A Theory of Domestic Insourcing, Outsourcing and FDI*

Cheng Chen†

December 12, 2007

*I am grateful to Taiji Furusawa, Jota Ishikawa and Hideshi Itoh for invaluable guidance and to Emily Blanchard, Daisuke Oyama, Eiichi Tomiura, Takashi Ui. I have also benefited from suggestions by participants at Hitotsubashi International Trade Seminar, Contract Theory Workshop in East Japan and Yokohama National University Modern Economics Seminar.

†Corresponding Address: Graduate School of Economics, Hitotsubashi University, 2-1 Naka, Kunitachi, Tokyo, Japan 186-8601. e-mail: chencheng1983613@hotmail.com

Abstract

Theoretical approaches to information and incentive problems in analyzing multinational firm's behavior remain under-examined. I present a model that explains a multinational firm's choice of production location, either in the north or south, and its organizational form, either integration or outsourcing. The basic tradeoff between domestic insourcing and foreign outsourcing is that while the labor costs in the north are higher, the productivity in the south is lower, and more importantly, the productivity information about the supplier in the south is private. In the case of outsourcing in the south, the multinational firm is faced with an adverse selection problem. In choosing organizational form in the south, the multinational firm is faced with an adverse selection problem if it outsources to a southern supplier whereas it is faced with a moral hazard problem if it chooses FDI. The moral hazard problem is restricted to the FDI case as, when outsourcing the multinational firm can include in the contract a fine for the failure of delivering intermediate goods and the southern owners of the supplier can monitor the employees. On the contrary, when the multinational firm decides to integrate the intermediate goods supplier in the south, information about the supplier's productivity becomes clear, but the threat with a fine is neutralized because the northern managers and owners can not monitor the southern employees.

1 Introduction

In comparing between outsourcing and FDI, Antras points out, there is one important finding from the empirical work:" Intra-firm trade (FDI) is heavily concentrated in capital-intensive industries." (Antras, 2003).[1] This is an interesting phenomenon which some trade economists want to explain. In the seminal work of Antras (2003), he uses the incomplete contract theory to explain this empirical finding. The contract between the MNE in the north and the intermediate goods supplier in the south is naturally incomplete. Because of the incompleteness, the hold up problem appears and as the consequence, the under-investment in inputs of two sides comes forth. In the capital-intensive industry, the investment of the MNE's input becomes more important compared with the intermediate goods supplier's, so the MNE wants to integrate the intermediate goods supplier to improve its threshold point in the bargaining process and to increase its own incentive to invest. As a result, the loss of efficiency will be alleviated in the capital-intensive industry when the MNE integrates the intermediate goods supplier in the south.

Antras and Helpman (2004) adopt a unified model to study the choice of production location and the form of organization. The tradeoff between FDI and outsourcing in their study is similar to Antras (2003), but a new ingredient in the tradeoff, the governance cost, is higher in integration compared with outsourcing. In the model below, I will point out that the reason why the governance cost is higher in the integration case is that there is a moral hazard problem in the integration case and the MNE must pay a higher wage

[1] You can see this phenomenon from table 1. FDI is heavily concentrated in capital-intensive industries such as chemical products, machinery and electrical electronic equipment.

Table 1: Share of foreign subsidiaries in total manufacturing employment

Sector (1998)	France	Germany	UK	USA
Food, beverages, tobacco	—	4.80	10.60	11.56
Textiles, clothing, leather, footwear	14.20	3.40	—	4.67
Wood products	17.70	2.70	—	1.28
Paper, printing and publishing	26.80	2.50	—	5.57
Chemical products	44.70	10.3	35.80	37.04
Machinery, total	38.90	7.60	40.40	12.20
Electrical electronic equipment	34.50	8.80	41.10	—
Scientific instruments	29.90	7.90	27.30	—
Other manufacturing	18.70	2.50	17.10	—

Source: OECD (2001); STAN Database for industrial Analysis, Vol.2002, Release 02.

or so-called efficiency wage to the employees to make them work hard. On the other hand, the tradeoff between domestic insourcing and going to the south is that the wage rate of the south is lower compared with that of the north, but the governance cost is higher and a contractual breach is likely to be more costly to MNE when MNE deals with an intermediate goods supplier in the south.

Antras (2005) uses the same idea to study the dynamic processes of product cycle. He assumes that as time elapses, the importance of the low-tech input increases. Due to contract's incompleteness, the product cycle involves domestic insourcing at first, then FDI and finally outsourcing. He reports that this theoretical result is consistent with empirical findings.

Other related approaches to the analysis of multinational firms have been proposed by Grossman and Helpman (2002, 2003, 2005). They also appeal to the idea of the incompleteness of contracts. But in their papers, there is a constant returns to scale matching process that occurs between the MNE and the intermediate goods supplier. For this reason alone, the intermediate goods supplier can make a positive profit. This crucially distinguishes Grossman and Helpman's work from that of Antras.

Turning from the trade literature, I would like to review a classic question in contract theory of why some firms seek to integrate other firms and different firms do not seek integration. Coase (1937) stresses the importance of transaction costs when a firm wants to buy intermediate goods from the supplier. So there are some demerits in outsourcing. On the contrary, there are some demerits in integration also, such as higher governance costs. Cremer (1995) stresses that the tradeoff between outsourcing and integration is a tradeoff between credible commitment and better information environment. When a firm integrates another firm, it will get clearer information about the integrated firm. But as the integrating firm has already known the type of the integrated firm, it will become more costly for the integrating firm to give incentives to the integrated firm to make it work hard as compared with outsourcing. The tradeoff becomes apparent here. Schmidt (1996) uses a similar idea to analyze the cost and benefit of privatization.

In my model, I use contract theory to explain the economic force behind the multinational firm's choice of production location and form of organization. I will focus on comparison of three types of production: *domestic insourcing, vertical outsourcing* and *vertical FDI*. The basic tradeoff between domestic insourcing and outsourcing in the south is that while the labor cost in the north is higher compared with that of the south, the productivity in the south is lower. More importantly, the information of productivity of the intermediate goods supplier in the south is the supplier's private information. So when a multinational firm goes to the south to outsource, it will face an adverse selection problem.[2] The MNE must design an incentive compatible contract to make the intermediate goods supplier in the south report its productivity truthfully. Due to this, the MNE has to pay the information rent, which offsets at least partially the advantage of lower labor cost in the south.

On the other hand, the basic tradeoff between outsourcing in the south and FDI is that although the multinational firm has to pay the information rent when outsourcing, it can write a contract with the intermediate goods supplier that sets a large enough fine that the intermediate goods supplier would have to pay should the production of intermediate goods in the south fail to force the employees of the supplier to choose good behavior. This is because either the employees own the supplier or the owners of the supplier can monitor the behavior of employees. On the other hand, when the multinational firm decides to integrate the intermediate goods supplier in the south, information about the supplier's productivity will become clear. The threat of fine in the case of failure of production, however, will be neutralized as either the employees are no longer the owners of the supplier[3] or the northern owners and managers can not monitor the behavior of southern employees. The moral hazard problem therefore arises in the FDI case.

The question arises: why is there no moral hazard problem in the outsourcing case? The lack of moral hazard problem in the outsourcing case is, then, due to the employees' ownership of the intermediate goods supplier.

[2]In reality, there may be adverse selection problems for the MNE even the intermediate goods supplier located in the north. But we stress that it is more likely that the adverse selection problem arises when two firms are located in different countries. The reasons are: (1).the system of accounting in the south is not reliable; (2).The MNE is usually located far away from the supplier in the south; (3).The law and governmental systems are usually imperfect in the south.

[3]For simplicity, I consider the 100 percent acquisition in ownership. The reason is that in reality, for example in China, recently there has been a trend that more and more MNEs integrated their affiliates in China totally (i.e. 100 percent ownership).

When they shirk, they have to pay a large enough fine to compensate the MNE when the intermediate goods production fails. The advantage of shirking, (i.e. The disutility of good behavior will be saved.) is dominated by losses of the employees' capital assets in the supplier. Because of this, the employees do not shirk in the outsourcing case. Another explanation for this is that the southern owners can monitor the behavior of their employees so they can make a wage schedule basing on the behavior of the employees.[4]

The FDI case, however, contrasts sharply. The ownership now belongs to the MNE and the employees are no longer the owners of the intermediate goods supplier. If the employees shirk and production fails, the employees do not have to pay anything from their own wealth, as the behavior of them is *unverifiable* to the owners and managers from the north and the employees are no longer owners of the supplier. Due to this change in monitoring and ownership, if there is no wage premium for the success of intermediate goods' production, the employees will shirk voluntarily. Accordingly, there is a moral hazard problem in the FDI case. The MNE must set an efficiency wage which is higher than the wage rate in the outsourcing case to give employees incentive to choose the good behavior. The tradeoff between the outsourcing in the south and FDI now is clear: in the outsourcing case, there is an adverse selection problem but no moral hazard problem. In other words, the MNE has to pay the information rent but no efficiency wage. On the contrary, in the FDI case, there is a moral hazard problem but no adverse selection problem. In other words, the MNE has to pay the efficiency wage

[4]In this paper, I assume that the behavior of employees is *verifiable* only to the owners and managers who come from the same country as the employees. For example, the behavior of employees in the northern intermediate goods supplier is *verifiable* to the people of MNE's headquarters. On the other hand, the behavior of employees in the southern intermediate goods supplier is *unverifiable* to the people of MNE's headquarters, because there are cultural differences (i.e. language, custom etc.).

but no information rent.

