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National Factor Endowment, Sector-specific Intensity, Technological Dependency and Organizational Structure: A Property-right Approach

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Abstract: This document using property-right approach analyzes the effect of national factor endowment, sector-specific intensity of head-quarter services and the degree of technological dependency on the decision of organizational structures of final-good producers.We highlight that the technological dependency of the final-good producer on the supplier is a significant factor resulting to the heterogeneity of firms within sectors so as their organizational structures. The conclusion is that cost advantage resulting from national factor endowment has significant effect on the decision of organizational structure of the final-good producer with high degree of technological dependency. The sector-specific intensity of head-quarter service has significant effect on the decision of organizational structure of the final-good producer with low degree of technological dependency.

Keywords:property-right approach, organizational structure, degree of technological dependency, integration, outsourcing

1. INTRODUCTION

Since 1980s, globalization and integration of world economy has become an irreversible trend resulted from technological innovations in communication and transportation.And with the deepening of international division of labor which is from inter-industry specialization to intra-industry specialization and then to intra-product specialization, traditional theories have undergone a substantial transformation that heterogeneous firms rather than countries or industries have been the center of analysis. Studies on the organizational structures and international strategies of firms are becoming more and more important.

Traditional theories of multinational corporations are vertical integration (Helpman,1984[1]； Helpman and Krugman, 1985[2])and horizontal integration (Markusen，1984)[3]. Markusen(2002)[4]incorporates vertical and horizontal integration into knowledge-capital model to analyze the international strategies of firms. Motta and Norman (1996)[5], Hanson, Mataloni and Slaughter(2001)[6], Ekholm et al.(2007)[7]show that products manufactured by foreign affiliates of multinational corporations have been exported to the country which is neither source country nor host country andhost country is more likely an export-platform. Ekholm et al. (2007) introduce a model with three countries to study the “export-platform” integration strategy. They indicate that variable cost advantage and high fixed cost of overseas production encourage the “export-platform” investment which explained the FDI from source country to host country combined with export from host country to the third country.Yeaple (2003)[8]constructs a complex integration model within a north-south framework and the conclusion is that when transportation cost is low, if endowment difference between north and south is significant, firms choose vertical integration; if endowment difference is small, firms choose domestic integration. When transportation cost is moderate and endowment difference is great, firms choose complex integration. When transportation cost is high, firms choose horizontal integration.

Since the late 1990s, lots of empirical studies challengethe assumption of traditional theories onthe homogeneous firms within industries. Clerides et al.(1998)[9] using Columbia data, Bernard and Jensen(1999)[10] , Helpman et al. (2004)[11]using U.S. data and Bee-Yan et al. (2000)[12] using Taiwan data

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among others, have uncovered stylized facts that exporters are in the minority within so-called exporting industries, and they are more productive and larger.Mayer and Ottaviano (2007)[13]estimate that exporters exhibit a 31% higher labor productivity than non-exporters in France. Melitz(2003)[14] introduces a monopolistic competition model with heterogeneous firms which has been a footstone of studies.Grossman et al. (2006)[15] extend the model of Yeaple(2003) by incorporating heterogeneous firms. The conclusion is that firms with low productivity choose domestic integration. Firms with high productivity,when transportation cost is low will choose to produce inputs and final goods in south and when transportation cost is high they will choose to produce inputs in south and assembled final goods in three countries separately. The strategies of firms with moderate productivity depend on fixed cost of overseas production and market size.

Theories of integration strategies focus on the decision of production locationabout intermediate inputs and final goods.More recently, firms are no longer only distributing production stages to different locations, and they also acquire inputs from unaffiliated companies.Outsourcing is becoming a prevailing organizational structure.McLaren (2000)[16]and Grossman and Helpman (2002)[17]highlight that"thickness" of the market is an important factor affecting decisions of firms to outsource.They indicate that there is a trade-off faced by a firm between higher fixed costs of integration production and searching costs for the appropriate supplier.And the probability that a firm matches successfully is positive correlated with degree of market thickness. Grossman and Helpman (2003, 2005)[18.19] stress that the quality of the institutions affects the organizationalstructure of firm because of the incomplete contract between the final-good producer and the supplier. Antràs(2003,2005)[20,21]indicates that the choice between integration and outsourcing depends on the factor intensity of sectors. Antràs and Helpman(2004)[22]consider there is a trade-off between "hold-up" problem related cost and the fixed cost of production. And based on the assumption of higher fixed cost under integration, they conclude that in component intensive sectors, outsourcing prevails over vertical integration, while in headquarter intensive sectors, vertical integration and outsourcing can coexist and specific strategy of a firm depends on its productivity.Antràs (2005)considers that organizational structure and location of production depend on the product cycles. More specifically, component intensity of final good is increasing as the standardization of intermediate inputs. Therefore, the organizational structure of firm is changing consequently.

