would be the monopoly seller.* Under this scenario firm 3 first decides w, the price of input per unit, and then firm 1 and 2 compete for quantities in the second stage.

Now, for any w, each of firm 1 and 2 will produce $q = (a - w)/3$. Then firm 3's first stage problem becomes:

$$\max_w (w - c_1)2q$$

This yields

$$w = w^m \equiv \frac{a + c_1}{2} \tag{10}$$

Then with this input price the payoffs of the firms are:

$$\hat{\pi}_1 = \hat{\pi}_2 = \frac{(a - c_1)^2}{36} \text{ and } \hat{\pi}_3 = \frac{(a - c_1)^2}{6} \tag{11}$$

When firm 1 sells its patent, it charges a fixed price $F > 0$, so its net payoff under outsourcing strategy will be

$$\Pi_1^* = \hat{\pi}_1 + F = \frac{(a - c_1)^2}{36} + F$$

Now, F is to be determined optimally. Since firm 3's disagreement payoff is zero, we may assume that firm 1 extracts all payoff from firm 3 as fee, that is, $F = \hat{\pi}_2$. In this case, firm 1's payoff becomes

$$\Pi_1^* = \hat{\pi}_1 + \hat{\pi}_3 = \frac{7(a-c_1)^2}{36} \tag{12}$$

Then outsourcing will occur if and only if $\Pi_1^* > \tilde{\pi}_1$, that is,

$$L(\delta) \equiv 3a'^2 - 20a'\delta + 20\delta^2 > 0$$

The $L(.)$ function is quadratic in δ with $L(.) > 0$ at $\delta = 0$ (i.e., $c_2 = c_1$) and $L(.) < 0$ at $\delta = a'/2$ (i.e., $c_2 = \bar{c}$) with L(.) becomes zero in between c_1 and $\bar{c}$. Therefore,

$$\exists c^*,\ c_1 < c^* < \bar{c},\ |\ \Pi_1^* > \tilde{\pi}_1 \Leftrightarrow c_2 < c^* \tag{13}$$

where $c^* = 0.18377a + 0.81623c_1$.

Thus, for low c_2, outsourcing is the optimal strategy for firm 1. Hence, we have the following proposition.

Proposition 3: *Firm 1 will outsource the input to the independent input seller for all* $c_2 \in (c_1, c^*)$ *and it will undertake in-house production if* $c_2 \in [c^*, \frac{a+c_1}{2})$.[6]

Thus, firm 1 would like to outsource for small technology gap but it would not do so if the technology gap is large. Note that as the technological advantage increases, the in-house production becomes more and more attractive for two reasons: First, firm 1 can make more profit from selling the input and would have more strategic cost advantage at the final good production stage. It should be clear that the strategic advantage of outsourcing stems mainly from the advantage of the input production technology of firm 1. Second, when firm 1 sells the patent in order to outsource from firm 3, it removes the input market competition. This increases the input price in the input market thereby softening the competition in the final good market. This advantage of extra profit from the final good market and the opportunity to extract the surplus from firm 3 due to patent sale make the outsourcing strategically advantageous for small technology gap.

[6] Note that we are considering the outright sale of the patent and hence it is natural that the payment would be settled upfront. Therefore, we have considered a fixed price for the sale of the patent. However, allowing for a two-part tariff payment (fixed fee and royalty as considered in the technology licensing context) for the sale of patent we find that the optimal payment structure would be fixed price. The details are available from the authors on request.

4. Welfare Analysis

Consider industry profit and consumers' surplus under outsourcing as compared to the case of in-house production. Industry profit under in-house production (that is, input market competition) is:

$$\tilde{\Pi} = \tilde{\pi}_1 + \tilde{\pi}_2 + \tilde{\pi}_3 = \frac{1}{9}[2a' - \delta^2 + a'\delta]$$

and industry profit under outsourcing

$$\hat{\Pi} = \hat{\pi}_1 + \hat{\pi}_2 + \hat{\pi}_3 = \frac{2}{9}a'^2$$

We can easily check that

$$\tilde{\Pi} > \hat{\Pi} \ \ \forall c_2 \in (c_1, c^*)$$

that is, when outsourcing is more profitable compared to in-house production, industry profit unambiguously falls under outsourcing. Here firm 1 benefits at the cost of firm 2.