The main result of this paper is that there are two types of equilibrium. One is the IN-OS type equilibrium, which means that in the capital-intensive industry, the firm chooses to undertake domestic insourcing (IN); for the labor-intensive industry, the firm chooses to outsource in the south (OS). There is no FDI in this equilibrium since, in this equilibrium, the efficiency wage is too high compared with the wage rate in the outsourcing case. Another equilibrium is the IN-FS-OS type equilibrium which indicates that in the most capital-intensive industry, the firm chooses to undertake domestic insourcing (IN); in the middle range capital intensity industry, the firm will go to the south to do FDI (FS); in the least capital-intensive industry, the firm chooses to outsource in the south (OS). Due to this type of sorting, my paper's main result is consistent with the empirical finding that, compared with the outsourcing, the intra-firm trade (FDI) is concentrated in capital-intensive industries.

While the main result of my paper is the same as those of Antras (2003) and Antras (2005), the economic intuition contrasts markedly. In my model, when the parameter of capital intensity is very high (i.e. close to 1), the advantage of a lower wage rate in the south becomes small, so the MNE will choose to produce at home. When the parameter of capital intensity falls into a middle range, it is profitable for the MNE to go to the south. It is also profitable engaging in FDI because the MNE will pay relatively small proportion of efficiency wage to overcome the adverse selection problem. But when the parameter of capital intensity is small (i.e. close to 0), it is very costly for the MNE to overcome the adverse selection problem as it has to pay a relatively large efficiency wage. As a result, the MNE will choose to not to integrate the intermediate goods supplier in the south.

Three points are highlighted for further discussion. The first one is the notion of governance cost in the multinational firm proposed by Antras and Helpman (2004). In their paper, governance cost is simply assumed to be higher under integration. In the present model, if the wage premium (i.e. the efficiency wage minus the wage rate in the outsourcing case) is taken as the governance cost, the assumption becomes a result. The MNE which outsources, for example, does not have to pay the wage premium. We also find that the governance cost is related to labor use in the firm. When the firm uses more labor, it has to pay more governance cost.

The second implication is that the moral hazard problem in the FDI case arises from the separation of ownership and control of the firm and the inability of northern owners and managers' monitoring.[5] The MNE owns the intermediate goods supplier but usually employs southern managers whose interest is not directly related to the MNE when there is no wage premium or send people who can not monitor the behavior of southern employees from the headquarters to control and run the firm. In either case, the MNE has to give southern employees or at least the southern managers the efficiency wage to prevent them from shirking. For convenience, I consider the case in which the MNE sends managers from the north and employ southern employees.

The last one is the role of cross-border ingredient. It can be seen from above reasoning that it is the cross-border ingredient that causes the adverse selection problem in the outsourcing case and the moral hazard problem in the FDI case. Because of this, my paper differs from the research about the decision of outsourcing and integration within a country.

[5]In reality, there may be moral hazard problems in every firm. But here, we stress that the moral hazard problem is more severe in MNE-affiliated intermediate goods suppliers because of the separation of ownership and control.

2 Expected Payoffs

There are two choices for the MNE to make: the location of production and the form of organization. I do not differentiate between the domestic insourcing and outsourcing.[6] Because of this, there are three possible production types left: the domestic insourcing (IN),[7] the outsourcing in the south (OS) and the FDI in the south (FS).[8]

2.1 Environment

There are two countries called the north and south. There are two factors—labor and capital. While the labor cannot move between countries, the capital is completely mobile in the worldwide range. Because of this, the capital rental rate will be the same across countries. Because of the technology's difficulty, the MNEs only locate in the north. But the intermediate goods suppliers can locate either in the north or south. N exogenously gives the number of industries in the world.

Consumer's preferences are such that a producer of good y in industry j faces the following iso-elastic demand function:

$$y = \lambda_j^{1/(1-\alpha)},$$

where p is the price of good and λ_j is a constant term that the producer

[6]Because information is perfect in the north, there is no adverse seleciton problem in the outsourcing case. On the other hand, because the behavior of the employees of the northern intermediate goods supplier is *verifiable* to the people of MNE's headquarters, there is no moral hazard problem in the insourcing case. Consequently, there is no difference between domestic insourcing and outsourcing.

[7]I use the domestic insourcing case as the production in the north.

[8]In this paper, I just consider a one period static model, because even in this type of model I can still express my viewpoint concerning the decision made by the MNE clearly.

takes as given. In the equilibrium, λ_j is determined as

$$\lambda_j = \frac{E_j}{\int_0^{n_j} p_j(i)^{-\alpha/(1-\alpha)} di}.$$[9]

The production technology for the intermediate goods supplier in the north is Cobb-Douglas type:

$$x = \left(\frac{K}{\beta}\right)^{\beta} \left(\frac{L}{1-\beta}\right)^{1-\beta}.$$

For simplicity, I assume that the production of final goods requires no further cost:

$$y = x.$$

2.2 The expected profit in the IN case

From the production function, we can calculate the cost function of the intermediate good supplier in the north as[10]

$$c(x) = r_N^{\beta} w_N^{(1-\beta)} x.$$

Because the production of final goods requires no further cost, the optimal pricing for each firm in the monopolistic competitive industry is

$$p = r_N^{\beta} w_N^{(1-\beta)} / \alpha.$$

The expected payoff in the domestic outsourcing case is

$$\Pi^N = (1-\alpha)\lambda_j \left(\frac{\alpha}{r_N^{\beta} w_N^{(1-\beta)}}\right)^{\alpha/(1-\alpha)}. \quad (1)$$

[9]This demand function can be derived from the C.E.S. utility function.
[10]It is the cost function of the final goods also.

Because the capital is completely mobile, we can normalize the capital rental rate: $r^N = r^S = 1$. And we assume that the wage rate in the north is higher than that in the south (i.e. $w_N > w_S$).[11]

2.3 The expected payoff in the OS case

The environment in the OS case is similar to the IN case. But one thing is different: now the production technology of intermediate goods supplier is[12]

$$x = \theta \left(\frac{K}{\beta} \right)^{\beta} \left(\frac{L}{1-\beta} \right)^{1-\beta}.$$

The parameter θ indicates the productivity level of the intermediate goods supplier and is uniformly distributed in $[\theta^*, 1](0 < \theta^* < 1)$. It is easy to see that the productivity of the intermediate goods supplier in the south is always lower than the north. What is more important is that the information about productivity level is intermediate supplier's private information. The MNE cannot get the information. So the adverse selection problem occurs. The MNE must design an incentive compatible contract to make the intermediate goods supplier tell its productivity level (type) truthfully. Because of this, the MNE has to give the information rent to the intermediate goods supplier and the supplier can make positive profits in equilibrium.[13]

There are two choices for the employees to choose. One is the good behavior and the other is the bad behavior. As table 2 indicates, if the employee chooses the good behavior, the production of intermediate goods will succeed with probability one but he has to burden the disutility d. If the employee chooses the bad behavior, the production of intermediate goods

[11] This assumption will be justified in the general equilibrium analysis section.
[12] This type of firm's heterogeneity was pioneered by Melitz(2003).
[13] Other than information rent, there is under-production problem in this case also.

Table 2: The behavior of employees

	The probability of success	Disutilities
The good behavior	1	d
The bad behavior	$p(0 < p < 1)$	0

will succeed only with probability p but he will not burden any disutility.

The timing of events in the OS case is described as follow.[14] At time 0, the MNE and intermediate goods supplier in the south will write a contract containing a large amount of fine in the case of failure of production. At time 1, employees choose their behavior.[15] At time 2, the production occurs. Because the employees always choose the good behavior, the production will succeed with probability one. At time 3, the MNE pays money to the intermediate goods supplier for the delivery of intermediate goods and the employees will get the wage.

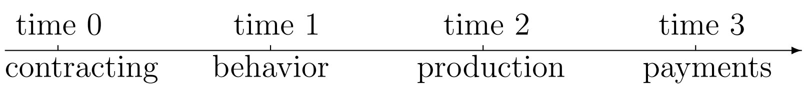


Figure 1: Timing of Events in the OS case

The cost function of the intermediate goods supplier in the south is

$$c(x) = w_S^{1-\beta} x/\theta,$$

where we use the tact that $r_S = 1$.

[14]See Figure 1.

[15]Either because the employees own the firm or the managers who are born in the south can monitor the behavior of employees, the employees will choose the good behavior.

The MNE (the principal)'s payoff and the intermediate goods supplier's payoff are (T is the money the MNE has to pay to buy the intermediate goods and we use the fact that $y = x$.)

$$V = \lambda_j^{(1-\alpha)} y^{\alpha} - T,$$
$$U = T - \frac{w_S^{(1-\beta)} y}{\theta}.$$

The objective function of the MNE is[16]

$$\Pi_O^S = \max_{y(.)} \int_{\theta^*}^{1} \left[\left(\lambda_j^{(1-\alpha)} y^{\alpha} - \frac{w_S^{(1-\beta)} y}{\theta} \right) - \frac{w_S^{(1-\beta)} y}{\theta^2}(1-\theta) \right] \frac{d\theta}{1-\theta^*} - U(\theta^*)$$

s.t. $U(\theta^*) = 0$,

$y(\theta)$ is an increasing function in θ.