This document using property-right approach analyzes the optimal organizational structures of final-good producer. We extends Antràs and Helpman(2004) by introducing a new firm-specific factor which is the degree of technological dependency of final-good producers on intermediate suppliers.

2. SETUP A MODEL

There are two countries: home (H) and foreign (F), sharing identical preference of representative consumer, which is given by a C.E.S. utility function:

$$U = \sum_{j=1}^{J} \mu_j \log\left(\int_i y_{ij}^{\alpha} di\right)^{1/\alpha} \qquad (1)$$

Where μ_j is the ratio of expenditure on final goods in sector j to total national income E_L, $L \in (H, F)$, $\sum_j \mu_j = 1$. y_{ij} isa final variety in sector j. α $(0 < \alpha < 1)$ denotes elasticity of substitution across final varieties. When maximizing (1) subject to the budget constraint $\mu_j E_L = \sum_i p_{ij} y_{ij}$, consumer demand for a particular variety is $y_{ij} = A_j p_{ij}^{-1/(1-\alpha)}$ where $A_j = (\mu_j E_L / P_j)$ is real total expenditure in finalvarieties of sector j in country L.There are two agents engaged in production: a final-good producer Z_{ij} located in H who

supplies the head-quarter service intensive input h_{ij} and produces the final good y_{ij} and an intermediate supplier M_{ij} with expertise located in H or F who supplies the customized component intensive input m_{ij}. Production function of the final good is

$$y_{ij} = \theta_{ij}\left[\lambda_j h_{ij}^{\rho_i} + (1-\lambda_j) m_{ij}^{\rho_j}\right]^{1/\rho_i} \quad (2)$$

Where θ_{ij} is productivity of final-good producer Z_{ij}. λ_j is the intensity of head-quarter service in final varieties in sector j. ρ_{ij} is the elasticity of substitution between h_{ij} and m_{ij}, and it represents the degree of technological dependency of Z_{ij} on M_{ij} ($\rho_i < 1$). The larger ρ_{ij} is, the lower the degree of technological dependency of Z_{ij} on M_{ij}. We assume that unit of production h_{ij} or m_{ij} needs unit local combined factor and unit price of combined factors in home country is 1, while its price in foreign countryis ω ($0 < \omega \leq 1$).

Since from now on we discuss a particular sector, we drop the index j from all the variables. The final-good producer Z_i acquires m_i by two organizational structures which are integration (V) and outsourcing (O). Following Grossman and Hart (1986) contracts are incomplete in the sense that only contractible ex ante are the allocation of residual rights and a lump sum transfers between two parties. The ex post bargaining is modeled as a Nash Bargaining game in which the final-good producer obtains a fraction β ($\frac{1}{2} < \beta < 1$) of the ex post gains from the relationship. Following the property rights approach, we assume that ex post bargaining takes place both under outsourcing and under integration. The distribution of surplus is sensitive to the organizational structures. In the case of integration organization, M_i is a division of Z_i. If negotiation fails, Z_i can fire M_i and seize m_i.The outside option of M_i is zero. Z_I can get ϕy_i of final-goods, by firing M_i and his outside option is $\phi^{\alpha} R_i$,where $R_i = p_i y_i$ representing the total revenue. In equilibrium the revenue of Z_i is $\phi^{\alpha} R_i + \beta(1-\phi^{\alpha}) R_i = \beta^{V} R_i$ and revenue of M_i is $(1-\beta)(1-\phi^{\alpha}) R_i = (1-\beta^{V}) R_i$. While in the case of outsourcing organization, M_i is independent supplier and has the residual right of control over m_i. A failure to reach an agreement on the distribution of the surplus leaves both parties with no income. In equilibriumthe revenue of Z_i is $\beta R_i = \beta^{O} R_i$ and the revenue of M_i is $(1-\beta) R_i = (1-\beta^{O}) R_i$, where $\beta^{V} > \beta^{O} = \beta$.It is easy to show that the maximum profit of Z_i in equilibrium is