To see the effect of outsourcing on consumers' welfare, under input market competition the industry output is:

$$\tilde{Q} = \tilde{q}_1 + \tilde{q}_2 = \frac{1}{3}[2a' - \delta]$$

and that under outsourcing

$$\hat{Q} = \hat{q}_1 + \hat{q}_2 = \frac{1}{3}a'$$

Again, we have unambiguously,

$$\tilde{Q} > \hat{Q} \ \ \forall c_2 \in (c_1, c^*)$$

Therefore, both consumers' welfare and industry profit will fall under outsourcing. Hence,

Proposition 4. *Whenever outsourcing occurs, it is welfare reducing.*

This is indeed an important finding of our model. The reason for such welfare loss is easy to explain. Note that by strategic outsourcing firm 1 gains, but both firm 2 and consumers loose. This is because of high price that prevails in the input market due to outsourcing, and this leads to softening of competition in the final good market. Firm 2 looses due to higher input price, so does the consumer due to higher final good price. However, only firm 1 gains out of strategic outsourcing, but the gain is not sufficient to offset the loss due to double marginalization problem under monopoly input supply under outsourcing as compared to input market competition**.**

5. Discussion

First we demonstrate the role of technology transfer in our framework. Suppose, on the contrary, firm 1 does not have any technological advantage, i.e., $c_2 < c_1$. In such a scenario firm 1 cannot transfer the technology either as patent sale or licensing. It still has the option of outsourcing or in-house production purely based on the consideration of cost minimization. Given the price competition in the input market, the prevailing price would be c_1, and firm 3 would be able to serve the entire demand that comes to the input market. In such a situation firm 1 is indifferent between outsourcing (i.e., buying input from the market) and in-house production. In other words there is no strategic advantage of outsourcing. One can ask whether there would be technology licensing or sale of patent from firm 3 to firm 1. Note that technology sale to firm 1 is equivalent to firm 1 acquiring firm 3 and in that case firm 1 would foreclose firm 2 from supplying input. This anticompetitive behavior is ruled out by the presence of antitrust authority in a country. However the technology licensing to firm 1 would not occur for the same reason as firm 1 cannot commit not to compete in the input market with firm 3 in case it undertakes in-house production.

Our analysis is based on the assumption that firm 1 makes a take-it-or-leave-it offer for its technology sale. A natural question is whether a bargaining between the two parties on the amount of payment would make any qualitative difference to the results derived in the paper. Since bargaining over the fixed payment does not change the choice of input price our analysis would hold as it is. The only difference is that the overall profit from the option of outsourcing would fall by the amount that would be appropriated by firm 3. As a result, the parameter zone for which the outsourcing would be preferred would shrink, unless the

bargaining power of firm 3 is so high that firm1 would do better by not choosing that option for all parameter values. One way to justify the zero bargaining power of firm 3 is that the reservation payoff of firm 3 is zero, as without the technology sold to firm 3 it cannot even operate in the market. We have not considered the option of acquiring firm 3 by firm 1. Note that once firm 3 is acquired, then firm 1 would foreclose firm 2 from supplying inputs. As a result the market for the final good would be the monopoly of firm 1. This kind of acquisition leading to monopoly is not generally allowed by antitrust authority in any country.

