Ownership Structure, Input Control and Bargaining in China's Processing Firms

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Abstract

This paper models the bargaining process between foreign investor and local managers. Their decision to engage in a joint processing firm or rely on spot markets for outsourcing will be determined by their strategic choices. Through bargaining, they will decide who should own the jointly set up processing firm and who will control input purchases, when they contract. Thickness of the market and alternative opportunity beside the joint project will affect their strategic decision in the bargaining process. This paper combines non cooperative game and cooperative game approach to model the bargaining process, and discuss interesting results gleaned by the model. When the market is thin, parties prefer owning the processing firm and controlling input purchases at the same time. However, when thickness of the market is increased, the processing firm tends to split factory ownership and input control in the equilibrium arrangement. Foreign investor will gravitate towards controlling the ownership of the processing firm, while local managers will incline to take charge of input sourcing. This implication fits well with empirical finding about the organizational form of China's processing firms. My model also forecasts that as the market becomes thicker and transactions are more efficient, contractual outsourcing with unrelated parties in the spot market will be more desirable and pervasive than pure engagement in the processing firm.

Keywords: Nash Bargaining, Ownership structure, Input Control, Outsourcing, Integration, Market Efficiency, Transaction Cost

Introduction

The decision to choose vertical integration or outsourcing is fundamental to any issue of industrial organization, especially when applied to international firms. Facing a host of complicated activities, which may range from product design to components production, from assembly to shipping, from marketing to final sale, firms have to decide whether to undertake the activity inside the firm or to purchase it from outside (Grossman and Helpman 2001). Although firms can integrate all the activities inside the firm, an increasing tendency indicates that firms seem to subcontract an ever expending set of activities. Vertical disintegration is especially evident in international trade (Abraham and Taylor 1996, Grossman and Helpman 2005).

Antras (2003, 2005), Antras and Helpman (2004), Grossman and Helpman (2004), and Feenstra and Hanson (2005), address the choice between vertical integration and the purchase of a specialized input through contractual outsourcing. McLaren (2000) and Grossman and Helpman (2002, 2005) emphasize the importance of the "thickness of the market" in determining the probability that final-good firms and suppliers of specialized inputs find an appropriate match so that investment and production can take place. Spencer and Qiu (2001), Qiu and Spencer (2002), Head, Ries, and Spencer (2004), and Feenstra and Spencer (2005), take a partial equilibrium approach and suggest outsourcing rather than vertical integration as a solution to this decision.

As Barbara Spencer (2005) describes:

"The growing importance of the international procurement of intermediate inputs either through outsourcing or within the firm, through foreign direct investment, cannot be explained by traditional trade theories that abstract from vertical fragmentation and contractual relationships between buyers and suppliers. Consequently, researchers have been motivated to enrich international trade theory with concepts from industrial organization and contract theory that explain the organizational form of the firm. The combination of trade with the choice of organizational form represents an important new area for both theoretical and empirical research."

Building on this literature, this paper tries to model the bargaining process between foreign investor and local managers. Their decision to engage in a joint processing firm or rely on spot markets for outsourcing will be determined by their strategic choices. Through bargaining, they will decide who should own the jointly set up processing firm and who will control input purchases, when they contract. Thickness of the market and alternative opportunity beside the joint project will affect their strategic decision in the Nash bargaining process. This paper will discuss interesting results gleaned by the model. When the market is thin, parties prefer owning the processing firm and controlling input purchases at the same time. However, when thickness of the market is increased, the processing firm tends to split factory ownership and input control in the equilibrium arrangement. Foreign investor will gravitate towards controlling the ownership of the processing firm, while local managers will incline to take charge of input sourcing. This implication fits well with Feenstra and Gordon's (2005) empirical finding about the organizational form of China's processing firms. My model also forecasts that as the market becomes thicker and transactions are more efficient, contractual outsourcing with unrelated parties in the spot market will be more desirable and pervasive than pure engagement in the processing firm.

Export processing firms in China

Export processing has played a major role in China's foreign trade and economic growth during past decades. Over the years 1997-2002, processing export accounted for 55.6% of China's total export (Feenstra and Hanson 2005). An export processing firm imports or purchases domestically intermediate inputs, processes them and exports the final good. There are roughly two regulatory regimes for export processing in China. One is the Pure-Assembly regime, and the other is the Import-and-Assembly regime. In the Pure-Assembly regime, the factory in China receives orders from a foreign client and processes imported materials, which belong to the foreign client. Final goods will be sold by that foreign client. The factory in China only receives a payment for its processing service. In the Import-and-Assembly regime, the processing factories in China import the materials they need in the production and control the ownership of these materials. They can also process goods for multiple foreign firms. In this regime, the factory in China controls both the inputs and the

export of the processed goods, but the marketing and sale of the good is still controlled by the foreign firm. Thus a Chinese manager plays an active role and has greater responsibility in the Import-and-Assembly regime. The processing factory could be owned by either a Chinese or foreigner, but foreign invested enterprises (FIEs) play a major role, which account for 62.8% of China's processing export from 1997-2002 (Feenstra and Hanson 2005) . The foreign invested enterprises include wholly foreign-owned and equity joint ventures[1].

The significance of the arrangement of ownership and input control rights in the processing firms was initially demonstrated by Feenstra and Hanson (2003, 2005). They tried to develop a property-right model, which applies a Nash bargaining solution to explain surplus division between foreign firm and Chinese manager. They applied this model to estimate China's export processing industry. Their paper provides fertile ground for further research into the theory of the firm. However, their model is incomplete as they only analyzed effort inputs by both parties and indicated relative threat points of both parties, which relates to different kinds of ownership and input right arrangements. Their model failed to demonstrate sufficiently how the threat points of the parties play a role in the bargaining process. They studied the modularity of the surplus function and analyzed when it would be optimal for the same party to control both the input and the factory or to split the rights. Obviously, this surplus function is measured by a third party, who is not involved in the bargaining. They failed to further the story by illustrating how the parties involved in the bargaining decide the firm's organizational form by their own interactive and strategic decision process. With the aggregative surplus function, their paper fails to ask an interesting question: when is it optimal for the foreign firm or the local manager to control the input or the ownership of the factory? To my understanding, their paper is only intended to provide just a simple model to facilitate their estimation of the China's processing firms.

[1] An equity joint venture will be considered as foreign control when a foreign interest has at least a 25% ownership stake.