The third term of the above integral is the information rent. When the intermediate goods supplier is the most productive (i.e. θ=1), it can get information rent most which equals to $\int_{\theta^*}^{1} (w_S^{(1-\beta)} y)/\theta^2 d\theta$. MNE wants to prevent it from mimicking less productive intermediate goods suppliers. On the contrary, when the intermediate goods supplier is the most unproductive (i.e. $\theta = \theta^*$), it cannot get any information rent.

Solving the problem, we get the optimal product schedule and expected payoff in the OS case:

$$y(\theta) = \lambda_j \left(\frac{\alpha \theta^2}{w_S^{(1-\beta)}} \right)^{1/(1-\alpha)};$$

$$\Pi_O^S = \left[(1-\alpha)\lambda_j \left(\frac{\alpha}{w_S^{(1-\beta)}} \right)^{\frac{\alpha}{(1-\alpha)}} \frac{(1-\alpha)(1-\theta^{*\frac{1+\alpha}{1-\alpha}})}{(1+\alpha)(1-\theta^*)} \right]. \quad (2)$$

[16] The problem here is a typical optimal contract design problem under agent's continuous type. For details, please see Fudenberg and Tirole (chapter 7, 1991).

Differentiating Π_O^S with respect to θ^*, we find that Π_O^S is a monotonic increasing function of θ^*. There are two effects concerning the increase of θ^*. The first one which I call the efficiency effect is a positive one. Because the intermediate goods supplier becomes more productive on average, the MNE will make more profits. The second effect, which I call the information rent effect is an ambiguous one. The pure rent for the more productive supplier becomes less, because the range of type that the more productive supplier can mimic narrows. But the distribution of rent which the MNE has to pay now first-order stochastically dominates the former distribution. In simple words, the probability of being a more productive supplier increases now, and because the more productive one supplier the more the MNE has to pay to the supplier as the information rent. As a result, the total effect is positive.

2.4 The expected payoff in the FS case

The timing of events in the FDI case is stated as follow.[17] At time 0, the MNE and the employees in the intermediate goods supplier write a wage schedule containing the wage rate and the wage premium in the case of the success of production. At time 1, the employees choose the behavior. At time 2, production occurs. At time 3, the result comes forth. If the production fails, the MNE will just pay the usual wage rate to the employees; on the other hand, if the production succeeds, the supplier will deliver the intermediate goods to the headquarters of the MNE and the employees will get the wage premium$(\tilde{w}_S - w_S)$.

[17]See figure 2.

Figure 2: Timing of Events in the FS case

The condition under which the employee will not shirk is [18]

$$p(\tilde{w}_S - 0) + (1-p)(w_S - 0) \leq \tilde{w}_S - d,$$

where $\tilde{w}_S$ is the wage when intermediate goods production succeeds (or the efficiency wage), w_S is the wage when intermediate goods production fails (or the usual wage). It is easy to see that if $\tilde{w}_s = w_S$, the employee will shirk, because he can get the same wage even if he shirks and the production fails. The efficiency wage is

$$\tilde{w}_s = w_S + \frac{d}{(1-p)},$$

$\frac{d}{(1-p)}$ is the wage premium.

There is no adverse selection problem,[19] so the optimal product decision will be

$$\max_{y(.)} \lambda_j^{1-\alpha} y^{\alpha} - \tilde{w}_S^{1-\beta} \frac{y}{\theta}.$$

[18] In the OS case, there is only one wage: w_S. But here, we consider w_S as the wage rate no matter whether the production of intermediate goods succeeds or not and $\tilde{w}_S - w_S$ as the wage premium for the success of the production of intermediate goods. In the OS case, because there is no moral hazard problem, the wage premium is not needed in the wage schedule.

[19] I assume that if the MNE integrate the intermediate goods supplier, the information about the productivity will be clear for the MNE.

Solving this problem, we get

$$y(\theta) = \lambda_j \left(\frac{\alpha\theta}{\tilde{w}_S^{(1-\beta)}} \right)^{1/(1-\alpha)}.$$

The expected payoff in the FS case will be

$$\Pi_F^S = \int_{\theta^*}^{1} \left[\left(\lambda_j^{(1-\alpha)} y^{\alpha} - \frac{\tilde{w}_S^{(1-\beta)} y}{\theta} \right) \right] \frac{d\theta}{1-\theta^*}$$

$$= (1-\alpha)^2 \lambda_j \left(\frac{\alpha}{\tilde{w}_S^{(1-\beta)}} \right)^{\frac{\alpha}{(1-\alpha)}} \frac{(1-\theta^{*\frac{1}{1-\alpha}})}{(1-\theta^*)}. \qquad (3)$$

There is a self-commitment condition, which means that the MNE wants to give employees efficiency wage voluntarily. This condition is the condition that the expected payoff under the good behavior is larger than that under the bad behavior. The expected payoff under the bad behavior is

$$\Pi_{FN}^S = p(1-\alpha)^2 \lambda_j \left(\frac{\alpha}{w_S^{(1-\beta)}} \right)^{\frac{\alpha}{(1-\alpha)}} \frac{(1-\theta^{*\frac{1}{1-\alpha}})}{(1-\theta^*)}$$

.

The self-commitment condition is

$$\Pi_F^S > \Pi_{FN}^S$$

or

$$\left(\frac{w_S}{\tilde{w}_S} \right)^{\alpha(1-\beta)/(1-\alpha)} > p$$

When the probability of success under the bad behavior p is small enough, this condition will be satisfied.

It is easy to see Π_F^S is an increasing function of θ^*. The economic intuition is straightforward. Because in the FS case, there are not information rent and under-production problem. When θ^* goes up, The only effect is the efficiency effect which is positive.

Before discussing more, I make an assumption to insure the wage rate in the north is always higher than that in the south.

Assumption 1.[20]

$$w_N > w_S + \frac{d}{(1-p)}.$$

This assumption means that in all cases, the wage rate in the south is higher than the north.

3 The comparison

There are three types of the production and the comparisons will be made between any two of them. First, please note that:

$$\frac{\Pi_O^S}{\Pi_F^S} = \left(\frac{\tilde{w}_S}{w_S}\right)^{\alpha(1-\beta)/(1-\alpha)} \frac{(1-\theta^{*\frac{1+\alpha}{1-\alpha}})}{(1+\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})},$$

Here we have lemma 1:[21]

$$0 < \frac{(1-\theta^{*\frac{1+\alpha}{1-\alpha}})}{(1+\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})} < 1$$

From lemma 1, we have the following result:

If

$$\left(\frac{\tilde{w}_S}{w_S}\right)^{\alpha/(1-\alpha)} \geq \frac{(1+\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})}{(1-\theta^{*\frac{1+\alpha}{1-\alpha}})},$$

The FS and OS coexist in the equilibrium.

[20] We can give d an appropriate value to meet this assumption for any (w_S, w_N) pair.

[21] For proof, please see appendix A.

If

$$\left(\frac{\tilde{w}_S}{w_S}\right)^{\alpha/(1-\alpha)} < \frac{(1+\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})}{(1-\theta^{*\frac{1+\alpha}{1-\alpha}})},$$

The FS (FDI) always dominates the OS for any given value of β.

In the latter case, the cutoff point between OS and FS is negative. This is the case that we are not interested in.[22] Because of this, I make another assumption.

Assumption 2.[23]

$$\left(\frac{\tilde{w}_S}{w_S}\right)^{\alpha/(1-\alpha)} \geq \frac{(1+\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})}{(1-\theta^{*\frac{1+\alpha}{1-\alpha}})}.$$

3.1 The comparison between IN and FS

First, we consider the comparison between IN and FS.

$$\frac{\Pi^N}{\Pi_F^S} = \left(\frac{\tilde{w}_S}{w_N}\right)^{\alpha(1-\beta)/(1-\alpha)} \frac{(1-\theta^*)}{(1-\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})}$$

We make the following abbreviation:

$$H(\theta^*) = \frac{(1-\theta^*)}{(1-\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})}$$

The assumption below assures that the cutoff point between FS and IN is smaller than 1 and larger than 0.

Assumption 3.[24]

[22]We are interested in the case in which the three cutoff points $\beta_{FN}, \beta_{ON}, \beta_{OF}$ are between zero and one (see below) and assumptions 2-4 assure this.

[23]For the existence of this assumption, please see the general equilibrium analysis part in the appendix.

