Under-Provision of Inputs in Joint Ventures with Market Power

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Abstract

A joint venture with market power bene…ts from restricting its output which, in turn, requires the partners to restrict the supply of their inputs. However, since each partner bene…ts only partially from restricting its input, both over-supply their inputs from the viewpoint of the optimal use of market power. We show that this pecuniary negative externality in the partners' input decisions mitigates the standard under-provision problem that arises in joint ventures. We also show that the degree of this problem declines as the demand becomes less elastic.

JEL classi…cation: L23, F23

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1. Introduction

It is well understood that joint ventures su¤er from an input under-provision problem: Relative to the jointly optimal outcome, partners in a joint venture tend to provide too little e¤ort as the marginal bene…t of their e¤ort is shared by

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the other partner.[1] Despite this incentive problem, however, joint ventures have been a prevalent form of doing business, especially in the context of international investment. For example, from 1996 to 1999, 82,274 foreign investment projects were approved in China, of which approximately 56% took the form of a joint venture between a local and a foreign firm and these accounted for approximately 58.9% of the total inward foreign investment (see China's Statistical Yearbooks for Foreign Relations and Trade, 1996-2000). A common explanation for the wide-spread existence of international joint ventures is that the benefit of pooling complementary strengths outweigh the efficiency loss that arises from the double moral hazard problem.

In this paper, we argue that for joint ventures that enjoy market power, the input under-provision problem is less severe than previously believed. This is because the existence of market power generates a pecuniary negative externality that counteracts the positive externality emanating from each partner's sub-optimal choice of its input level. The pecuniary negative externality works as follows. When a joint venture has market power, an increase in any partner's input lowers the price of the joint venture's final product by increasing its total output. However, each agent ignores this negative effect of its input choice on its partner's revenue. By contrast, when a joint venture is a price-taker (as is the case in the existing literature), an increase in any partner's input results in additional output without depressing the product's price. Thus, a joint venture with market power benefits from restricting its output which, in turn, requires the partners to restrict the supply of their inputs. However, since each partner benefits only partially from restricting its input, both over-supply their inputs from the viewpoint of the optimal use of market power.

We illustrate the trade-off created by the above-mentioned externalities for two different downward sloping demand functions (linear and constant elasticity demand). The main result is that while the under-provision problem continues to affect a joint venture with market power, the presence of market power mitigates its extent. We also show that the degree of this problem is lower for less elastic demand. This is so because as the demand elasticity declines, a given increase in the joint venture's output leads to a larger drop in price, resulting in a stronger pecuniary negative externality.

[1] The double moral hazard problem with input provision has been analyzed in a variety of different contexts. See, for example, Holmstrom (1982) for a study of team production, Eswaran and Kotwal (1985) for an explanation of share-cropping in agriculture, and Bhattacharyya and Lafontaine (1995) for a more recent analysis of franchising contracts.

The existing literature on double moral hazard in joint ventures often abstracts from external factors such as demand conditions and market concentration. However, empirical evidence indicates that international joint ventures are often formed in highly concentrated industries. For example, joint ventures formed between giant multinational companies and firms in developing countries, such as those by Coca Cola and Pepsi in India and China, General Motors, Motorola, and Microsoft in China, undoubtedly enjoy great market power in their respective markets. In fact, the policy concerns raised by the high degree of concentration in such markets are so important that the 1997 World Investment Report focuses exclusively on issues of market power and competition associated with foreign direct investment. This report emphasizes that host countries are frequently concerned about the abuse of market power by international joint ventures (p. 153).[2] Our paper shows that for joint ventures with market power, the pecuniary externality between joint venture partners has non-trivial implications for the magnitude of the input under-provision problem. Our result helps explain why international joint ventures are so popular despite the fact that they suffer from the input under-provision problem.

2. A Model of a Joint Venture

Two agents, called 1 and 2, form a joint venture to produce a good. The input (effort) of agent i is denoted by x_i. The production function of the joint venture is given by

$$Q = \varepsilon x_1^{\alpha_1} x_2^{\alpha_2}; \qquad \alpha_1 + \alpha_2 < 1;$$

where ε is a random variable with $E(\varepsilon) = 1$ and variance σ^2.[3] The demand function for the product is $P = P(Q)$ with $P'(Q) < 0$. Let θ_i denote agent i's share of the total revenue of the joint venture ($\theta_1 + \theta_2 = 1$). While the two partners share revenue, the cost of providing each input is private. For simplicity, assume the unit cost of input i is w_i. Both partners are risk neutral and maximize their expected profits.

As is in the literature, we assume that the realization of ε is unobservable to both parties and that input levels are unverifiable. Therefore, contracts based

[2] See also Child (1998) and China Joint Venturer (1996) for analyses of joint ventures in China.