Table 6-1 Foreign ownership, export processing, and trade in China

Year	Processing exports/Total exports	FIE exports/Total exports	Share in total processing exports	
			Import-and-assembly	FIE exports
1997	0.545	0.361	0.704	0.561
1998	0.568	0.393	0.705	0.587
1999	0.568	0.413	0.677	0.609
2000	0.552	0.439	0.701	0.646
2001	0.554	0.462	0.714	0.669
2002	0.550	0.484	0.741	0.697

From Feenstra and Hanson 2005, and update from Chinese export data from the Customs General Administration of the People's Republic of China

We will explore the specific decision process of the foreign investors and local managers in the export industry to answer the classic question whether to go for integration or market contracts. Furthermore, we will investigate the type of arrangement of the organizational form when both parties decide to integrate to set up a processing firm. We want to model the mechanism which inspires the choice of the organizational form and switch from engagement in processing firm to a contractual market outsourcing under the background of the evolution of market thickness.

This paper will provide a frame which enables us to compare different ownership and input control arrangements in the scope of Nash equilibria analysis. We want to specify conditions for the optimal arrangement in which each party is engaged in specific assignment. Our analysis will help to answer the questions below:

1. When is the engagement in the processing firm more desirable for the parties than contractual outsourcing in the market?
2. When is the ownership of the processing firm essential and important? Or in other words, what is the condition for the foreign firm or local manager to control the firm, and which is optimal for both parties?

3. When is it efficient to split or unify the rights, which include ownership and input control between foreign investor and local manager?

A Model on ownership and input control arrangement

The model is presented as the following. There is a potential project, which needs the cooperation between foreign firm and Chinese manager to make a profit. A single product will be made in China and sold abroad. The project requires parties to purchase inputs from markets, process the inputs into a final product, and sell the final product. There are three steps for the project: input sourcing, processing and selling.

From the introduction about two kinds of export processing regimes in China, we can find that, in a processing firm, processing will be issued to a Chinese manager, who will hire local workers to process the inputs into a final good. Since they have comparative advantage in the knowledge of the local conditions, a Chinese manager will control the processing right naturally. Meanwhile, the marketing and selling of the product will be the advantage of the foreign firm, who will sell the product abroad. However, who should control the input purchase is not predetermined. Both foreign firm and Chinese manager have incentives to take on the job.

Ownership of the processing firm will be decided by the negotiation between parties. Both foreigner and Chinese could be the owner of the firm. The eventual owner will claim the residual right of the profit; also he has the power to determine who will be in charge of the sourcing of inputs. If both parties decide to engage in the project, they cooperate in the processing firm and agree to divide the profit based on Nash bargaining. But, if their bargaining fails to yield a solution, they will turn to outsourcing and contract with unrelated parties in spot market.

From the table 6-2 below, we can find the combinations between the ownership and progress rights

Table 6-2 Rights in the processing firm

Ownership	Progress rights		
	Input sourcing	Processing	Selling
Foreign control	By foreigner	By domestic only	By foreigner only
	By domestic manager		
Domestic control	By foreigner		
	By domestic manager		

The game: Rights arrangement and Nash bargaining

Biform game[2]

Both non cooperative game and cooperative game have been combined to analyze the bargaining process. There are two stages in this process. In the first stage, foreign investor and domestic manager choose their strategies to decide what kind of rights they prefer to control. This is a non cooperative game process. They try to match their choices, which results in the engagement in the firm or outsourcing in the spot market. In the second stage, after they engaged in the firm, they distribute the profit of the firm by a cooperative approach. I use Nash bargaining solution to model the second stage distribution.

Why Nash bargaining?

Incomplete contracts are increasingly applied in recent trade models (Spencer 2005). Since such a contract is incomplete, each person involved in the firm has an incentive to achieve a larger component in the final distribution by bargaining. They will bargain based on his reserve condition, which is the threat point in the Nash bargaining solution. So it is natural for us to apply the Nash bargaining in the analysis of distribution in the processing firm. Furthermore, threats are important in the bargaining process, and the threat point will factor in from his previous choice of ownership and input control rights, which we call path dependent

[2] Although I have used the approach, which combined the non cooperative and cooperative game, to describe the bargaining process, I found the term "biform game" from Brandenburger and Stuart (2006), which express exactly what my approach essentially is, and save my time to defend my approach from the arguments that question my model.

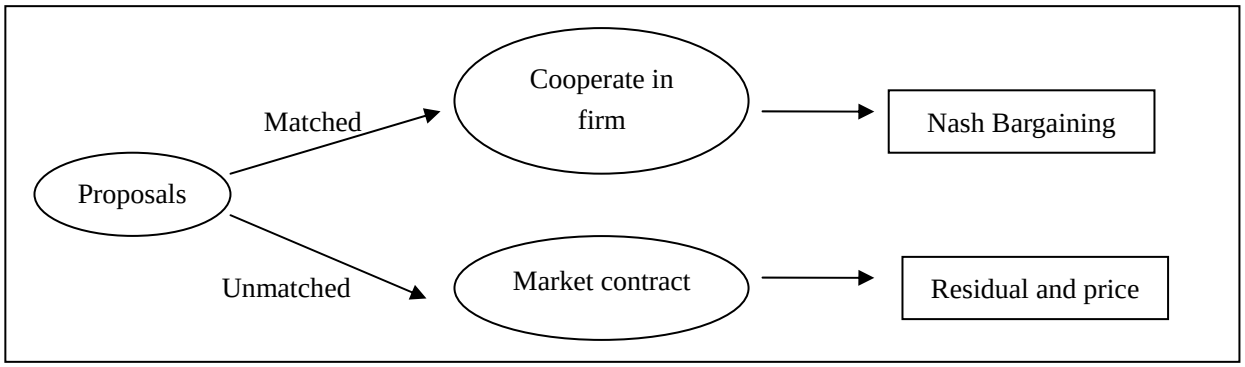
relationship between the initial arrangement and later bargaining opportunities.

Timing of the game

At period 0, both foreign firm and domestic manager meet together and disclose their proposals on the arrangement of the ownership and progress rights.