[24]For the existence of this assumption, please see the general equilibrium analysis part in the appendix.

$$\left(\frac{w_N}{\tilde{w}_S}\right)^{\alpha/(1-\alpha)} > H(\theta^*)$$

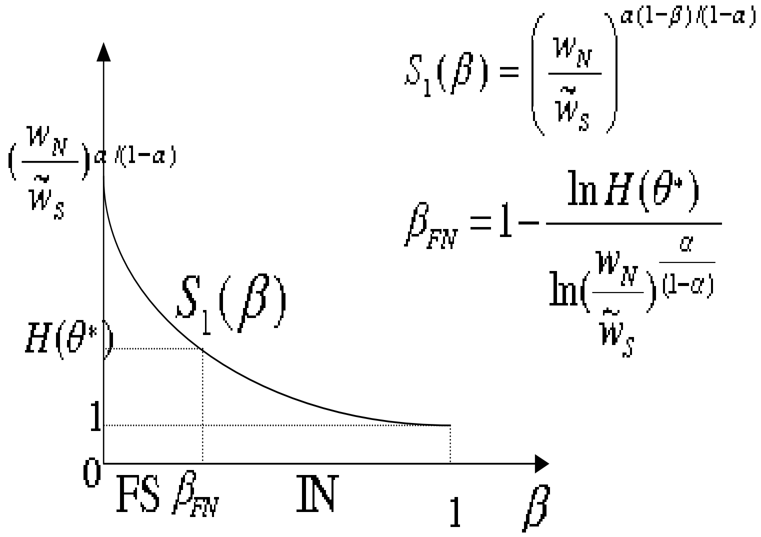
Under assumption 3, we have the following Claim 1.

Claim 1.

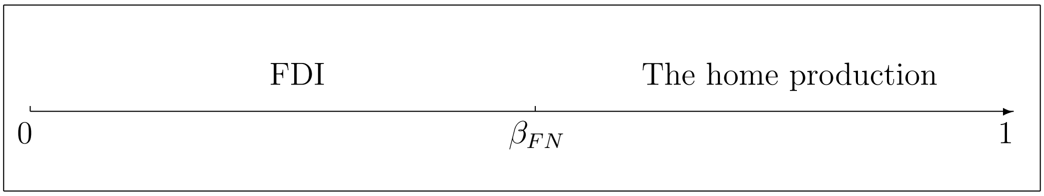
Under assumption 1-3, without considering the option of OS, there exists one cutoff point $\beta_{FN} \in (0,1)$, when $\beta > \beta_{FN}$, the home production is optimal, and when $\beta < \beta_{FN}$, the FDI is optimal.

We can use figure 3 to prove this claim. It is easy to see that $S_1(\beta)$ is the advantage of lower labor cost of producing in the south using FDI. $H(\theta^*)$ is the disadvantage of producing in the south because of the lower productivity of the intermediate goods' production.

Figure 3



The illustration is the following.



3.2 The comparison between IN and OS

Next, we consider the comparison between IN and OS:

$$\frac{\Pi^N}{\Pi^S_O} = \left(\frac{w_S}{w_N}\right)^{\alpha(1-\beta)/(1-\alpha)} \frac{(1+\alpha)(1-\theta^*)}{(1-\alpha)(1-\theta^{*\frac{(1+\alpha)}{(1-\alpha)}})}$$

We make the following abbreviation:

$$L(\theta^*) = \frac{(1+\alpha)(1-\theta^*)}{(1-\alpha)(1-\theta^{*\frac{(1+\alpha)}{(1-\alpha)}})}$$

The following assumption assures that the cutoff point between OS and IN is smaller than 1 and larger than 0.

Assumption 4.[25]

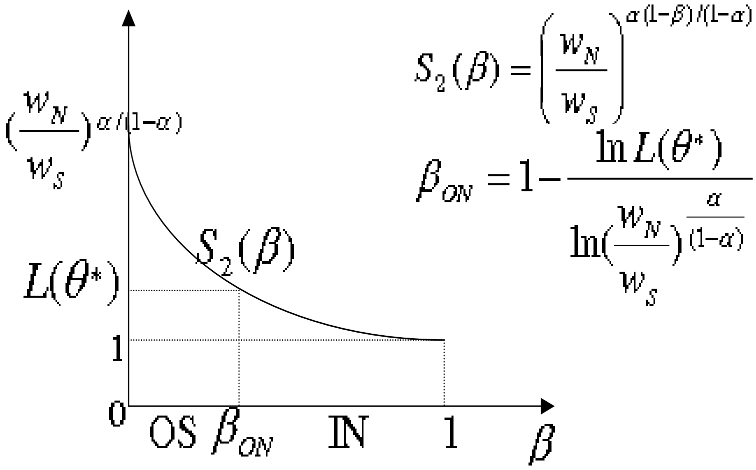
$$\left(\frac{w_N}{w_S}\right)^{\alpha/(1-\alpha)} > L(\theta^*)$$

Under assumption 4, we will have another cutoff point β_{ON} between IN and OS.[26]

[25]For the existence of this assumption, please see the general equilibrium analysis part in the appendix.

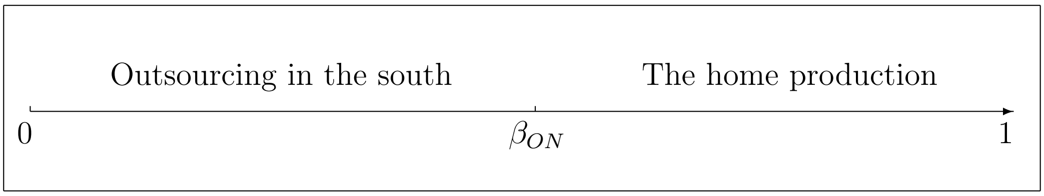
[26]See figure 4.

Figure 4



Here $S_2(\beta)$ is the advantage of lower labor cost of producing in the south using outsourcing. $L(\theta^*)$is the disadvantage of producing in the south because of the lower productivity of the intermediate goods' production and the adverse selection problem.

The illustration is the following.



3.3 The comparison between OS and FS

Finally, we consider the comparison between OS and FS.

$$\frac{\Pi_O^S}{\Pi_F^S} = \left(\frac{\tilde{w}_S}{w_S}\right)^{\alpha(1-\beta)/(1-\alpha)} \frac{(1-\theta^{*\frac{(1+\alpha)}{(1-\alpha)}})}{(1+\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})}$$

Setting

$$M(\theta^*) = \frac{(1+\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})}{(1-\theta^{*\frac{(1+\alpha)}{(1-\alpha)}})}$$

Then we have the following claim:

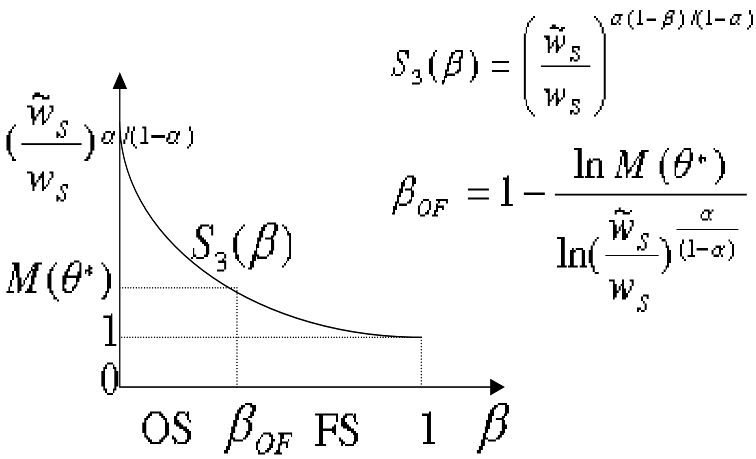
Claim 2.[27]

$$dM(\theta^*)/d\theta^* < 0$$

M is a decreasing function of θ^*. The economic meaning is that when θ^* goes up, which means that the developing country makes improvement in technology, the outsourcing should be more profitable compared with the FDI.

Under assumption 2, we have another cutoff point β_{OF} between OS and FS.[28]

Figure 5



[27]For proof, please see appendix B

[28]See figure 5.

Here $S_3(\beta)$ is the advantage of lower labor cost of outsourcing. $M(\theta^*)$ is the disadvantage of outsourcing in the south because of the adverse selection problem.

3.4 The comparative statics

We want to see the relationship between θ^* and three cutoff points.

Claim 3.[29]

When θ^* goes up, three cutoff points (i.e. $\beta_{FN}, \beta_{ON}, \beta_{OF}$) increase.

It is not difficult to see that the first two cutoff points increase when θ^* goes up, because the expected payoffs of OS and FS go up while the payoff of producing in the north stays unchanged. But the economic meaning of the relationship between the last cutoff point and θ^* is not straightforward. Why when technology in the south develops, the outsourcing becomes more attractive compared with FDI. One possible interpretation is that the second effect (i.e. the information rent effect) of the increased θ^* on Π_O^S is positive in total. Because of this, there is one additional positive effect in the OS case. So the expected profit in the case of outsourcing will increase faster than that in the case of FDI.[30]

It is easy to see that when p or d goes up, β_O^F increases. This is because the efficiency wage increases. Also, when w_S decreases, the cutoff point β_{OF} goes up.

3.5 Important findings

There are only two types relationships between above three cutoff points.[31] Based on the discussion above, we have the followings important results.

[29]For proof, please see appendix C.

[30]Still, I need some empirical findings to support my result.

[31]For details, please see appendix D.

