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Economies of Scope and Patterns of Global Outsourcing

by

Zhihao Yu

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The Author

Zhihao Yu is Assistant Professor of Economics at Carleton University and an External Fellow in the Leverhulme Centre for Research on Globalisation and Economics Policy at the University of Nottingham.

Correspondence: 1125 Colonel By Drive, Ottawa, Ont. K1S 5B6, Canada; Tel: 1-613-520-2600 ext. 3763; Fax: 1-613-520-3906; Email: zhihao_yu@carleton.ca; Home Page: www.carleton.ca/~zyu

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Abstract

This paper presents a model in which economies of scope in production play a key role in a vertically-linked production structure. It identifies the *divergence* in the degrees of economies of scope and the attribute spaces of the products in different stages of production as a fundamental economic force behind outsourcing. Among other things, it is shown that outsourcing occurs in the following two extreme/opposite scenarios in terms of production and characteristics of the good: either (i) the degree of economies of scope is relatively very high and/or the attribute space is very small (i.e., close to a homogenous good), or (ii) the degree of economies of scope is relatively very low and/or the attribute space is very large (i.e. highly specialized input/service).

JEL Classification: F2, L22

Keywords: Outsourcing, Economies of Scope, Vertical Disintegration

Outline

Non-Technical Summary

Outsourcing is surging in popularity across a wide range of production activities and sectors. In the automobile industry, for instance, we see outsourcing ranging from product design, data processing, assembly, special components, and minor parts and components, etc. Why do firms engage in very different kinds of outsourcing business in that some require high-skilled labor and are very specialized but others are very simple and minor? What kind of intermediate input/service do firms often choose for outsourcing? Can we say anything about the characteristics/attributes of the goods or services in outsourcing? More importantly, what is the fundamental economic force behind the recent trend of outsourcing? The purpose of this paper is to address these questions and understand the patterns of outsourcing.

Although it is often viewed as a means for firms to look for cheaper suppliers to cope with increasing competition, this is not the underlying economic force behind outsourcing. A fundamental economic force, as identified in this paper, lies in the *divergence* in the degrees of economies of scope and the attribute spaces of the products in different stages of production. \ In this essay I develop a simple model of two-stage production in which economies of scope in production (in conjunction with product differentiation) play a key role in a vertically-linked production structure. The model allows us to discuss how outsourcing activities are affected by the degree of product differentiation and economies of scope in production of the intermediate input relative to that of the final good.

The paper derives three main results that yield new insights on the patterns of outsourcing. First, outsourcing occurs with the following two extreme/opposite scenarios in terms of production and characteristics of the good: either (i) the degree of economies of scope is relatively very high and/or the attribute space is very small (i.e., close to a homogenous good), or (ii) the degree of economies of scope is relatively very low and/or the attribute space is very large (i.e., highly specialized input/service). The results are driven by production efficiency and the *divergence* in the degrees of economies of scope and the attribute spaces of the products in different stages of production. Second, since it is the `relative vertical link' between the intermediate-input and final-good production that matters for outsourcing activities, a progress of the `general-purpose-technology' (e.g., information technology, etc.) that improves production techniques may either *increase* or *decrease* outsourcing. In contrast, a technology progress that reduces market transaction costs will always increase outsourcing. Third, if a technology progress, however, is what we called `pro-EOScope' (or `anti-EOScope'), and its effect on the production techniques is persistently biased towards one stage of production (either intermediate-good or final-good production), it will eventually increase outsourcing. These results are useful to shed light on the wide-ranging outsourcing activities across different industries and countries.

1 Introduction

Outsourcing is surging in popularity across a wide range of production activities and sectors. In the automobile industry, for instance, we see outsourcing ranging from product design, data processing, assembly, special components, and minor parts and components, etc.[1] Why do firms engage in very different kinds of outsourcing business in that some require high-skilled labor and are very specialized but others are very simple and minor? What kind of intermediate input/service do firms often choose for outsourcing? Can we say anything about the characteristics/attributes of the goods or services in outsourcing? More importantly, what is the fundamental economic force behind the recent trend of outsourcing? The purpose of this paper is to address these questions and understand the patterns of outsourcing.

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[1] See details in *WTO Annual Report 1998* (p.36), cited by Grossman and Helpman (forthcoming).

may either *increase* or *decrease* outsourcing. In contrast, a technology progress that reduces market transaction costs will always increase outsourcing. Third, if a technology progress, however, is what we called 'pro-EOScope' (or 'anti-EOScope'), and its effect on the production techniques is persistently biased towards one stage of production (either intermediate-good or final-good production), it will eventually increase outsourcing. These results are useful to shed light on the wide-ranging outsourcing activities across different industries and countries.