Period 1, they will find out the other's proposal. If their proposals match, for example, foreign firm's proposal is "ownership is foreign control and input sourcing is controlled by domestic manager" and domestic manager's proposal is the same, then they will initiate the project according to the proposal and profit will be divided by Nash bargaining. However, if their proposals can't match, to illustrate, foreign firm's proposal is "ownership is controlled by himself and input sourcing is also controlled by him" but domestic manager's proposal is "ownership is domestic control, and input sourcing is foreign control", they turn to a market contract with an unrelated party to outsource the job. For foreign firm with the proposal "ownership is controlled by himself and input sourcing is also controlled by himself", he will hire someone in the market to do processing and pay a market price for it. Similarly, the domestic manager has to hire someone in the market to sell the product, but do the input sourcing by himself[3].

Figure 6-1



[3] We will assume later that hiring someone from the market will cause a loss of efficiency, due to transaction cost and supervision difficulty, compared with the cooperator's job in the firm.

Period 2, both parties invest their efforts, and a product is produced and sold. Both parties get their payoff from either the project or the market contract.

Actions, strategies, and outcomes

We have introduced two kinds of export processing regimes in China. In both regimes, processing will be taken on by a domestic manager and the selling of the products will be undertaken by the foreign firm. Besides the processing and selling, parties will decide their choices of the ownership and input sourcing right, which will be their actions in the game (please look at table 6-2).

We define α to present the ownership, where $\alpha = 0$ means the foreign firm will control the ownership of the processing firm, and $\alpha = 1$ means that the domestic manager is the owner. Similarly, we define β to present the input sourcing right, and $\beta = 0$ means that foreign firm will do the input sourcing, or $\beta = 1$ means domestic manager will do the input sourcing.

Then (α , β) will be the action combination for both parties. For foreign firm, (0, 1) means he will control the ownership but ask the domestic manager to do the input sourcing.

Strategy will be the strategic actions of one party according to the other party's action. For example, for foreign firm, the strategy [(0, 1), (0, 1)] will be the case that when domestic manager chooses (0, 1), he will choose (0, 1) accordingly.

As we have described in the timing process, if both parties' actions match up with each other, they will engage in the firm, produce and sell the products. Profit will be divided by Nash bargaining. However, if both parties' actions do not match, then they will turn to the market to sign a contract with someone else to finish the job

under the cost of market price and suffer a loss in the transaction. Before we analyze the outcome, we have two interrelated assumptions on this.

A1: when there is a failure to match, the party owning the firm is entitled to the residual profits and completes the job by contracting for the services in the spot market. The party who does not own the firm will sell his service in the market.

A2: Under the spot market contract, parties earn only a fraction of their marginal productivity. The marginal productivity of their efforts are reduced by ψ, with $0 \le \psi \le 1$, so the payoff are $(1-\psi)$ times the first-best level. The owner of the firm also earns only $(1-\psi)$ times the profit. ψ could be considered as a coefficient of transaction cost or loss.

Efforts, production and profit

The efforts undertaken in Period 2 are as follows: e_1, effort devoted to searching for a low-priced input, by either foreigner or local manager; e_2, effort devoted to processing the input to produce final good by the local manager; e_3, effort devoted to marketing and selling the final good, by the foreign firm.

Following the literature (Baker et al 2003, Feenstra and Gordon 2005), we define the profit function. Cost of input sourcing is given by the linear function $P \cdot (1-e_1)$, where $P > 0$ and $0 \le e_1 \le 1$, so that more search effort e_1 will lower the input price. The cost of input processing is given by $A \cdot (1-e_2)$, where $A > 0$ and $0 \le e_2 \le 1$, so effort e_2 lowers processing cost. Revenue from final sale is given by $B \cdot (1+\lambda e_2 + e_3)$, where $0 \le \lambda \le 1$, $0 \le e_3 \le 1$ and $B > A + P > 0$. Here, more e_2 and e_3 will raise the revenue, which indicates that better processing and more marketing effort will lead to a higher sale

revenue, but e_3 has a larger impact on the selling than e_2. But e_1 has not directly effect on final sale. $B > A + P > 0$ will promise that the residual of the profit is not negative, so that people has incentive to be owner to claim the residual right.

Then we get the profit function as below:

$$\pi = B(1+\lambda e_2 + e_3) - A(1-e_2) - P(1-e_1)$$

Rearrange the profit function, we get,

$$\pi = (B - A - P) + P \cdot e_1 + (B\lambda + A) \cdot e_2 + B \cdot e_3$$

We assume the cost to foreign firm is given by

$$C_F(e_1, e_3) = \frac{1}{2}(e_1^2 + e_3^2)$$

And for local manager[4] is

$$C_L(e_1, e_2) = \frac{1}{2}(e_1^2 + e_2^2)$$

We have introduced β to present the input sourcing right. $\beta = 0$ means the foreign firm will do the input sourcing, and $\beta = 1$ means domestic manager will do the input sourcing.

Then we get:

$$C_F[(1-\beta) \cdot e_1, e_3] = \frac{1}{2}[(1-\beta) \cdot e_1^2 + e_3^2]$$

$$C_L(\beta \cdot e_1, e_2) = \frac{1}{2}(\beta \cdot e_1^2 + e_2^2)$$

Profit distribution and Nash bargaining

We define the solution for Nash Bargaining as below, following the Proposition 2-1 in Zhang Juyan (2005),

$$\underset{\pi_F, \pi_L}{Max}(\pi_F - \bar{U}_F)(\pi_L - \bar{U}_L)$$

[4] Here we simplify the situation to assume that the disutility of the effort is the same for both foreign firm and local manager, and also the same among different kind of efforts.

$$\text{s.t. } \pi_F + \pi_L = \pi$$

Here $\pi = (B - A - P) + P \cdot e_1 + (B\lambda + A) \cdot e_2 + B \cdot e_3$, and π_F is the bargaining outcome for foreign firm to get from the total profit π, and $\bar{U}_F$ is the threat point for foreign firm. Similarly, π_L is the bargaining outcome for local manager to get from the total profit π, and $\bar{U}_L$ is the threat point for local manager. To simplify, we assume both parties have the same bargaining skill.

From the Proposition 2-1 in Zhang (2005), we get the solution for this maximization of Nash Product as below:

$$\pi_F = \frac{1}{2}(\pi + \bar{U}_F - \bar{U}_L)$$
$$\pi_L = \frac{1}{2}(\pi + \bar{U}_L - \bar{U}_F)$$

The solutions are the payoffs for both parties. Then each party will choose their effort levels to maximize the difference between these payoffs and their cost of effort:

For foreign firm:

$$\underset{(1-\beta)e_1, e_3}{Max}\ U_F = \pi_F - C_F[(1-\beta) \cdot e_1, e_3]$$

For local manager:

$$\underset{\beta e_1, e_2}{Max} U_L = \pi_L - C_L(\beta \cdot e_1, e_2)$$

Where $\beta = 0$ means foreign firm will do the input sourcing, and $\beta = 1$ means domestic manager will do the input sourcing.