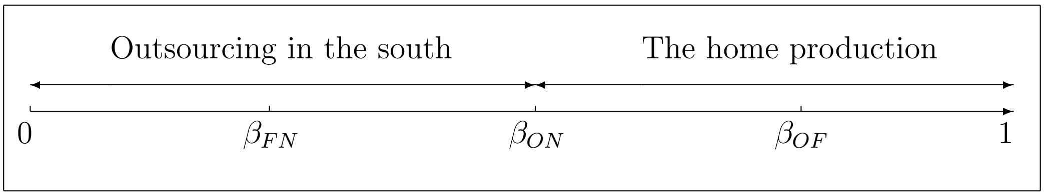
$$\beta_{FN} < \beta_{ON} < \beta_{OF} \; (case\ 1)$$

$$\beta_{FN} > \beta_{ON} > \beta_{OF} \; (case\ 2)$$

Proposition 1.

Under assumptions $1-4$ and in case 1, there exists one $\beta_{ON} \in (0,1)$, when $\beta > \beta_{ON}$, the home production is optimal, when $\beta < \beta_{ON}$, outsourcing in the south is optimal.

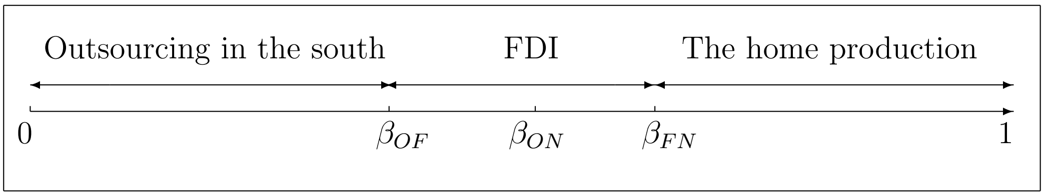
The illustration is the following.



Proposition 2.

Under assumptions $1-4$ and in case 2, there exist $1 > \beta_{FN} > \beta_{ON} > \beta_{OF} > 0$, when $\beta > \beta_{FN}$, the home production is optimal; when $\beta_{FN} > \beta > \beta_{OF}$, FDI is optimal. when $\beta < \beta_{OF}$, outsourcing in the south is optimal.

The illustration is the following.



From proposition 2, we have the following main result of this paper:

Compared with outsourcing, intra-firm trade (FDI) is heavily concentrated in capital-intensive industries.

Other than proposition 1 and 2, we have some empirical hypotheses from the discussion above.

Testable Hypothesis 1**.**

When the southern country becomes more efficient in the intermediate good's production, the outsourcing in the south becomes more possible; the home production becomes less possible.

Testable Hypothesis 2**.**

In the south, the average wage of the employees who work for the MNE affiliated intermediate goods supplier is higher than that of the works who work for the home country's intermediate goods supplier.

I hope the findings from empirical research will support my hypotheses.[32]

4 The concluding remarks

I present a simple model using the contract theory to explain the behavior of the multinational firm. The main ideas are that for the firm which has high enough capital intensity the option of producing at home is optimal, because it cannot use the advantage of the lower labor cost in the south. For the firm whose capital intensity falls into the middle range, the option of FDI will be optimal, because it can avoid the adverse selection problem by using relatively small proportion of governance cost (i.e. wage premium). For the least capital-intensive firm, the option of outsourcing in the south is optimal. This is because it can use the advantage of lower labor cost and cannot

[32]In Graham (2000), he reports that the average wage of the employees who work for the MNE affiliated intermediate goods supplier is on average ten percent higher than that of the works who work for the home country's intermediate goods supplier and in some cases, it is forty or even one hundred percent higher.

avoid the adverse selection problem by using relatively small proportion of governance cost.

The features of this paper are listed as follow. First, The information problem has been studied in this paper as the disadvantage of engaging in outsourcing, which I think has been ignored by the previous research. Second, This paper gives a new explanation for the wage premium in the MNE companies.[33] Finally, the adverse selection problem in the Outsourcing case and the moral hazard problem in the FDI case are all derived from the cross border ingredient of goods trade and integration. Consequently, the cross border ingredient of economic activities (i.e. outsourcing and integration) plays a crucial role in this paper's scenario which is different from the story of the economic activities (i.e. outsourcing and integration) within a specific country.

[33]The MNE wants to prevent the employees from shirking.

References:

1. Aghion, Philippe and Patrick Bolton (1992), "An Incomplete Contracts Approach to Financial Contracting," *Review of Economic Studies* 59, 473-494.

2. Antras, Pol (2003), "Firms, Contracts, and Trade Structure," *Quarterly Journal of Economics* 118, 1375-1418.

3. Antras, Pol (2005), "Incomplete Contracts and the Product Cycle," *American Economic Review* 95, 1054-1073.

4. Antras, Pol and Elhanan Helpman (2004), "Global Sourcing," *Journal of Political Economy* 112, 552-580.

5. Antras, Pol (2007), International Economics I Unpublished Lecture Notes MIT.

6. Coase, Ronald (1937), "The Nature of the Firm," *Economica* 4, 386-405.

7. Cremer, Jacques (1995), "Arm's Length Relationships," *Quarterly Journal of Economics* 110, 275-295.

8. Dixit, Avinash and Joseph Stigtitz (1977), "Monopolistic Competition and optimum product diversity," *American Economics Review* 67, 297-308.

9. Fudenberg, Drew and Jean Tirole (1991), Game Theory (Cambridge, MA: The MIT Press).

10. Graham,E. (2000), Fighting the Wrong Enemy: Antiglobal Activists and Multinational Enterprise (Washington, DC: Institute for International Economics).

11. Grossman, Gene and Elhanan Helpman (2002), "Integration versus Outsourcing in Industry Equilibrium," *Quarterly Journal of Economics* 117, 85-120.

12. Grossman, Gene and Elhanan Helpman (2003), "Outsourcing versus FDI in Indus- try Equilibrium," *Journal of the European Economic Association* 1, 317-327.

13. Grossman, Gene and Elhanan Helpman (2005), "Outsourcing in a Global Economy," *Review of Economic Studies* 72, 135-159.

14. Grossman, Sanford and Oliver D. Hart (1986), "Costs and benefits of ownership: a theory of vertical and lateral integration," *Journal of Political Economy* 94, 691-719.

15. Hart,Oliver(1995), Firms, Contracts and Market Structure (Oxford: Oxford University Press).

16. Hart, Oliver and John Moore (1990), "Property rights and the nature of the firm," *Journal of Political Economy* 98, 1119-1158.

17. Helpman, Elhanan (2006), "Trade, FDI, and the Organization of Firms," *Journal of Economic Literature* 44, 589-630.

18. Helpman, Elhanan and Paul R. Krugman (1985), Market Structure and Foreign Trade Cambridge (Cambridge, MA: The MIT Press).

19. McLaren, John (2000), "Globalization and vertical structure," *American Economic Review* 90, 1239-1254.

20. Melitz, Marc (2003), "The impact of trade on intra-industry reallocations and aggregate industry productivity, " *Econometrica* 71, 1695-1725.

21. OECD (2001) Measuring globalization: The role of multinationals in OECD economies, manufacturing and services (Paris: OECD).

22. Schmidt, Klaus (1996), "The Costs and Benefits of Privatization: An Incomplete Contracts Approach ," *The Journal of Law, Economics and Organization* 12, 1-24.

23. Venables, Anthony and Giorgio Navaretti(2004), Multinational Firms in the World Economy (Princeton, NJ: Princeton University Press).

Appendix A

Supposing that

$$\frac{(1-\theta^{*\frac{1+\alpha}{1-\alpha}})}{(1+\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})} \geq 1,$$

We get:

$$T(\theta^*) = (1-\theta^{*(1+\alpha)/(1-\alpha)}) - (1+\alpha)(1-\theta^{*1/(1-\alpha)}) \geq 0.$$

But

$$\frac{dT}{d\theta^*} = \frac{(1+\alpha)}{(1-\alpha)}(\theta^{*\alpha/(1-\alpha)} - \theta^{*2\alpha/(1-\alpha)}) > 0.$$

So $T(\theta^*) < T(1) = 0$. (a contradiction)

So we have lemma 1:

$$0 < \frac{(1-\theta^{*\frac{1+\alpha}{1-\alpha}})}{(1+\alpha)(1-\theta^{*\frac{1}{(1-\alpha)}})} < 1$$

Appendix B

Differentiating M with respect to θ^*, we get:

$$\begin{aligned}\frac{dM}{d\theta^*} &= Sign(1+\alpha)\theta^{*2\alpha/(1-\alpha)}(1-\theta^{*1/(1-\alpha)}) - \theta^{*\alpha/(1-\alpha)}(1-\theta^{*(1+\alpha)/(1-\alpha)}) \\ &= Sign(1+\alpha)\theta^{*2\alpha/(1-\alpha)} - \alpha\theta^{*(1+2\alpha)/(1-\alpha)} - \theta^{*\alpha/(1-\alpha)}\end{aligned}$$

Because $y = \theta^{*x}$ is a convex function. By Jensen's inequality, we have:

$$\frac{\alpha}{(1+\alpha)}\theta^{*(1+2\alpha)/(1-\alpha)} + \frac{1}{(1+\alpha)}\theta^{*\alpha/(1-\alpha)} > \theta^{*2\alpha/(1-\alpha)}.$$

So, we have:

$$\frac{dM}{d\theta^*} < 0.$$

Appendix C

Because an increase in θ^* will lead increases in the expected payoffs in the FS case and the OS case leaving the payoff in the IN case unchanged, β_{FN} and β_{ON} will go up when θ^* increases.