The important role that economies of scope play as a fundamental economic force behind the trend of outsourcing business can be revealed by a review of the automobile manufacturing industry. In the 1920s when workers in the Ford Motor Company were getting the highest pay (much higher than all others) in the industry, Ford did not seek outsourcing to reduce costs.[2] The first sign of outsourcing in the automobile industry, however, came at the beginning of 1920s when the General Motors Company started a major innovation in producing automobiles by focusing on *economies of scope* in production, rather than *economies of scale*. The success of Ford, and its relatively inexpensive automobile, was based on mass production of a single, basically unchanging product. However, in 1923 General Motors (lead by Alfred P. Sloan) introduced the 'car for every purse' policy (i.e., different cars for people with different incomes) and started annual model changes. To make model changes relatively cheaper, GM had to install multi-purpose machines and design more common parts into the cars of various models. GM even published its specification lists of some parts and components, thereby enabling other carmakers to share in any upstream economies. These changes ultimately lead to outsourcing business in the General Motors company and the automobile industry. GM's innovation focusing on economies of scope was further advanced by Japanese carmakers (Toyota and Nissan) after the Second World War (Cusumano, 1985). To accommodate consumer preferences for product variety in the changing world, in contrast to Ford's vertically-integrated production system Toyota built a flexible manufacturing system relying heavily on subsidiaries and other suppliers, which had a profound impact on the increasing outsourcing activities in Japanese automobile industry. According to Edward Davis (1992), typically the degree of outsourcing is 60-70 percent in Toyota compared to 30-40 percent in General Motors.

The evolution of modern manufacturing was one of the main subjects of research interests

[2]Henry Ford introduced the famous 'five-dollar day', which doubled the sums he was paying his work force at a time when the American economy was beginning to lurch into a deep recession (Raff, 1991).

in the industrial organization literature over a decade ago. The most important contributions in the literature are Milgrom and Roberts (1990), and Milgrom, Qian and Roberts (1991). In these studies, firms exercise flexibility in a number of dimensions, including inventory policy, product market strategy, the internal organization of the firm, and the number and attributes of products. Their focus is on flexible manufacturing, complementarities in production, and the theory of firm organization. The implication of flexible manufacturing for market structure has been investigated by MacLeod, et al (1988), Eaton and Schmitt (1994), and Norman and Thisse (1999).

Outsourcing has become the most significant industrial phenomenon since the 1990s and has widely spread across national boundaries.[3] This has generated increasing research interest in pursuing rigorous theories for outsourcing. One approach in the literature has focused on the role of trade liberalization, or globablization, to explain (international) outsourcing.[4] Another approach focuses on the theories of transaction cost and incomplete contracts. In McLaren (2000), for instance, globalization lowers transaction costs and therefore makes it easier for an input supplier to find an attractive buyer abroad, which strengthens its bargaining power *ex post* and thus makes an arm's-length arrangement more attractive. Grossman and Helpman (2002, forthcoming) recently have developed a wide-ranging theory to explain outsourcing based on a number of issues that include the degree of market competition, substitutability between final products, thickness of input suppliers, costs of customizing inputs, and nature of the contracting environment.[5] This approach has been further extended by Antràs (2003), and Antràs and Helpman (2004). For example, Antràs and Helpman focus on the effect of heterogeneities that are intra-sectorial (low- or high-productivity firms) as well as inter-sectorial (headquarter-intensive or component-intensive sectors).

The current paper focuses on the production technology and attributes of products, rather than heterogeneities among firms. It investigates the role of economies of scope in outsourcing and identifies the *divergence* in the degrees of economies of scope in different stages of production

[3]See evidence of international outsourcing in Hanson (1996), Slaughter (1995), Campa and Goldberg (1997), and Feenstra and Hanson (2003), among many others. Feenstra (1998) provides an excellent overview of this topic. Also see Hummels, *et al.* (2001) and Yi (2003) on a closely related topic - vertical specialization.

[4]E.g., see Jones (2000), Jones and Kierzkowski (2001), Cheng and Kierzkowski (2001), Zhao (2001), and Chen, Ishikawa and Yu (2004).

[5]Also see Grossman and Helpman (2004).

as the fundamental economic force behind the recent trend of outsourcing. The basic structure of the model (i.e. single-stage production) is borrowed from the spatial/address model of Eaton and Schmitt (1994). The paper is able to provide new insights on the patterns of outsourcing and, in particular, on how outsourcing activities are affected by the degree of product differentiation and economies of scope in production of the intermediate input relative to that of the final good.

The rest of the paper is organized as follows. Section 2 develops the basic framework. It first derives the equilibrium for both the vertically-integrated and vertically-disintegrated production structures, and then obtains the production-efficient equilibrium outcome. Section 3 characterizes the equilibrium of vertically-disintegrated production and the patterns of outsourcing. Section 4 discusses the implications for international outsourcing. Section 5 discusses some alternative assumptions adn the robustness of our results. Section 6 concludes the paper.