$$\pi_{Z_i}^{Lk} = A\alpha^{\frac{\alpha}{(1-\alpha)}} \Theta_i \left(\lambda^{\frac{1}{\rho_i}} \beta^{k}\right)^{\frac{\alpha}{(1-\alpha)}} \left(1 + \Phi_i^{\mathrm{Lk}}\right)^{\frac{\alpha-\rho_i}{\rho_i(1-\alpha)}} \left[1 - \alpha\beta^{k} + \Phi_i^{Lk}\left(1 - \alpha + \alpha\beta^{k}\right)\right] - f^{LK} - f_E \quad (3)$$

Where $\Theta_i = \theta_I^{\frac{\alpha}{(1-\alpha)}}$, $\Phi_i^{Lk} = \left(\frac{1-\beta^k}{\beta^k W^L}\right)^{\rho_i/(1-\rho_i)} \left(\frac{1-\lambda}{\lambda}\right)^{1/(1-\rho_i)}$, $W^H = 1, W^F = \omega\ f^{Lk} = f_Z^{Lk} + f_M^{Lk}$.

3. THE OPTIMAL ORGANIZATIONALSTRUCTURES

There are two kinds of organizational structures: integration and outsourcing. The final-good producer will choose the optimal organizational structure which can bring him higher expected profit. So it is straightforward to show that the optimal ownership structure is the solution to derivative the profit of Z_i with β^k:

$$\frac{\partial \pi_{Z_i}^{Lk}}{\partial \beta^k} = A\alpha^{\frac{1}{1-\alpha}}\Theta_i \frac{(\beta^k \lambda^{\frac{1}{\rho_i}})^{\frac{\alpha}{1-\alpha}}}{\beta^k}(1+\Phi_i^{Lk})^{\frac{\alpha-\rho_i}{\rho_i(1-\alpha)}-1}\left[\frac{1-\beta}{1-\alpha} + \frac{1-2\beta}{(1-\rho_i)(1-\beta)}\Phi_i^{Lk} - \frac{\beta^2}{(1-\alpha)(1-\beta)}\Phi_i^{Lk^2}\right] \quad (4)$$

The relationship between the profit of Z_i and β^k depends on the expression in the square brackets of (4), which is a quadratic function of Φ_i^{Lk} ($\Phi_i^{Lk} \geq 0$) and in (0, +∞) there is a unique solution $\Phi_0 = \frac{1}{2}\left(\frac{1}{\beta^k}\right)^2\left\{\frac{(1-2\beta^k)(1-\alpha)}{(1-\rho_i)} + \sqrt{\frac{(1-2\beta^k)^2(1-\alpha)^2}{(1-\rho_i)^2} + \left[2\beta^k\left(1-\beta^k\right)\right]^2}\right\}$ showing as figure 1.

When $\Phi_i^{Lk} > \Phi_0$, we have $\left(\partial \pi_{Z_i}^{Lk} / \partial \beta^k\right) < 0$, which means the profit of Z_i is negative correlative with β^k. In this case, the profit under outsourcing organization is higher. When $\Phi_i^{Lk} < \Phi_0$, we have $\left(\partial \pi_{Z_i}^{Lk} / \partial \beta^k\right) > 0$, which means the profit of Z_i is positive correlative with β^k. In this case, choosing integration organization will bring higher profit. The relationship between Φ_i^{Lk} and Φ_0 depends on the degree of technological dependency ρ_i, the intensity of head-quarter inputs λ and relative factor cost ω.