From appendix B, we know that $M(\theta^*)$ is monotonically decreasing in θ^*, so an increase in θ^* will lead an increase in β_{OF} also.

Appendix D

From above, we have:

$$1 - \beta_{ON} = \frac{\log L(\theta^*)}{\log (\frac{w_N}{w_S})^{\alpha/(1-\alpha)}} = \frac{\log H(\theta^*) + \log M(\theta^*)}{\log (\frac{w_N}{\tilde{w}_S})^{\alpha/(1-\alpha)} + \log (\frac{\tilde{w}_S}{w_S})^{\alpha/(1-\alpha)}}.$$

$$1 - \beta_{FN} = \frac{\log H(\theta^*)}{\log (\frac{w_N}{\tilde{w}_S})^{\alpha/(1-\alpha)}};$$

$$1 - \beta_{OF} = \frac{\log M(\theta^*)}{\log (\frac{\tilde{w}_S}{w_S})^{\alpha/(1-\alpha)}}.$$

From above, we know that the value of $1-\beta_{ON}$ must be between the value of $1 - \beta_{FN}$ and $1 - \beta_{OF}$. Accordingly, the following result is straightforward.

$$(1 - \beta_{FN} < 1 - \beta_{ON} < 1 - \beta_{OF}) or (1 - \beta_{FN} > 1 - \beta_{ON} > 1 - \beta_{OF}).$$

This is equivalent to

$$(\beta_{FN} > \beta_{ON} > \beta_{OF}) or (\beta_{FN} < \beta_{ON} < \beta_{OF}).$$

Appendix E

E-1. The number of firms

I extend the analysis above to the general equilibrium framework in this section. There are two main purpose of doing general equilibrium analysis.

The first one is that I want to know the number of operating firms (intermediate goods suppliers and final goods producers) in the north and the south in the equilibrium. The second goal is to determine the wage rates in two countries endogenously and check the existence of assumptions in the model. If the assumptions are possible for some values of parameters, we can conclude that the context studied in partial equilibrium analysis is possible under some circumstances.

There are some new ingredients in the model. The preference of the representative consumer can be represented by the following utility function:

$$U = \int_0^N \log \left(\int_0^{n_j} y_j(i)^\alpha di \right)^{(1/\alpha)} dj.$$

N is the number of industry, which is constant. n_j is the number of varieties in industry j. I want to determine n_j, because this is also the number of operating final goods producers in industry j in the equilibrium.

The entry into the final good's industry in the north and the intermediate good's industry in the south require the fixed labor costs: F_f and F_I.[34] I assume that the number of intermediate goods suppliers in the south is large than that of the final goods producers, so the MNE can find a partner in the south with probability one in the OS and FS cases. On the contrary, the intermediate goods supplier just can meet the partner in the north with probability less than one, which equals to the ratio of the number of final goods producers and the number of intermediate goods suppliers.[35]

I make some notations about the number of the firms in the equilibrium.

[34] I do not want to add any new factor that the MNE has to consider when it chooses between IN, FS and OS. So I assume all the entry costs are the same across production types.

[35] There is a matching process between the final goods producer and the intermediate goods producer and I assume that the matching process exhibits constant returns to scale as Grossman and Helpman (2002).

M_N^H: the number of the final goods producer in the IN case;
M_N^O: the number of the final goods producer in the OS case;
M_N^F: the number of the final goods producer in the FS case;
M_N^I: the number of the intermediate goods supplier in the IN case;
M_S^O: the number of the intermediate goods supplier in the OS case;
M_S^F: the number of the intermediate goods supplier in the FS case;
E: The total income of the world (i.e. $E = K + w_N L_N + w_S L_S$).

From the definition of λ_j and the property of the representative consumer's utility function, we can write λ_j as follow.

$$\lambda_j = \frac{E}{N \int_0^{n_j} p_j(i)^{-\alpha/(1-\alpha)} di}.$$

E-1-1. The IN case

First we calculate the simplest case: IN case. Because the final goods producer owns the intermediate goods supplier in this case, we have $M_N^H = M_N^I$.

the zero profit condition for the MNE[36] is:

$$(1-\alpha)\lambda_j \left(\frac{\alpha}{r_N^{\beta} w_N^{(1-\beta)}} \right)^{\alpha/(1-\alpha)} = f_F w_N.$$

$$\lambda_j = \frac{E}{N M_N^H \left(w_N^{(1-\beta)}/\alpha \right)^{-\alpha/(1-\alpha)}}.$$

So the number of MNE and the intermediate goods supplier is

$$M_N^H = M_N^I = \frac{(1-\alpha)E}{f_F w_N N}. \tag{4}$$

E-1-2. The OS case

[36] In fact, if the firm does the home production, you may not call it the MNE. But for simplicity, I maintain this name for the firm.

The zero expected profit condition for MNE is

$$\left[(1-\alpha)\lambda_j\left(\frac{\alpha}{w_S^{(1-\beta)}}\right)^{\frac{\alpha}{(1-\alpha)}}\frac{(1-\alpha)(1-\theta^{*\frac{1+\alpha}{1-\alpha}})}{(1+\alpha)(1-\theta^*)}\right]=f_Fw_N.$$

From the above, we have:

$$\lambda_j=\frac{(1-\theta^*)}{NM_O^N\left(w_S^{(1-\beta)}/\alpha\right)^{-\alpha/(1-\alpha)}\int_{\theta^*}^1\theta^{\frac{2\alpha}{(1-\alpha)}}d\theta},$$

$$M_N^O=M_N^H=\frac{(1-\alpha)E}{f_Fw_NN}. \tag{5}$$

For the intermediate supplier, there is a matching process between them and MNEs.[37] We add another assumption to calculate the number of the intermediate supplier:

$$\theta^*=0.$$

The zero expected profit for the intermediate goods supplier is

$$\bar{\pi}_Op_O=f_Iw_S.$$

$$p_O=\frac{M_N^O}{M_S^O};\bar{\pi}_O=\frac{\alpha}{2}f_Fw_N.^{38}$$

We have to make an assumption to ensure the number of the intermediate goods supplier is larger than that of MNE in the north.

Assumption 5.[39]

[37]If a intermediate supplier does not find the partner in the north, it will earn zero revenue.

[38]For details, please see appendix F.

[39]This assumption ensures that the number of intermediate goods suppliers is larger than the number of MNEs in the equilibrium.

$$\frac{\bar{\pi}_O}{f_I w_S} > 1.$$

Finally, we have:

$$M_S^O = \frac{\alpha(1-\alpha)E}{2 f_I w_S N}. \tag{6}$$

E-1-3. The FS case

The zero expected profit condition for MNE is

$$(1-\alpha)^2 \lambda_j \left(\frac{\alpha}{\tilde{w}_S^{(1-\beta)}}\right)^{\frac{\alpha}{(1-\alpha)}} \frac{(1-\theta^{*\frac{1}{1-\alpha}})}{(1-\theta^*)} = f_F w_N.$$

$$\lambda_j = \frac{(1-\theta^*)}{N M_F^N \left(\tilde{w}_S^{(1-\beta)}/\alpha\right)^{-\alpha/(1-\alpha)} \int_{\theta^*}^1 \theta^{\frac{\alpha}{(1-\alpha)}} d\theta}.$$

$$M_N^F = M_N^O = M_N^H = \frac{(1-\alpha)E}{f_F w_N N}. \tag{7}$$

For the intermediate supplier, there is a matching process between them and MNE. We add another assumption to calculate the number of the intermediate supplier:

$$\theta^* = 0.$$

The zero expected profit for the intermediate goods supplier is

$$\bar{\pi}_F p_F = f_I w_S.$$

$$p_F = \frac{M_N^F}{M_S^F}; \bar{\pi}_F = \frac{\alpha d(1-\beta)}{\tilde{w}_S(1-\alpha)(1-p)} f_F w_N.\text{[40]}$$

[40] For details, please see appendix F.

We have to make an assumption to ensure the number of the intermediate goods supplier is larger than that of MNE in the north.

Assumption 6.[41]

$$\frac{\bar{\pi}_F}{f_I w_S} > 1.$$

$$M_S^F = \frac{\alpha(1-\beta)dE}{N f_I w_S \tilde{w}_S (1-p)}. \tag{8}$$

It is very interesting that the number of MNEs in three cases are the same, especially no matter the value of θ^* is. The economic interpretation is that an increase in θ^* leads an increase in the expected profits of MNEs for any given λ_j. But the competitors will charge more aggressive (cheaper) prices because of the improvement in technology. So the term λ_j itself decreases. As a result, the two effects offset each other completely and the number of MNEs does not change in each of the three cases.

E-2. The wage rates

In this section, I will calculate the equilibrium wage rates in the north and the south. Then I will justify the existence of the two possible equilibriums. We have three equations (full employment conditions) to pin down two wage rates. Because of the Walras's law, one equation is abundant. So we neglect the full employment condition in the world capital market.[42]

E-2-1. The OS-IN type

We first consider the first possible equilibrium—OS-IN type.

The full employment conditions of the labor in the north and the south are[43]

[41] This assumption ensures that the number of intermediate goods suppliers is larger than the number of MNEs in the equilibrium.

[42] In this section, we maintain the assumption: $\theta^* = 0$.