[3] Alternatively, we can consider the case where $Q = x_1^{\alpha_1} x_2^{\alpha_2} + \varepsilon$, and $E(\varepsilon) = 0$. It is easy to see that our results for the linear demand case still hold under this formulation. However, for the case of constant elasticity demand, analytical results are difficult to derive.

on input levels are not feasible.[4] Given this, the partners choose their inputs non-cooperatively and simultaneously. Therefore, partner i solves the following problem to maximize its expected profit:

$$\max \ \theta_i E\left(P(Q)Q\right) - w_i x_i$$

The first order condition for the above problem is

$$\theta_i E\left(P\frac{\partial Q}{\partial x_i}\right) - w_i + \theta_i E\left(P'\frac{\partial Q}{\partial x_i}Q\right) = 0 \qquad (2.1)$$

The first two terms on the LHS of the above equation captures the problem of under-provision of inputs: while each partner bears the full cost of providing its input (w_i) it receives only a fraction of the marginal benefit of its input since part of the additional revenue generated accrues to its partner ($\theta_i < 1$). The third term on the LHS of equation (2.1) captures the other type of externality that exists in a joint venture with market power, the focus of this paper. An increase in agent i's input also reduces the price of the product (due to increase in output) and this decrease in price lowers the expected total revenue of the joint venture. Since only a fraction of θ_i of this effect is internalized by agent i, its input choice exerts a negative externality on its partner. Thus, relative to a joint venture that is a price-taker ($P' = 0$), the problem of under-provision of inputs is less severe in the presence of market power. In what follows, we illustrate this result for two different demand functions.

2.1. Linear Demand

First consider the case of linear demand: $P = a - bQ$. While choosing its input partner i solves the following problem:

$$\max \ \theta_i E((a - bQ)Q) - w_i x_i$$

$$\text{subject to} \qquad Q = \varepsilon x_1^{\alpha_1} x_2^{\alpha_2}$$

Taking the first order condition, we obtain

$$x_i = \frac{\theta_i \alpha_i \left[a - 2bE(\varepsilon^2)\overline{Q}\right]\overline{Q}}{w_i}; \quad \text{where } \overline{Q} \equiv x_1^{\alpha_1} x_2^{\alpha_2}.$$

[4] Note that the purpose of this paper is not to explain the existence of joint ventures. Rather, it examines how market power affects the magnitude of the input under-provision problem within a joint venture, given that it exists.

Substituting the above equation into the production function yields the expected level of the Nash equilibrium output of the joint venture

$$Q^e = \theta_1^{\alpha_1}\theta_2^{\alpha_2}\left(\frac{\alpha_1}{w_1}\right)^{\alpha_1}\left(\frac{\alpha_2}{w_2}\right)^{\alpha_2}\left[aQ^e - 2bE(\eta^2)(Q^e)^2\right]^{\alpha_1+\alpha_2} \tag{2.2}$$

If the two partners could coordinate their actions to maximize joint profits, they would choose x_1 and x_2 to solve the following problem:

$$\max \; E\left((a - bQ)Q\right) - w_1x_1 - w_2x_2$$

$$\text{subject to} \quad Q = \eta x_1^{\alpha_1}x_2^{\alpha_2}$$

Taking the first order conditions and solving for x_i, we obtain

$$x_i = \frac{\alpha_i\left[a - 2bE(\eta^2)\overline{Q}\right]\overline{Q}}{w_i}$$

Substituting x_i into the production function, we get the expected level of the jointly optimal output of the joint venture

$$Q^* = \left(\frac{\alpha_1}{w_1}\right)^{\alpha_1}\left(\frac{\alpha_2}{w_2}\right)^{\alpha_2}\left[aQ^* - 2bE(\eta^2)(Q^*)^2\right]^{\alpha_1+\alpha_2} \tag{2.3}$$

To illustrate the ranking of the two output levels, let us consider the case that $\alpha_1 + \alpha_2 = 1/2$. In this case, we can solve equations (2.2) and (2.3) explicitly to get

$$Q^e = \frac{a}{2bE\eta^2 + [\delta/(\theta_1^{\alpha_1}\theta_2^{\alpha_2})]^2} \quad \text{and} \quad Q^* = \frac{a}{2bE\eta^2 + \delta^2}$$

where

$$\delta \equiv 1/\left[\left(\frac{\alpha_1}{w_1}\right)^{\alpha_1}\left(\frac{\alpha_2}{w_2}\right)^{\alpha_2}\right].$$

Since $\theta_1^{\alpha_1}\theta_2^{\alpha_2}$ is always less than 1, it follows that $Q^e < Q^*$. Thus, the under-provision of input problem continues to exist. The degree of this problem can be measured by the ratio of the two output levels

$$r(b) \equiv \frac{Q^e}{Q^*} = \frac{2bE\eta^2 + \delta^2}{2bE\eta^2 + [\delta/(\theta_1^{\alpha_1}\theta_2^{\alpha_2})]^2}$$

Note that the ratio $r(b)$ is an increasing function of b. If $b = 0$, we have $r(0) = [\theta_1^{\alpha_1}\theta_2^{\alpha_2}]^2$ which is nothing but the ratio derived under the price-taking assumption.