Threat points

Threat points will depend on different situations which will be described by the parameters α and β, that

means different arrangement of the ownership and progress rights will lead to different threat points. We will then specify the different kinds of threat points according to initial actions and market contracting.

Threat point means the breaking down of the bargaining. The party who owns the firm will turn to market to sign contract with unrelated someone and pay the cost to finish the project. The party who does not own the firm will try to sell their service in the market. However, as described by A2, we assume there is a transaction loss, and parties earn only a fraction of their marginal products $1-\psi$.

We have the threat points as below:

$$\bar{U}_F = \bar{\pi}_F(\alpha,\beta) - C_F(\alpha,\beta) \quad \text{and}$$

$$\bar{U}_L = \bar{\pi}_L(\alpha,\beta) - C_L(\alpha,\beta) ,$$

where $\alpha \in \{0,1\}$ and $\beta \in \{0,1\}$

For $\bar{\pi}_F(0,0)$ and $\bar{\pi}_L(0,0)$, it means that the foreign firm owns the processing firm and also controls the input sourcing; the local manager is only responsible for input processing. In this case, if bargaining breaks down, the owner(foreign firm) will turn to market to sign a contract with some other local manager to do the processing job. In this case, the foreign firm will have to pay the new local manager according to his marginal contribution to total profit, and suffer a reduction of the total profit by ψ, which represents the market transaction cost. Then we get,

$$\bar{\pi}_F(0,0) = (1-\psi)[(B-A-P) + P\cdot e_1 + (B\lambda + A)\cdot e_2 + B\cdot e_3 - (B\lambda + A)\cdot e_2]$$

Here $(B\lambda + A)\cdot e_2$ is the payment to the contracting local manager. So we have,

$$\bar{\pi}_F(0,0) = (1-\psi)[(B-A-P) + P\cdot e_1 + B\cdot e_3]$$

For the local manager, now he has to sell his service in the market. Since he does not own the firm, neither does he control input sourcing, he will just sign a contract with another foreign firm to provide processing job, his reward will be,

$$\bar{\pi}_L(0,0) = (1-\psi)[(B\lambda + A)\cdot e_2]$$

Similarly, For $\bar{\pi}_F(0,1)$ and $\bar{\pi}_L(0,1)$, we have,

$$\bar{\pi}_F(0,1) = (1-\psi)[(B-A-P) + P\cdot e_1 + (B\lambda + A)\cdot e_2 + B\cdot e_3 - P\cdot e_1 - (B\lambda + A)\cdot e_2]$$

That is $\bar{\pi}_F(0,1) = (1-\psi)[(B-A-P) + B\cdot e_3]$

And $\bar{\pi}_L(0,1) = (1-\psi)[P\cdot e_1 + (B\lambda + A)\cdot e_2]$

For $\bar{\pi}_F(1,1)$ and $\bar{\pi}_L(1,1)$, we have,

$$\bar{\pi}_F(1,1) = (1-\psi)(B\cdot e_3)$$

$$\bar{\pi}_L(1,1) = (1-\psi)[(B-A-P) + P\cdot e_1 + (B\lambda + A)\cdot e_2]$$

For $\bar{\pi}_F(1,0)$ and $\bar{\pi}_L(1,0)$, we have,

$$\bar{\pi}_F(1,0) = (1-\psi)(P\cdot e_1 + B\cdot e_3)$$

$$\bar{\pi}_L(1,0) = (1-\psi)[(B-A-P) + (B\lambda + A)\cdot e_2]$$

We get the table 6-3 as below:

Table 6-3 Profit in threat points under specific arrangement of the ownership and progress rights

		β	
		$\beta=0$	$\beta=1$
α	$\alpha=0$	$\bar{\pi}_F(0,0)=(1-\psi)[(B-A-P)+P\cdot e_1+B\cdot e_3]$ $\bar{\pi}_L(0,0)=(1-\psi)[(B\lambda+A)\cdot e_2]$	$\bar{\pi}_F(0,1)=(1-\psi)[(B-A-P)+B\cdot e_3]$ $\bar{\pi}_L(0,1)=(1-\psi)[P\cdot e_1+(B\lambda+A)\cdot e_2]$
	$\alpha=1$	$\bar{\pi}_F(1,0)=(1-\psi)(P\cdot e_1+B\cdot e_3)$ $\bar{\pi}_L(1,0)=(1-\psi)[(B-A-P)+(B\lambda+A)\cdot e_2]$	$\bar{\pi}_F(1,1)=(1-\psi)(B\cdot e_3)$ $\bar{\pi}_L(1,1)=(1-\psi)[(B-A-P)+P\cdot e_1+(B\lambda+A)\cdot e_2]$

Maximize the difference between these payoffs and the costs of efforts for each party, that is

$$\underset{e}{Max}\bar{U}=\bar{\pi}-C(e)$$

We get

Table 6-4 utility level of threat points under specific arrangement of the ownership and progress rights

		β	
		$\beta=0$	$\beta=1$
α	$\alpha=0$	$\bar{U}_F(0,0)=(1-\psi)(B-A-P)+\frac{1}{2}(1-\psi)^2(P^2+B^2)$ $\bar{U}_L(0,0)=\frac{1}{2}(1-\psi)^2(B\lambda+A)^2$	$\bar{U}_F(0,1)=(1-\psi)(B-A-P)+\frac{1}{2}(1-\psi)^2B^2$ $\bar{U}_L(0,1)=\frac{1}{2}(1-\psi)^2[P^2+(B\lambda+A)^2]$
	$\alpha=1$	$\bar{U}_F(1,0)=\frac{1}{2}(1-\psi)^2(P^2+B^2)$ $\bar{U}_L(1,0)=(1-\psi)(B-A-P)+\frac{1}{2}(1-\psi)^2(B\lambda+A)^2$	$\bar{U}_F(1,1)=\frac{1}{2}(1-\psi)^2B^2$ $\bar{U}_L(1,1)=(1-\psi)(B-A-P)+\frac{1}{2}(1-\psi)^2[P^2+(B\lambda+A)^2]$

From the table above, we can find that $\bar{U}_F(0,0)>\bar{U}_F(0,1),\bar{U}_F(1,0)>\bar{U}_F(1,1)$, Similarly

$\bar{U}_L(1,1) > \bar{U}_L(0,1), \bar{U}_L(1,0) > \bar{U}_L(0,0)$. It can be explained that in the market contracting situation, owning the firm and controlling input sourcing will be better than all the other possible arrangements, since the residual right will benefit the claimant. It is intuitive that in the market, being the boss and doing more tasks by yourself will lead to higher utility level. The case without ownership and controlling of input sourcing will be the worst situation when they turn to market contracting.