[43] For details, please see appendix H.

$$(1-\alpha)E + \alpha E\left(\frac{1}{2} - \beta_{ON} + \frac{\beta_{ON}^2}{2}\right) = w_N L_N......(1)$$

$$\frac{1}{2}\alpha(1+\alpha)\left(\beta_{ON} - \frac{\beta_{ON}^2}{2}\right)E + \frac{1}{2}\alpha(1-\alpha)\beta_{ON}E = w_S L_S......(2)$$

(1)/(2), we get:

$$\omega = \frac{w_N}{w_S} = \frac{L_S}{L_N}\frac{(1-\alpha) + \alpha\left(\frac{1}{2} - \beta_{ON} + \frac{\beta_{ON}^2}{2}\right)}{\frac{1}{2}\alpha(1+\alpha)\left(\beta_{ON} - \frac{\beta_{ON}^2}{2}\right) + \frac{1}{2}\alpha(1-\alpha)\beta_{ON}} = \frac{L_S}{L_N}B(\beta_{ON}).$$

We have:

$$\beta_{ON} = 1 - \frac{\log(1+\alpha)/(1-\alpha)}{\log\left(\frac{w_N}{w_S}\right)^{\alpha/(1-\alpha)}}......(3)$$

From (3), we get

$$\omega = \frac{w_N}{w_S} = C(\beta_{ON}).$$

It is easy to see that $B(\beta_{ON})$ is a monotonically decreasing function of β_{ON}. On the contrary, $C(\beta_{ON})$ is a monotonically increasing function of $B(\beta_{ON})$ and $C(\beta_{ON}) > C(0) > 1$. Having the above two functions, we can pin down ω and β_{ON} (see figure 6).

We have the following proposition:

Proposition 3.
In IN-OS type equilibrium, the wage rates are endogenously determined and the wage rate in the north is higher than that in the south.[44]

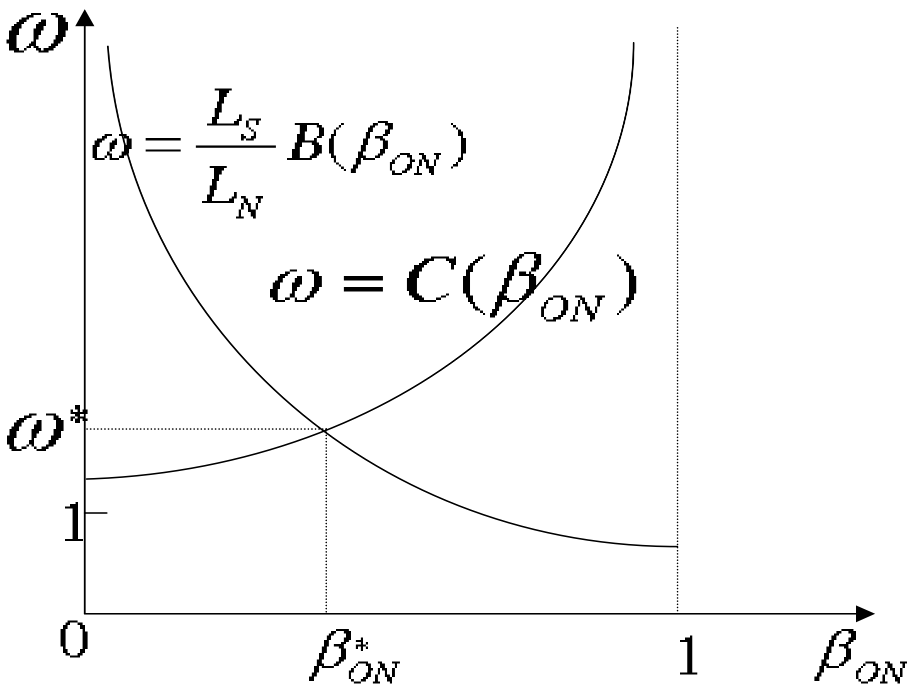
We can see that when the labor endowment in the south increases or the labor endowment in the north decreases, the cutoff point β_{ON} and the ratio of the wage rates in north and south will increase. The economic intuition is straightforward: relatively more labor endowment in the south can make

[44]See figure 6.

the labor force in the south cheaper and can attract more MNEs from the north.

We can check the conditions that ensure the existence of this type's equilibrium: $\beta_{FN} < \beta_{ON} < \beta_{OF}$; $\beta_{FN} > 0$ and $\beta_{OF} < 1$ which mean:

Figure 6



$$\frac{\log\left(\frac{\tilde{w}_S}{w_S}\right)\log\left(\frac{1}{1-\alpha}\right)}{\log(1+\alpha)} > \log\frac{w_N}{\tilde{w}_S} > \frac{(1-\alpha)}{\alpha}\log\left(\frac{1}{1-\alpha}\right).$$

When $\alpha = 0.5$, this condition becomes:

$$\frac{\log\left(\frac{\tilde{w}_S}{w_S}\right)\log 2}{\log 1.5} > \log\frac{w_N}{\tilde{w}_S} > \log 2.$$

If the equilibrium ω^* is large enough and the wage premium d is large enough, this condition will be satisfied.

The economic meaning is that when the wage rate in the south is much more lower than that in the north, it is profitable for the MNE to go to the south in the labor-intensive industry. Furthermore, when the wage premium is much higher compared with the usual wage rate (the fixed payment) in the south, the option of FDI will be excluded from the equilibrium.

E-2-2. The OS-FS-IN type

Next, we consider the OS-FS-IN type equilibrium.

The full employment conditions of the labor in the north and the south are[45]

$$(1-\alpha)E + \alpha\left(\frac{1}{2} - \beta_{FN} + \frac{\beta_{FN}^2}{2}\right)E = w_N L_N ......(4)$$

$$\alpha\big(\beta_{FN} - \frac{\beta_{FN}^2}{2}\big)E + \frac{(1-\alpha)\alpha\beta_{OF}^2}{4}E = w_S L_S ......(5)$$

It is interesting that the efficiency wage $\tilde{w}^S$ does not appear in equilibrium equations. Why this happens? The reason is that when w_N and w_S do not change and d increases, the labor use in the FDI case will decrease but the number of potential entrants will increase, which means more labor will be consumed as fixed costs. And more industries will choose outsourcing which consumer relatively more labor in the production process.

(4)/(5), we get (6):

$$\omega = \frac{w_N}{w_S} = \frac{L_S}{L_N}\frac{(1-\alpha) + \alpha\left(\frac{1}{2} - \beta_{FN} + \frac{\beta_{FN}^2}{2}\right)}{\alpha\big(\beta_{FN} - \frac{\beta_{FN}^2}{2}\big) + \frac{(1-\alpha)\alpha\beta_{OF}^2}{4}} = \frac{L_S}{L_N}B^*(\beta_{FN}, \beta_{OF}) ......(6)$$

We have the following results from appendix D:

[45]For details, please see appendix I.

$$\beta_{FN} = 1 - \frac{(1-\alpha)\log\left(\frac{1}{1-\alpha}\right)}{\alpha\log\left(\frac{w_N}{\tilde{w}_S}\right)} ......(7)$$

$$\beta_{OF} = 1 - \frac{(1-\alpha)\log(1+\alpha)}{\alpha\log\left(\frac{\tilde{w}_S}{w_S}\right)} ......(8)$$

From (7) and (8), we get

$$\frac{\log\left(\frac{1}{1-\alpha}\right)}{1-\beta_{FN}} + \frac{\log(1+\alpha)}{1-\beta_{OF}} = \frac{\alpha}{(1-\alpha)}\log\omega$$

or

$$\omega = C^*(\beta_{FN}, \beta_{OF}).$$

Here $B^*(\beta_{FN}, \beta_{OF})$ is a monotonically decreasing function in (β_{FN}, β_{OF}). $C^*(\beta_{FN}, \beta_{OF})$ is a monotonically increasing function in (β_{FN}, β_{OF}),

$$B^*(\beta_{FN}, \beta_{OF}) \geq B^*(1,1) = \frac{4L_S(1-\alpha)}{L_N(3\alpha - \alpha^2)}.$$

When $\frac{L_S}{L_N}$ is large enough,

$$B^*(\beta_{FN}, \beta_{OF}) > 1(0 < \beta_{FN} < 1, 0 < \beta_{OF} < 1)$$

Generally we have the equilibrium wage rates in the north and south from equations (4) and (5). So there exists ω^*, which is larger than one in equilibrium.

Now, we have the following proposition.

Proposition 4.

In IN-FS-OS type equilibrium, the wage rates are endogenously determined and the wage rate in the north is higher than that in the south in equilibrium.

We can check the conditions that ensure the existence of this type's equilibrium: $\beta_{FN} > \beta_{ON} > \beta_{OF}$; $\beta_{FN} < 1$ and $\beta_{OF} > 0$ which mean:

$$\frac{\log\left(\frac{w_N}{\tilde{w}_S}\right)\log(1+\alpha)}{\log\left(\frac{1}{1-\alpha}\right)} > \log\left(\frac{\tilde{w}_S}{w_S}\right) > \frac{(1-\alpha)}{\alpha}\log(1+\alpha).$$

When $\alpha = 0.5$, this condition becomes

$$\frac{\log\left(\frac{w_N}{\tilde{w}_S}\right)\log 1.5}{\log 2} > \log\left(\frac{\tilde{w}_S}{w_S}\right) > \log 1.5$$

If the equilibrium ω^* is large enough and the wage premium d is not large enough compared with the wage rate in the south, this condition will be satisfied.