2 The Basic Set-up

There are two goods in the economy, a differentiated product (the good of interest) and a numeraire good. Following the standard circular model for differentiated product, we assume that each good is described by a point x in some continuum of product attributes represented by a circumference of a circle of length L. Each consumer is assumed to purchase only one unit of the differentiated good at price $p(x)$ and has a quasi-linear preference. The indirect utility function for consumer i is given by

$$V_i = v - t|x - x_i^o| + I - p(x) \tag{1}$$

where x_i^o describes consumer i's most preferred differentiated good (or the consumer's address in the attribute space), v is consumer's reservation price, and t is the marginal disutility of distance in the attribute space. Assume that v is large so that in equilibrium all individuals consume the differentiated good. Income I comes from wages only and is identical for each consumer. There are ϕL consumers, whose preference of attributes for the most preferred good is uniformly distributed along a circumference, and ϕ is the population density.

2.1 Vertically-integrated (In-house) Production

Suppose labor is the only primary input factor in the economy. The numeraire good is produced by a constant-return-to-scale technology using labor only and, by choice of units, it uses one unit of labor to produce one unit of output. This implies that the wage rate is equal to one and therefore I also represents the constant labor supply of each individual.

For production of the differentiated product, I extend the model of Eaton and Schmitt (1994) to a two-stage production structure, in which the technology of both production stages exhibits economies of scope. In addition to the direct labor input, to produce one unit of final output requires one unit of an intermediate input/component,[6] which is also produced using labor. Specifically, in both stages of production, firms must first incur a fixed cost to develop a *basic product* and then can produce variants by modifying the basic product. We use X_i to denote the location in the final-good attribute space of basic product i and x_j that of variant j, and similarly, Y_i and y_j for the intermediate good, respectively.

Assume that each firm owns only one basic product and therefore a firm is identified by a basic product.[7] Suppose that $q_i(x_j)$ is the quantity of variant j $(j = 1, ..., m)$ produced from basic product i (including the basic product - a 'variant' with no modification from X_i). The overall production can be described by

$$(\mathbf{x}, \mathbf{q_i}) = \{[(x_1, q_i(x_1)], [x_{2,}q_i(x_2)], ..., [(x_m, q_i(x_j)]\}. \tag{2}$$

Then, the overall production costs are given by the following expression,

$$\begin{aligned} C((\mathbf{x}, \mathbf{q_i}); X_i) &= K + (m-1)S + \sum_{j=1}^{m} q_i(x_j)(\tilde{c}_i^y + c_x + r_x|x_j - X_i|) \qquad (3) \\ &= K + (m-1)S + C((\mathbf{y}, \mathbf{q_i}); Y_i) + \sum_{j=1}^{m} q_i(x_j)(c_x + r_x|x_j - X_i|),\ K > 0, r_x > 0 \end{aligned}$$

where $\tilde{c}_i^y$ is the average cost and $C((\mathbf{y}, \mathbf{q_i}); Y_i)$ the total cost of the variants of the basic intermediate input Y_i. Specifically,

$$\tilde{c}_i^y = C((\mathbf{y}, \mathbf{q_i}); Y_i) / \sum_{j=1}^{m} q_i(x_j), \qquad j = 1, ..., m \tag{4}$$

$$C((\mathbf{y}, \mathbf{q_i}); Y_i) = k + (m-1)s + \sum_{j=1}^{m} q_i\,(x_j)\,(c_y + r_y|y_j - Y_i|), \qquad k > 0, r_y > 0. \tag{5}$$

[6]For the sake of clarity, we assume only one intermediate input/component. The model can be easily generalized to use many intermediate components (using one unit of each) to produce the final good. The results derived in the paper are carried over to the case with many intermediate inputs/components.

[7]Even if firms can own more than one *basic product*, our results remain as long as there are additional organizational costs of having more than one *basic product* (or other production/sales activities). This is similar to the common assumption in the literature that there are cost advantages for specialized firms.

Parameters K and k respectively denote the sunk cost of developing the basic final and intermediate product (X_i and Y_i), and S and s the (fixed) cost of switching from production of one variant to another. The term $c_y + r_y|y_j - Y_i|$ is the marginal cost of producing one unit of variant y_j, where $r_y|y_j - Y_i|$ is the incremental marginal cost of modification. Similarly, $\tilde{c}_i^y + c_x + r_x|x_j - X_i|$ is the marginal cost of producing one unit of variant x_j using input y_j. The further away a variant (x_j or y_j) is from its basic product, the larger is the cost of modification. Parameters r_x and r_y are (constant) unit modification costs (i.e., per unit of the attribute space). Without loss of generality, for the rest of our analysis we assume $c_x = c_y = 0$. Following Eaton and Schmitt, we focus on the case of *strong* economies of scope where the switching cost is equal to zero (i.e., $S = s = 0$).