We have showed that, $\pi_F = \frac{1}{2}(\pi + \bar{U}_F - \bar{U}_L)$, and $\pi_L = \frac{1}{2}(\pi + \bar{U}_L - \bar{U}_F)$, then we will calculate $\pi_F(\alpha, \beta)$ and $\pi_L(\alpha, \beta)$ respectively, and maximize

$$\underset{e}{Max} U_F(\alpha, \beta) = \pi_F(\alpha, \beta) - C_F(e) \text{ and}$$

$$\underset{e}{Max} U_L(\alpha, \beta) = \pi_L(\alpha, \beta) - C_L(e)$$

Then we get $U_F(\alpha, \beta)$ and $U_L(\alpha, \beta)$ as showed in Table 6-5

Table 6-5 Nash Bargaining outcome and utility level

		β	
		$\beta = 0$	$\beta = 1$
α	$\alpha = 0$	$U_F(0,0) = \frac{2(2-\psi)(B-A-P)+[\frac{1}{2}+(1-\psi)^2]P^2+(2\psi-\psi^2)(B\lambda+A)^2+[\frac{1}{2}+(1-\psi)^2]B^2}{4}$ $U_L(0,0) = \frac{2\psi(B-A-P)+(2\psi-\psi^2)P^2+[\frac{1}{2}+(1-\psi)^2](B\lambda+A)^2+(2\psi-\psi^2)B^2}{4}$	$U_F(0,1) = \frac{2(2-\psi)(B-A-P)+(2\psi-\psi^2)P^2+(2\psi-\psi^2)(B\lambda+A)^2+[\frac{1}{2}+(1-\psi)^2]B^2}{4}$ $U_L(0,1) = \frac{2\psi(B-A-P)+[\frac{1}{2}+(1-\psi)^2]P^2+[\frac{1}{2}+(1-\psi)^2](B\lambda+A)^2+(2\psi-\psi^2)B^2}{4}$
	$\alpha = 1$	$U_F(1,0) = \frac{2\psi(B-A-P)+[\frac{1}{2}+(1-\psi)^2]P^2+(2\psi-\psi^2)(B\lambda+A)^2+[\frac{1}{2}+(1-\psi)^2]B^2}{4}$ $U_L(1,0) = \frac{2(2-\psi)(B-A-P)+(2\psi-\psi^2)P^2+[\frac{1}{2}+(1-\psi)^2](B\lambda+A)^2+(2\psi-\psi^2)B^2}{4}$	$U_F(1,1) = \frac{2\psi(B-A-P)+(2\psi-\psi^2)P^2+(2\psi-\psi^2)(B\lambda+A)^2+[\frac{1}{2}+(1-\psi)^2]B^2}{4}$ $U_L(1,1) = \frac{2(2-\psi)(B-A-P)+[\frac{1}{2}+(1-\psi)^2]P^2+[\frac{1}{2}+(1-\psi)^2](B\lambda+A)^2+(2\psi-\psi^2)B^2}{4}$

Now let us go back to the beginning of the game at Period 0, where both foreign firm and local manager meet and disclose their proposals on the arrangement of the ownership and progress rights. Their proposals will be the combination between ownership and input sourcing right, which is expressed as $\{\alpha, \beta\}$. For example, if foreign firm reveals his proposal as $\{\alpha = 0, \beta = 1\}$, which indicates that the foreign firm wants to own the firm but ask the local manager to do the input sourcing. As indicated by the figure 6-1, if the proposal of the local manager matches the foreign firm's, then they will cooperate to set up the processing firm following the arrangement of the proposal, and divide the profit by Nash bargaining. If they fail to match, each party will do his scheduled job. When he intends to be owner, he will set up the firm, finish part of the job and turn to the market to sign a contract with an unrelated party to finish the rest task, and get the utility level which is $\bar{U}_F(0,0)$ or $\bar{U}_F(0,1)$ for the foreign firm, and $\bar{U}_L(1,0)$ or $\bar{U}_L(1,1)$ for the local manager. When he is not the owner, he will just sell his work in the market, the utility level for them to get are $\bar{U}_F(1,0)$ or $\bar{U}_F(1,1)$ for foreign firm, and $\bar{U}_L(0,0)$ or $\bar{U}_L(0,1)$ for local manager. Outcomes from market contracts will suffer a loss in the transaction, which is expressed as ψ. We have showed them in Table 6-3. Now we want to indicate payoff for both the foreign firm and local manager, which is related to their actions.

We will show the Payoff Matrix in the Table 6-6 below

Table 6-6 Actions, Outcomes and Payoff

		Local manager's actions			
		{0, 0}	{0, 1}	{1, 0}	{1, 1}
Foreign firm's Actions	{0, 0}	$U_F(0,0)$, $U_L(0,0)$	$\bar{U}_F(0,0)$, $\bar{U}_L(0,1)$	$\bar{U}_F(0,0)$, $\bar{U}_L(1,0)$	$\bar{U}_F(0,0)$, $\bar{U}_L(1,1)$
	{0, 1}	$\bar{U}_F(0,1)$, $\bar{U}_L(0,0)$	$U_F(0,1)$, $U_L(0,1)$	$\bar{U}_F(0,1)$, $\bar{U}_L(1,0)$	$\bar{U}_F(0,1)$, $\bar{U}_L(1,1)$
	{1, 0}	$\bar{U}_F(1,0)$, $\bar{U}_L(0,0)$	$\bar{U}_F(1,0)$, $\bar{U}_L(0,1)$	$U_F(1,0)$, $U_L(1,0)$	$\bar{U}_F(1,0)$, $\bar{U}_L(1,1)$
	{1, 1}	$\bar{U}_F(1,1)$, $\bar{U}_L(0,0)$	$\bar{U}_F(1,1)$, $\bar{U}_L(0,1)$	$\bar{U}_F(1,1)$, $\bar{U}_L(1,0)$	$U_F(1,1)$, $U_L(1,1)$

Shaded parts in the table represent the match of the actions between foreign firm and local manager, in which case they cooperate to set up an processing firm and divide the profit by Nash bargaining. They get the respective utility levels, U_F and U_L. Otherwise, they will get the $\bar{U}_F$ and $\bar{U}_L$, in which cases they achieve the profit and utility through market contract..