Another related point is what happens if there is a competitive fringe to supply the input rather than one independent input supplier. In this case technology licensing to one or more firms will not be possible due to the commitment problem of input market competition. Now technology sale to one input supplier among the competitive fringe may be possible, but the equilibrium price in the input market would then be c_2 and the firm which would buy the patent would serve the input market. However, firm 1 could then extract $(c_2 - c_1)$ price-cost margin per unit of input demand. By in-house production firm 1, in fact, would do better because since its own cost of production would be low (i.e., c_1) and the profit from selling input to firm 2 would remain the same. Thus, it is easy to understand that by simply producing the input in-house and then by selling the input to its rival at the cost price of the other input suppliers, firm 1 does better than outsourcing. This is true whenever there is more than one independent input supplier.

Our welfare result sheds an important light on the issue of international outsourcing also. Suppose, firm 1 and firm 2 are from North and firm 3 is from a southern country. The final good is produced and consumed in the North. The northern firms have the option of outsourcing from the south. Let the per unit input cost of production by firm 3 (the southern firm) be $c_2 = c + t$, where c is the basic cost of production and t the trade cost which includes both transport and tariff imposed by the North. Suppose, due to trade liberalization trade cost falls leading to a fall in c_2. Suppose we begin from a situation where the difference between c_1 and c_2 is high so that the input market is characterized by competition and the outcome is that firm 1 supplies input to firm 2 at the competitive price. Now, with the advent of trade liberalization the difference of costs between c_1 and c_2 falls, as a result outsourcing from the South becomes profitable. Here outsourcing is triggered by trade liberalization and welfare in the North ultimately falls. Hence, there is good enough reason for the North to be

skeptical about too much outsourcing, especially when this is driven by strategic consideration rather than cost consideration. Our model provides a foundation for such welfare reducing outsourcing in the international context.[7]

6. Conclusion

In this paper we have shown the possibility that although a firm possesses a superior input producing technology, it outsources the crucial input from outside at a much higher price than its in-house production cost under some parametric configurations. More specifically, the outsourcing occurs when the technological gap between its in-house input production and that of the outside input supplier is not large and it would produce the input in-house and also supply to its rival when the technology gap is large. Outsourcing leads to high input price, which softens the competition in the final good market. We have introduced the issue of technology transfer in the outsourcing literature and provided a new strategic reason for outsourcing which was hitherto not recognized in the literature.

We have analyzed the problem in a setting where an integrated firm competes in the final goods market with a rival that has to depend on the input market for the supply of input and the independent input producer has an inferior input producing technology. The integrated firm by selling off the patent of its technology to the independent input producing firm credibly commits to purchase inputs from the monopoly input seller. This raises not only its own production cost but also that of the rival. Thus by transferring its technology not only it captures the surplus profit of the input supplier by means of a fee, but outsourcing helps in reducing competition in the final goods market. In this set up, the overall industry profit falls in the final good market due to high price in the input market under outsourcing. The outsourcing firm manages to appropriate an extra surplus from the input supplier through a price for its technology sale and thereby it benefits the most, but the rival in the final good

[7] There are some interesting papers which stress the welfare loss as a result of outsourcing decision of firms. For instance, see Marjit and Mukherjee (2008), Mukherjee and Tsai (2010). There exists a considerable literature dealing with different aspects of international outsourcing. In particular, Chen et al (2004) dealt with the strategic outsourcing in the international context and focused on the effect of trade liberalization in intermediate input which might lead to higher prices for inputs as well as for final goods.

market becomes the worst sufferer as it has to buy the input at a higher price. And consumers also suffer because of double marginalization in the upstream and downstream pricing that raises the final products price. Our analysis thus raises a serious policy concern over the strategic outsourcing.

Though we have posed the problem in the context of a standard vertical structure model of industrial organization, our model is equally applicable in the context of international outsourcing. One such application is discussed in the paper. If outsourcing is triggered by trade liberalization, then it is likely that welfare in the countries which indulge in outsourcing might fall even though the firms which are engaged in strategic outsourcing actually gain. Thus, there is reasonable concern over excessive outsourcing which occurs beyond the cost consideration of such transaction.

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