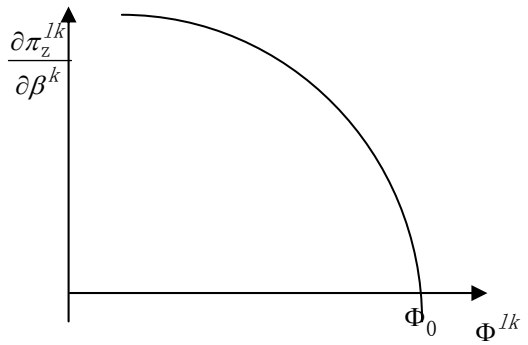

Figure1. Relationship between $\frac{\partial \pi_z^{lk}}{\partial \beta^k}$ and

3.1 The optimal organizational structure in head-quarter intensive sectors[①]

We denote $G = \ln\left(\Phi_i^{Lk} / \Phi_0\right)$. In head-quarter intensive sectors, G is negative correlative with ρ_i, and its

[①] When $\lambda_j > \lambda_H$, $\lambda_H = \left[1 + \left(\frac{\beta^k W^L}{1-\beta^k}\right) e^{-\frac{(2\beta^k-1)(1-\alpha)}{2\beta^k(1-\beta^k)}}\right]^{-1}$, e is the base of natural logarithm.

maximum and minimum are $G_{\max}(\rho \to -\infty) = \ln\left[\left(\frac{\beta^k}{1-\beta^k}\right)^2 W^L\right]$ and $G_{\min}(\rho \to 1) = -\infty$ respectively.

If $W^L < \left[(1-\beta^k)/\beta^k\right]^2$, then $G < 0$ .in this case, integration is a preferable organizationalstructure. If $W^L > \left[(1-\beta^k)/\beta^k\right]^2$ and when the degree of technologial dependency of Z_i is high($\rho_i \in (-\infty, \rho_1)$[①]), then $G > 0$ and outsourcing is a preferable organizational structure. While the degree of techological dependency is low($\rho_i \in (\rho_1, 1)$), then $G < 0$ and integration is a preferable organizational structure.

We can conclude that in head-quarter intensive sectors, when acquiring component inputs from the foreign country with significant cost advantage, the degree of technological dependency has no effect on the decision of organizational structure of final-good producer. In this case, integration is preferable organizational structure. When acquiring component inputs from home or foreign country with insignificant cost advantage, the final-good producer with high degree of technological dependency will choose outsourcing organization, while final-good producer with low degree of technological dependency will choose integration organization.

3.2 The optimal organizational structure in component intensive sectors[②]

In component intensive sectors, G is positive correlative with ρ_i, and its maximum and minimum are $G_{\max}(\rho_i \to 1) = \infty$ 和 $G_{\min}(\rho_i \to -\infty) = \ln\left[\left(\frac{\beta^k}{1-\beta^k}\right)^2 W^L\right]$ respectively. If $W^L < \left[(1-\beta^k)/\beta^k\right]^2$, and when the degree of technological dependency is high($\rho_i \in (-\infty, \rho_2)$[③]), then $G < 0$ and integration is a preferable organizational structure, while when the degree of technologial dependency is low($\rho_i \in (\rho_2, 1)$), then $G > 0$ and outsourcing is a preferable organizational structure. If $W^L > \left[(1-\beta^k)/\beta^k\right]^2$, then $G > 0$. In this case, outsourcing is a preferable organizational structure .

We can conclude that in component intensive sectors, when acquiring component inputsfrom the foreign country with significant cost advantage, the final-good producer with high degree of technological dependency will choose integration structure while the final-good producer with low technological dependency will choose outsourcing structure. When the final-good producer acquires componentinputsform home or the foreign country with insignificant cost advantage, the degree of technological dependency has no effect on his

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① ρ_1 is the solution of $G(\rho_1, \bar{\lambda}) = 0$, where $\left(\frac{1-\bar{\lambda}}{\bar{\lambda}}\right)^{\frac{1}{1-\rho_1}}\left(\frac{1-\beta^k}{\beta^k W^L}\right)^{\frac{\rho_1}{1-\rho_1}} = \frac{1}{2\beta^k}\left\{\sqrt{\left[\frac{(2\beta^k-1)(1-\alpha)}{1-\rho_1}\right]^2 + 4\left[\beta^{k^2}(1-\beta^k)\right]^2} - \frac{(2\beta^k-1)(1-\alpha)}{1-\rho_1}\right\}$, $\bar{\lambda} = \{\lambda \mid \lambda \in (\lambda_H, 1)\}$.