Nash equilibria and conditions

Now we are able to analyze the conditions for each combination of actions and when they are a Nash equilibrium, which means where both parties will accept the arrangement, then produce and sell to get profit.

Before that, we will investigate the specific cases and analyze the conditions. Specifically, we are more interested in the condition for the cooperative cases, for example the cases {(0, 0), (0, 0)}, in which foreign firm owns the processing firm and also controls the input sourcing, and the local manager joins the processing firm to process the input and bargains about the final profit with foreign firm, or the case {(0, 1), (0, 1)}, in which foreign firm owns the processing firm but local manager controls the input sourcing.

For the case {(0, 0), (0, 0)}, the conditions for a Nash equilibrium is given by:

$U_F(0,0) > \bar{U}_F(0,1)$ $\quad$ $U_L(0,0) > \bar{U}_L(0,1)$

$U_F(0,0) > \bar{U}_F(1,0)$ $\quad$ $U_L(0,0) > \bar{U}_L(1,0)$

$U_F(0,0) > \bar{U}_F(1,1)$ $\quad$ $U_L(0,0) > \bar{U}_L(1,1)$

Since we have showed that

$$U_F(0,0) = \frac{2(2-\psi)(B-A-P)+[\frac{1}{2}+(1-\psi)^2]P^2+(2\psi-\psi^2)(B\lambda+A)^2+[\frac{1}{2}+(1-\psi)^2]B^2}{4}$$

$$U_L(0,0) = \frac{2\psi(B-A-P)+(2\psi-\psi^2)P^2+[\frac{1}{2}+(1-\psi)^2](B\lambda+A)^2+(2\psi-\psi^2)B^2}{4}$$

And

$$\bar{U}_F(0,1) = (1-\psi)(B-A-P)+\frac{1}{2}(1-\psi)^2 B^2$$

$$\bar{U}_F(1,0) = \frac{1}{2}(1-\psi)^2(P^2+B^2)$$

$$\bar{U}_F(1,1) = \frac{1}{2}(1-\psi)^2 B^2$$

$$\bar{U}_L(0,1) = \frac{1}{2}(1-\psi)^2[P^2+(B\lambda+A)^2]$$

$$\bar{U}_L(1,0) = (1-\psi)(B-A-P)+\frac{1}{2}(1-\psi)^2(B\lambda+A)^2$$

$$\bar{U}_L(1,1) = (1-\psi)(B-A-P)+\frac{1}{2}(1-\psi)^2[P^2+(B\lambda+A)^2]$$

We get the conditions:

$$\frac{1}{2}[1-(1-\psi)](B-A-P)+\frac{1}{4}[\frac{1}{2}+(1-\psi)^2]P^2+\frac{1}{4}[1-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2]B^2>0$$

$$\frac{1}{2}[1+(1-\psi)](B-A-P)+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2]P^2+\frac{1}{4}[1-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2]B^2>0$$

and

$$\frac{1}{2}[1-3(1-\psi)](B-A-P)+\frac{1}{4}[1-3(1-\psi)^2]P^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[1-(1-\psi)^2]B^2>0$$

We can find that when $(1-\psi)$ is small enough, for instance, in the extreme, $1-\psi=0$, that means the transaction cost is extremely high, all the inequalities above will hold at the same time. But when $(1-\psi)$ is large enough, the inequalities will not hold. We can test the case when $1-\psi=1$, then we get

$$\frac{3}{8}P^2-\frac{1}{8}B^2>0$$

$$(B-A-P)-\frac{1}{8}P^2-\frac{1}{8}B^2>0$$

$$-(B-A-P)-\frac{1}{2}P^2-\frac{1}{8}(B\lambda+A)^2>0$$

The third inequality is not held obviously. It means when $(1-\psi)$ is large enough, the case {(0, 0), (0, 0)} that foreigner owns the firm and control the input will not be a sustainable arrangement. Both parties will turn to a market contract to finish the project, since the transaction efficiency is high enough to support the transaction and both parties' threats to break up the processing firm are credible.

Similarly, we get conditions for the case {(0, 1), (0, 1)} to be a Nash equilibrium, which are:

$$\frac{1}{2}[1-(1-\psi)](B-A-P)+\frac{1}{4}[1-3(1-\psi)^2]P^2+\frac{1}{4}[1-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2]B^2>0$$

$$\frac{1}{2}[1-3(1-\psi)](B-A-P)+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2]P^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[1-(1-\psi)^2]B^2>0$$

We get conditions for the case {(1, 0), (1, 0)} to be a Nash equilibrium, which are:

$$\frac{1}{2}[1-3(1-\psi)](B-A-P)+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2]P^2+\frac{1}{4}[1-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2]B^2>0$$

$$\frac{1}{2}[1-(1-\psi)](B-A-P)+\frac{1}{4}[1-3(1-\psi)^2]P^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[1-(1-\psi)^2]B^2>0$$

We get conditions for the case {(1, 1), (1, 1)} to be a Nash equilibrium, which are:

$$\frac{1}{2}[1-3(1-\psi)](B-A-P)+\frac{1}{4}[1-3(1-\psi)^2]P^2+\frac{1}{4}[1-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2]B^2>0$$

$$\frac{1}{2}[1+(1-\psi)](B-A-P)+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2]P^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[1-(1-\psi)^2]B^2>0$$

$$\frac{1}{2}[1-(1-\psi)](B-A-P)+\frac{1}{4}[\frac{1}{2}+(1-\psi)^2]P^2+\frac{1}{4}[\frac{1}{2}-(1-\psi)^2](B\lambda+A)^2+\frac{1}{4}[1-(1-\psi)^2]B^2>0$$

From all the conditions, we can solve out the interval for the value of $1-\psi$ in the condition that other parameters are fixed, and see the change of the Nash equilibria. It means that when $1-\psi$ changes, the equilibrium will shift from one of the possible equilibria to another.