The economic meaning is that when the wage rate in the south is much more lower than that in the north, it is profitable for MNEs to go to the south in the labor-intensive industry. Furthermore, when the wage premium is not so higher compared with the usual wage rate in the south, the option of FDI will be included into the equilibrium. For those firms, whose capital intensities fall into the middle range of $[0, 1]$, the option of FDI will be optimal.

Appendix F

We calculate the expected payoff for the intermediate goods supplier in the OS case in the following way:

$$\begin{aligned}\bar{\pi}_O &= \int_{\theta^*}^{1} \left(T - \frac{w_S^{(1-\beta)} y}{\theta}\right) \frac{d\theta}{(1-\theta^*)} \\ &= \int_{\theta^*}^{1} \left(\lambda_j^{1-\alpha} y^{\alpha} - \frac{w_S^{(1-\beta)} y}{\theta}\right) \frac{d\theta}{(1-\theta^*)} - V\end{aligned}$$

Here

$$y(\theta) = \lambda_j \left(\frac{\alpha\theta^2}{w_S^{(1-\beta)}}\right)^{1/(1-\alpha)};$$

$$\lambda_j = \frac{(1+\alpha) f_F w_N}{(1-\alpha)^2 (w_S^{(1-\beta)}/\alpha)^{-\alpha/(1-\alpha)}};$$

$$V = \Pi_O^S = \left[(1-\alpha)\lambda_j \left(\frac{\alpha}{w_S^{(1-\beta)}} \right)^{\frac{\alpha}{(1-\alpha)}} \frac{(1-\alpha)(1-\theta^{*\frac{1+\alpha}{1-\alpha}})}{(1+\alpha)(1-\theta^*)} \right].$$

Adding another assumption that $\theta^* = 0$, we get

$$\bar{\pi}_O = \frac{\alpha}{2} f_F w_N.$$

Appendix G

We calculate the expected payoff for the intermediate goods supplier in the FS case in the following way:

The labor use in the intermediate goods supplier that has the productivity level θ is[46]

$$L = \lambda_j \frac{(\alpha\theta)^{1/(1-\alpha)}(1-\beta)\tilde{w}_S^{-\beta}}{\tilde{w}_S^{(1-\beta)/(1-\alpha)}\theta}.$$

The intermediate goods supplier can make positive profit form the wage premium:

$$\frac{d}{(1-p)}.$$

Adding another assumption that $\theta^* = 0$, we get

$$\bar{\Pi}_F = \int_0^1 \theta^{\alpha/(1-\alpha)} \frac{\lambda_j d(1-\beta)\tilde{w}_S^{(\alpha\beta-1)/(1-\alpha)}\alpha^{1/(1-\alpha)}}{(1-p)} d\theta.$$

here

$$\lambda_j = \frac{f_F w_N}{(1-\alpha)^2 (\tilde{w}_S^{(1-\beta)}/\alpha)^{-\alpha/(1-\alpha)}}.$$

[46] For details, please see appendix H.

From aboe, we have the result:

$$\bar{\pi}_F = \frac{\alpha d(1-\beta)}{\tilde{w}_S(1-\alpha)(1-p)} f_F w_N.$$

Appendix H

We have to calculate the labor and capital demands of the final goods producer and the intermediate goods supplier in home production case and outsourcing case.

The labor demand of the fixed cost of the MNE in all industries is

$$f_F N \frac{(1-\alpha)E}{f_F N w_N} = \frac{(1-\alpha)E}{w_N}.$$

In the IN case, the labor and capital demands in the production of the intermediate goods in the north are

$$L = \frac{(1-\beta)y}{w_N^{(1-\beta)}} = \frac{\alpha(1-\beta)}{(1-\alpha)} f_F;$$

$$K = \beta w_N^{(1-\beta)} y = \frac{\alpha\beta}{(1-\alpha)} f_F w_N.$$

In the OS case, the labor demand of fixed cost of one industry in the south is

$$f_I \frac{\alpha(1-\alpha)E}{2 f_I w_S N} = \frac{\alpha(1-\alpha)E}{2 w_S N}.$$

In the OS case, the labor and capital demands in the production of the intermediate goods in the south are

$$L = \frac{\alpha(1-\beta)(1+\alpha)\theta^{(1+\alpha)/(1-\alpha)} f_F w_N}{(1-\alpha)^2 w_S};$$

$$K = \frac{\alpha\beta(1+\alpha)\theta^{(1+\alpha)/(1-\alpha)} f_F w_N}{(1-\alpha)^2}.$$

So the full employment condition in the north is

$$\frac{(1-\alpha)E}{w_N} + \int_{\beta_{ON}}^{1} \Big(N\frac{\alpha(1-\beta)}{(1-\alpha)} f_F \frac{(1-\alpha)E}{f_F N w_N} \Big) d\beta = L_N.$$

or

$$(1-\alpha)E + \alpha E\left(\frac{1}{2} - \beta_{ON} + \frac{\beta_{ON}^2}{2}\right) = w_N L_N......(1)$$

The full employment condition in the south is

$$\int_0^1 \int_0^{\beta_{ON}} \left(\frac{\alpha(1-\beta)(1+\alpha)\theta^{(1+\alpha)/(1-\alpha)} f_F w_N}{(1-\alpha)^2 w_S} \times \frac{(1-\alpha)E}{f_F w_N} \right) d\beta d\theta + \frac{\alpha(1-\alpha)E\beta_{ON}}{2w_S} = L_S.$$

or

$$\frac{1}{2}\alpha(1+\alpha)\left(\beta_{ON} - \frac{\beta_{ON}^2}{2}\right)E + \frac{1}{2}\alpha(1-\alpha)\beta_{ON}E = w_S L_S......(2)$$

Appendix I

In order to calculate the labor demand in the OS-FS-IN type's equilibrium, we have to calculate the labor demand in the FS case.

In the FS case, the labor demand of fixed cost of one industry in the south is

$$f_I \frac{\alpha(1-\beta)E}{N f_I w_S \tilde{w}_S} \times \frac{d}{(1-p)} = \frac{\alpha(1-\beta)E}{N w_S \tilde{w}_S} \times \frac{d}{(1-p)}.$$

In the FS case, the labor and capital demands in the production of the intermediate goods are

$$L = \frac{\alpha(1-\beta)\theta^{\alpha/(1-\alpha)} f_F w_N}{(1-\alpha)^2 \tilde{w}_S};$$

$$K = \frac{\alpha\beta\theta^{\alpha/(1-\alpha)} f_F w_N}{(1-\alpha)^2}.$$

The results we obtained in appendix-H are still correct in this section. So the full employment condition in the north is

$$\frac{(1-\alpha)E}{w_N} + \int_{\beta_{FN}}^{1} \Big(N\frac{\alpha(1-\beta)}{(1-\alpha)} f_F \frac{(1-\alpha)E}{f_F N w_N}\Big) d\beta = L_N.$$

or

$$(1-\alpha)E + \alpha E\left(\frac{1}{2} - \beta_{FN} + \frac{\beta_{FN}^2}{2}\right) = w_N L_N......(4)$$

The labor demand of the intermediate supplier in the OS case[47]

$$\frac{E}{2w_S}\alpha(1+\alpha)\left(\beta_{OF} - \frac{\beta_{OF}^2}{2}\right)E + \frac{E}{2w_S}\alpha(1-\alpha)\beta_{OF}......(9)$$

The variable labor demand of the intermediate supplier in the FS case:

$$\int_0^1 \int_{\beta_{OF}}^{\beta_{ON}} \left(\frac{\alpha(1-\beta)\theta^{\alpha/(1-\alpha)} f_F w_N}{(1-\alpha)^2 \tilde{w}_S} \times \frac{(1-\alpha)E}{f_F w_N}\right) d\beta d\theta$$

$$= \frac{\alpha E}{\tilde{w}_S}\Big(\beta_{FN} - \frac{\beta_{FN}^2}{2} - \beta_{OF} + \frac{\beta_{OF}^2}{2}\Big)......(10)$$

The fixed labor demand of the intermediate supplier in the FS case:

$$\int_{\beta_{OF}}^{\beta_{ON}} \left(\frac{\alpha(1-\beta)E}{N w_S \tilde{w}_S} \times \frac{d}{(1-p)} \times N\right) d\beta$$

$$= \frac{\alpha E}{w_S \tilde{w}_S} \times \frac{d}{(1-p)} \times \Big(\beta_{FN} - \frac{\beta_{FN}^2}{2} - \beta_{OF} + \frac{\beta_{OF}^2}{2}\Big)......(11)$$

Finally, we add equation (9)-(11) to get the full employment condition in the south:[48]

$$\alpha\big(\beta_{FN} - \frac{\beta_{FN}^2}{2}\big)E + \frac{(1-\alpha)\alpha\beta_{OF}^2}{4}E = w_S L_S......(5)$$

[47]It is similar to equation (2)

[48]In calculation, you need to use the fact that (9)+(10)+(11) $= L_S$ and $\frac{d}{(1-p)} = \tilde{w}_S - w_S$.