② When $\lambda_j < \lambda_L$, and $\lambda_L = \left(\frac{\beta^k W^L}{1-\beta^k} + 1\right)^{-1}$.

③ ρ_2 is the solution of $G(\rho_2, \underline{\lambda}) = 0$ where $\underline{\lambda} = \{\lambda \mid \lambda \in (0, \lambda_L)\}$.

organizational decision, and outsourcing is a preferable organizational structure.

3.3 The optimal organizational structure in sectors with moderate intensity of head-quarter service

In these sectors, the relationship between G and ρ_i is shown in figur 2. If $W^L < \left[\left(1-\beta^k\right)/\beta^k\right]^2$ and when $G_{\max}\left(\rho_I^*\right) < 0$ [①],corresponding to case 1, then $G < 0$,in this case, integration is preferable organizational strructure.While when $G_{\max}\left(\rho_I^*\right) > 0$ corresponding to case 2, if $\rho_i \in \left(-\infty, \rho_3\right)$ and $\rho_i \in \left(\rho_4,1\right)$, then $G < 0$ and integration is preferable organizational structure, if $\rho_i \in \left(\rho_3, \rho_4\right)$,then $G > 0$, outsourcing is preferable organizational strructure. If $W^L > \left[\left(1-\beta^k\right)/\beta^k\right]^2$ corresponding to case 3, if $\rho_i \in \left(-\infty, \rho_5\right)$, then $G > 0$, outsourcing is preferable organizational strructure, and if $\rho_i \in \left(\rho_5,1\right)$ then $G < 0$ and integration is preferable organizational structure.

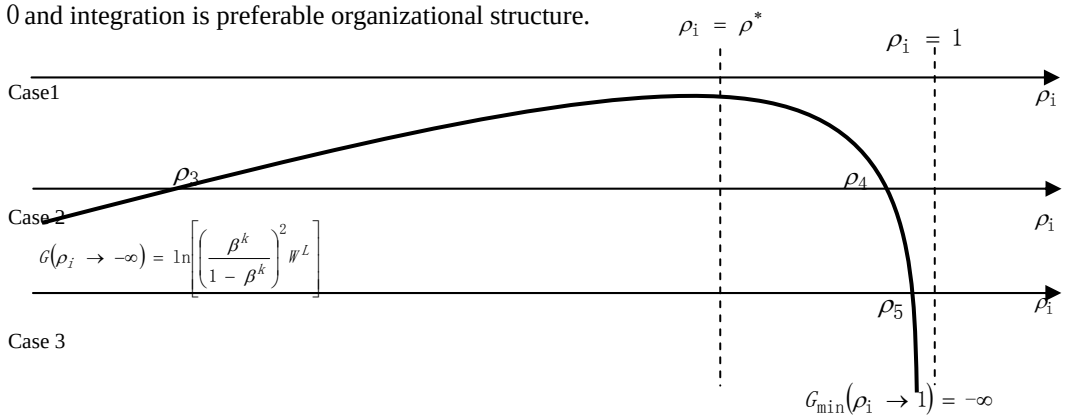

Figure2. The sectors with moderate intensity of head-quarter service

We conclude that when acquiring component inputsfrom the foreign country with significant cost advantage, final-good producer in the sectors with higher intensity of head-quarter service($\lambda_M < \lambda < \lambda_H$) will choose integration organization, and final-good producer in the sectors with lower intensity of head-quarter service ($\lambda_L < \lambda < \lambda_M$), with high or low degree of technological dependency will choose integration, while final-good producer with moderat degree of tech dependency will choose outsourcing. When acquiring componentinputsform home or the foreign country with insignificant cost advantage, final-good producer with higher degree of tech dependency will choose outsourcing organization, and with lower degree of tech dependency will choose integration.