A significant case

We test the case when $P=1, A=1, B=3, \lambda=\frac{1}{3}$,

Then we get the conditions for the equilibrium for {(0, 0), (0, 0)} is：

$0<1-\psi<0.8777$

$0<1-\psi<0.961$

$0<1-\psi<0.767$

So we have $0<1-\psi<0.767$

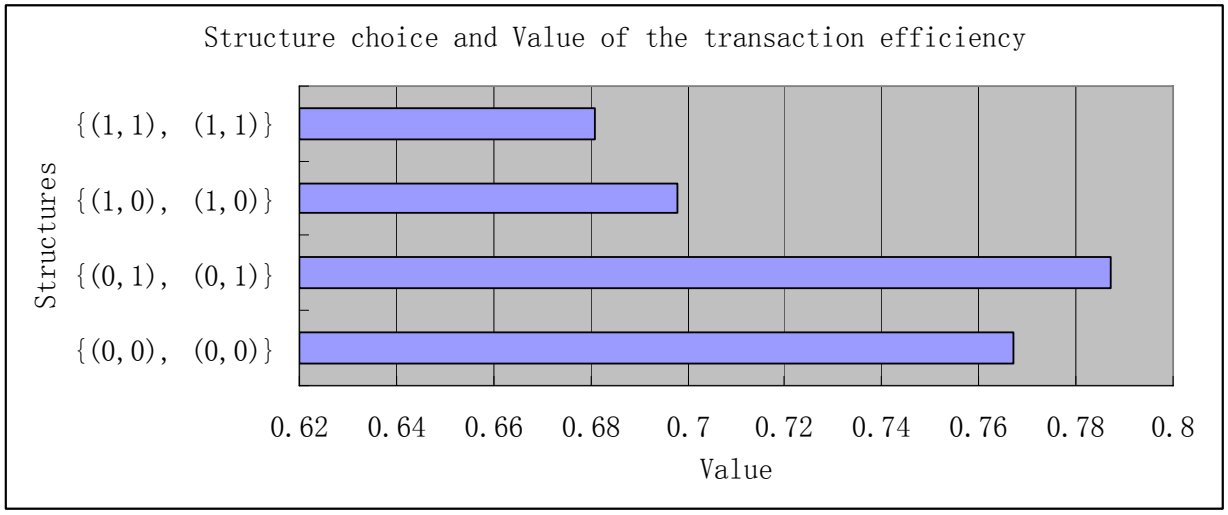
Similarly, we get the condition for {(0, 1), (0, 1)} is $0<1-\psi<0.787$

The condition for {(1, 0), (1, 0)} is $0<1-\psi<0.698$

The condition for {(1, 1), (1, 1)} is $0<1-\psi<0.681$

Interestingly, look at the figure 6-2 below

Figure 6-2



We can find that when $1-\psi$ is low, $0<1-\psi<0.681$, which means market transaction efficiency is low, then all the four arrangements of the processing firm {(0, 0), (0, 0)}, {(0, 1), (0, 1)}, {(1, 0), (1, 0)}, {(1,1), (1, 1)} are possible to exist. But when $1-\psi$ rises, certain arrangements of the ownership and input control will be eliminated. As we can find from the Figure 6-2, when $1-\psi$ becomes larger, the structure which will be eliminated in turn as: firstly {(1,1), (1, 1)}, then {(1, 0), (1, 0)}, then {(0, 0), (0, 0)}, then {(0, 1), (0, 1)}. When $1-\psi>0.787$, market transaction will be more preferable, thus people will incline to sign market contract to finish the project in stead of engaging in the processing firm.

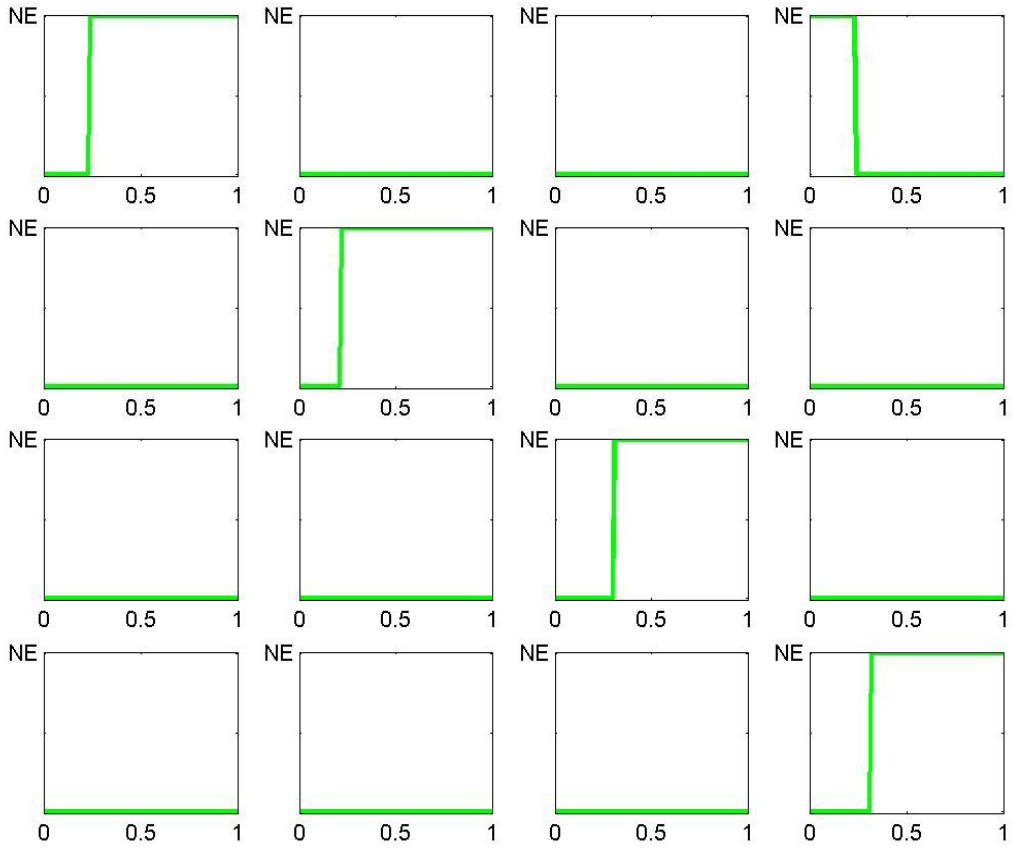
Especially, when $0.767<1-\psi<0.787$, there is only one arrangement {(0, 1), (0, 1)} which is sustainable, the case that the foreigner owns the processing firm, but the local manager control the input sourcing.