As b increases, the ratio r also increases. Hence, the problem of under-provision of inputs becomes less severe as the demand curve becomes steeper.[5] The intuition for this can be seen in terms of the first order condition in its general form, equation (2.1): as b increases, the negative externality in the input decisions becomes stronger ($P' = b$). Thus, the positive externality that leads to the under-production problem plays a weaker role in equilibrium. As a result, Q^e is closer to Q^*. Lastly, note that as b goes to infinity the ratio r approaches unity so that the under-production problem vanishes in the limit.

Next we turn to our second example.

2.2. Constant Elasticity Demand

Suppose that the demand function is given by $P = Q^{-\epsilon}; \epsilon > 0$. As before, partner i in the joint venture solves the following problem:

$$\max \theta_i E(PQ) - w_i x_i = \theta_i E(\eta x_1^{\alpha_1} x_2^{\alpha_2})^{1-\epsilon} - w_i x_i$$

which yields

$$x_i = \frac{\theta_i \alpha_i (1-\epsilon) E(\eta^{1-\epsilon})}{w_i} \overline{Q}^{1-\epsilon}; \quad \text{where } \overline{Q} \equiv x_1^{\alpha_1} x_2^{\alpha_2}.$$

Substituting x_i into the production function, and solving for the expected Nash equilibrium output level, we get:

$$Q^e = (\theta_1^{\alpha_1}\theta_2^{\alpha_2})^{\frac{1}{1-(1-\epsilon)(\alpha_1+\alpha_2)}} \left(\frac{\alpha_1(1-\epsilon)E\eta^{1-\epsilon}}{w_1} \right)^{\frac{\alpha_1}{1-(1-\epsilon)(\alpha_1+\alpha_2)}} \left(\frac{\alpha_2(1-\epsilon)E\eta^{1-\epsilon}}{w_2} \right)^{\frac{\alpha_2}{1-(1-\epsilon)(\alpha_1+\alpha_2)}} \quad (2.4)$$

Under coordination, x_1 and x_2 would be chosen to solve the following problem:

$$\max E(PQ) - w_1 x_1 - w_2 x_2 = E(Q^{1-\epsilon}) - w_1 x_1 - w_2 x_2$$

subject to

$$Q = \eta x_1^{\alpha_1} x_2^{\alpha_2}$$

Taking the first order conditions, we obtain

$$x_i = \frac{\alpha_i (1-\epsilon) E(\eta^{1-\epsilon})}{w_i} \overline{Q}^{1-\epsilon}$$

[5] It is also easy to see that the difference between the optimal output and the Nash equilibrium output decreases with b.

Substituting this into the production function, and solving for the jointly optimal output level, we get

$$Q^{*} = \left(\frac{\alpha_1(1-\epsilon)}{w_1}\right)^{\frac{\alpha_1}{1-(1-\epsilon)(\alpha_1+\alpha_2)}}\left(\frac{\alpha_2(1-\epsilon)}{w_2}\right)^{\frac{\alpha_2}{1-(1-\epsilon)(\alpha_1+\alpha_2)}}\left(E(\eta^{1-\epsilon})\right)^{\frac{\alpha_1+\alpha_2}{1-(1-\epsilon)(\alpha_1+\alpha_2)}} \tag{2.5}$$

As before, we calculate the ratio of the Nash equilibrium output to the optimal output:

$$r(\epsilon) \equiv \frac{Q^e}{Q^*} = (\theta_1^{\alpha_1}\theta_2^{\alpha_2})^{\frac{1}{1-(1-\epsilon)(\alpha_1+\alpha_2)}} \tag{2.6}$$

which is obviously smaller than 1 (under-provision of inputs). When $\epsilon = 0$, we have

$$r(0) = (\theta_1^{\alpha_1}\theta_2^{\alpha_2})^{\frac{1}{1-(\alpha_1+\alpha_2)}}$$

which is simply the ratio of the two output levels derived under the price-taking assumption. Note that $r(\epsilon)$ is an increasing function of ϵ. In other words, as the demand becomes less elastic ($1/\epsilon$ becomes smaller), the problem of under-provision of inputs becomes less severe. The intuition for this is as follows: as the elasticity of the demand decreases, a given increase in output (caused by an increase in a partner i's effort) leads to a larger reduction in the price level. Therefore, the negative externality imposed by agent i on its partner increases. As a result, the severity of the under-provision problem is reduced. When ϵ approaches infinity we have $Q^e = Q^*$: the under-production problem vanishes in the limit as demand becomes perfectly inelastic.

3. Conclusion

It is well understood that joint production in partnerships, such as international joint ventures, suffers from the problem of under-provision of inputs since each partner only partially benefits from its effort. We argue in this paper that if joint ventures enjoy market power, as they often do, the extent of the under-provision problem is reduced. This is because, under market power, output must be restricted to maximize profits but each partner fails to take into account the adverse impact of increasing its input on its partner. Thus, the pecuniarily externality that operates through the market can counter-act the positive externality that plagues the level of input provision within a joint venture. We explicitly demonstrate this result for two different demand functions. As can be seen, our results also apply to partnerships in general.

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