We incorporate the three parts analysis above into table 1. If the cost advantage in foreign country is insignificant, the location of production of customized component does not affect the decision of organizational structures of the final-good producer. In head-quarter intensive sector, the final-good producer with high degree of tech dependencywill choose outsourcing while the final-good producer with low degree of tech dependency will choose integration. In component intensive sectors, final-good producer will choose outsourcing when he acquires customized component either from home or from the foreign country. If the cost advantage of

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① $G_{\max}\left(\rho_I^*\right) = \frac{1}{1-\rho_I^*}\ln\left(\frac{1-\lambda}{\lambda}\right) + \frac{\rho_I^*}{1-\rho_I^*}\ln\left(\frac{1-\beta^k}{\beta^k W^L}\right) + \ln 2\left(\beta^k\right)^2 - \ln\left\{\sqrt{\left[\frac{\left(2\beta^k-1\right)\left(1-\alpha\right)}{1-\rho_I^*}\right]^2 + \left[2\beta^k\left(1-\beta^k\right)\right]^2} - \frac{\left(2\beta^k-1\right)\left(1-\alpha\right)}{1-\rho_I^*}\right\}$ is negative correlative with λ, where ρ_i^* meet the condition $\ln\left[\frac{\left(1-\lambda\right)\left(1-\beta^k\right)}{\lambda\beta^k W^L}\right] + \frac{\left(2\beta^k-1\right)\left(1-\alpha\right)}{\sqrt{\left[\frac{\left(2\beta^k-1\right)\left(1-\alpha\right)}{1-\rho_I^*}\right]^2 + \left[2\beta^k\left(1-\beta^k\right)\right]^2}} = 0$.

production in foreign country is significant, the location of production ofcustomized components affects thedecision of organizational structure of final-good producer with high degree of tech dependency. When he acquires components from home, he will choose outsourcing, and when he acquires components from foreign country, he will choose integration. Sector-specific intensity of head-quarter service has significant effect on the decision of final-good producer with low degree of tech dependency on organizational structure.

Table 1. Cost advantage, intensity of head-quarter service, degree of tech dependency and the organizational structures

Cost advantage of location acquiring m_i	Intensity of head-quarter service	Degree of tech dependency	Organizationalstructures
Home or foreign country with insignificant cost advantage($1 \geq W^L > \left[\left(1-\beta^k\right)/\beta^k\right]^2$)	Head-quarter intensive sectors	High degree	outsourcing
		Low degree	integration
	Component intensive sectors		outsourcing
The foreign country with significant cost advantage ($W^L < \left[\left(1-\beta^k\right)/\beta^k\right]^2$)	Head-quarter intensive sectors		integration
	Component intensive sectors	High degree	integration
		Low degree	outsourcing
	Sectors with moderate intensity	High degree	integration
		Moderate degree	outsourcing
		Low degree	integration

4. CONCLUSIONS

This document using property-right approach analyzes the optimal organizational structure of final-good producer. We show that cost advantage resulting from national factor endowment, sector-specific intensity of head-quarter service and the degree of technological dependency of final-good producer on the component supplier affect the decision of final-good producer on the organizational structure.Different from the new-new trade theory, we consider the technological dependency of final-good producer on the supplier is a significant factor resulting to the heterogeneity of firms within industries so as their organizational structure.

We conclude that in head-quarter intensive sectors, when final-good producer acquires component inputs from foreign country with significant cost advantage, the degree of technological dependency has no effect on theorganizational structures of final good producer. In this case, integration is preferable organizational structure. When acquiring component inputs from home or foreign country with insignificant cost advantage, the final-good producer with high degree of technological dependency will choose outsourcing organization, while final-good producer with low degree of technological dependency will choose integration organization. In component intensive sectors, when acquiring component input from foreign country with significant cost advantage, the final-good producer with high degree of technological dependency will choose integration structure while the final-good producer with low technological dependency will choose outsourcing structure. When the final-good producer acquires component input form home or foreign country with insignificant cost advantage, the degree of technological dependency has no effect on his organizational decision.

By comparing the analysis above, forthermore, we conclude that cost advantage resulting from national factor endowment has significant effect on the decision of final-good producer with high degree of tech dependency on organizational structure. The sector-specific intensity of head-quarter service has significant effect on the decision of final-good producer with low degree of tech dependency on organizational structure.

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