So, in this case that $P=1, A=1, B=3, \lambda=\frac{1}{3}$, when $0.767<1-\psi<0.787$, there is only one Nash equilibrium, that is {(0, 1), (0, 1)}, in which foreigner owns the processing firm, but the local manager control the input sourcing. This result fits amazingly Feenstra and Hanson's estimation of China's outsourcing industry (Feenstra and Hanson 2005), that foreign firm owning the processing firm and Chinese manager controlling the input is the most familiar arrangement in the outsourcing industry in China.

More Nash equilibria and their relationship with $1-\psi$, transaction efficiency

Using Matlab to find out the equilibria in the case when we fix the values of P, A, B, and λ, and let $P=1, A=1, B=3, \lambda=\frac{1}{3}$. We let the value of ψ variate from 0 to 1, which means the market transaction efficiency $1-\psi$ shifts from 1 to 0. We get the outcome as below:

Figure 6-3 outcome of the Nash equilibria

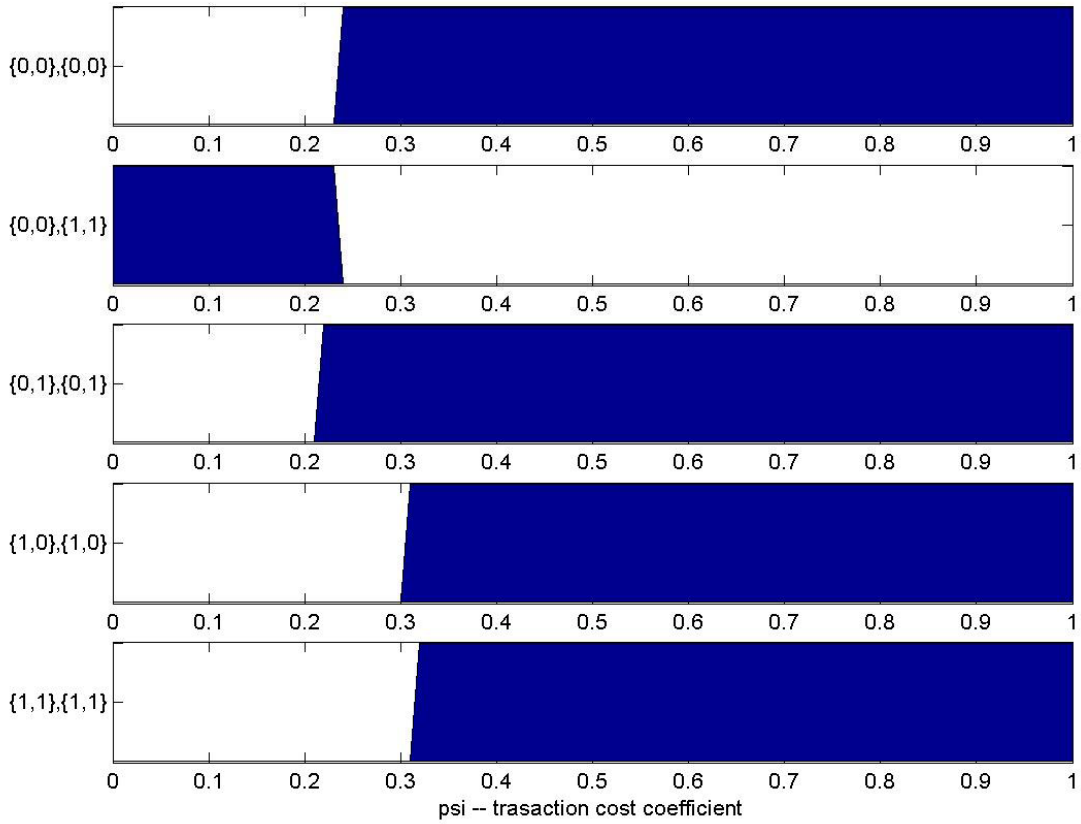


Each pane in the figure represents a possible outcome, which matches the matrix in Table 6-6. For example, the pane on the north western corner represents the outcome {(0, 0), (0, 0)} with the payoff $U_F(0,0)$, $U_L(0,0)$. The horizon of the pane represents the value of ψ, which ranges from 0 to 1. The vertical has only two values, 0 and NE. Zero indicates that the outcome will not be a Nash equilibrium, and NE represents the Nash equilibrium outcome. So these panes indicate the possible shift of each outcome from non Nash

equilibrium to Nash equilibrium, when the value of ψ changes from 0 to 1.

From figure 6-3, we can find that among all the 16 possible outcomes, 11 of them are impossible to be a Nash equilibrium. There are only 5 outcomes, which will turn out to be Nash equilibrium under the condition of the value change of ψ. We show them below in figure 6-4

Figure 6-4 Nash Equilibria and value of ψ



This figure is similar to figure 6-2, but here we get one more Nash equilibrium {(0, 0), (1, 1)}, which means the both foreigner and local manager build up their own processing firm and control the input purchase by themselves. In this case, there is no match between the foreigner and local manager. It shows the case that when market transaction efficiency is high enough, $1-\psi > 0.787$, both parties prefer to control both the ownership and input purchase in the firm, and outsource all the other activities to outsiders. Outsourcing is preferable than integration when $1-\psi > 0.787$

Short conclusion

Through our Nash Bargaining model, we showed the mechanism that simulates the bargaining process by which both foreign investor and local manager engage into the choice of the processing firm, which is the integration case. Also we find that, when the market transaction efficiency is increased, which means “the thickness of the market” is thick enough, separation of the ownership and input control will be a desirable arrangement in the processing firm for both foreign investor and local manager. However, as the market is thicker, and transaction efficiency is considerable higher, outsourcing will be a preferable choice. Both foreign investor and local manager have incentive to be owner and set up their own processing factory. By outsourcing relevant activities to outsider, they will achieve a better outcome in the process.

We have provided a model to understand the choice between integration and outsourcing. Furthermore, we described how the parties who engaged in the integrated processing firm divide the rights when they cooperate. By the dimension of the improvement of transaction efficiency, we also showed the condition, under which outsourcing will be more preferable than integration. Also, our model provides rich predictions about patterns of the structure in the processing firm and shows how the market efficiency will affect the decision of the parties to choose integration or outsourcing.

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