Therefore, (3) and (5) now become

$$C((\mathbf{x}, \mathbf{q_i}); X_i) = K + \sum_{j=1}^{m} q_i(x_j)(\tilde{c}_i^y + r_x|x_j - X_i|), \quad K > 0, r_x > 0 \tag{6}$$

$$C((\mathbf{y}, \mathbf{q_i}); Y_i) = k + \sum_{j=1}^{m} q_i(x_j)(r_y|y_j - Y_i|), \quad k > 0, r_y > 0. \tag{7}$$

Therefore, K and r_x (*resp.* k and r_y) are the key parameters that determine the degree of economies of scope in production of the final (*resp.* intermediate) good. Following the textbook definition[8], the degree of economies of scope in the final-good production can be characterized by

$$\frac{(m-1)K - r_x \sum_{j=1}^{m} q_i(x_j)|x_j - X_i|}{C((\mathbf{x}, \mathbf{q_i}); X_i)} > 0 \tag{8}$$

For economies of scope to exist, either K has to be large or r_x has to be small so that (8) holds. The higher the degree of economies of scope, the larger the value of K and/or the smaller the value of r_x. Similarly, the degree of economies of scope in the intermediate-good production is given by

$$\frac{(m-1)k - r_y \sum_{j=1}^{m} q_i(x_j)|y_j - Y_i|}{C((\mathbf{y}, \mathbf{q_i}); Y_i)} > 0 \tag{9}$$

[8]As in Pepall, et al (1999), for example, the degree of economies of scope is defined by

$$\frac{C(Q_1, 0) + C(0, Q_2) - C(Q_1, Q_2)}{C(Q_1, Q_2)}$$

where $C(.,.)$s represent the costs of producing singal or two products, respectively.

2.1.1 Equilibrium without economies of scope

When there are no economies of scope in production, a firm produces only the basic product. Then, (3) and (5) reduce to:

$$C(X_i) = K + q_i \tilde{c}_i^y \quad \text{and} \quad C(Y_i) = k \tag{10}$$

where q_i is output (of the basic product), and $\tilde{c}_i^y = c_i^y \equiv C(Y_i)/q_i^y$ since there are no variants produced except for the basic product. In this case, minimum-cost production requires that the basic intermediate product Y_i is designed to exactly fit the production of X_i

Suppose there are n firms symmetrically located along the circumference of a circle in the attribute space. In the symmetric equilibrium under free entry, it is straightforward to show the following textbook results (e.g., Tirole, 1988):

$$p_i = L/n^o + c_i^y \quad \text{and} \quad c_i^y = \frac{kn^o}{\phi L}, \qquad i = 1, ..., n \tag{11}$$

where

$$n^o = L(\phi/K)^{1/2}. \tag{12}$$

Therefore, the average cost of production of the intermediate input and the price of the final good become

$$c^y \equiv c_i^y = k/(K\phi)^{1/2}, \qquad i = 1, ..., n \tag{13}$$

$$p \equiv p_i = (K/\phi)^{1/2} + k/(K\phi)^{1/2}, \qquad i = 1, ..., n \tag{14}$$

2.1.2 Equilibrium with economies of scope

Let $MC_i(x)$ denote firm i's the marginal cost of producing good x, a variant located away from X_i at a distance of x. Then,

$$MC_i(x) = \tilde{c}_i^y + r_x x \tag{15}$$

Similar to Eaton and Schmitt, we assume $t > \tilde{c}_i^y + r_x$ for all i so that in equilibrium the consumer will always choose to buy her most preferred good even though she is free to buy any good in the entire spectrum. Since each firm can produce goods along the continuum circumference L, a price equilibrium involves a complete price schedule for each firm. In such a Bertrand equilibrium, as shown by these authors, the most efficient firm sets its price equal to the marginal cost of the second most efficient firm and makes the sale of the good. That is, in this model we have

$$p_i(x) = MC_{i+1}(x) = \tilde{c}^y_{i+1} + r_x|L/n_x - x|, \qquad 0 \le x \le L/(2n_x) \tag{16}$$

In the free-entry symmetric equilibrium, we obtain

$$\tilde{c}^y \equiv \tilde{c}^y_i = \tilde{c}^y_{i+1}, \qquad i = 1, ..., n \tag{17}$$

$$p_i(x) = \tilde{c}^y + r_x(L/n_x - x), \quad 0 \le x \le L/(2n_x), \quad i = 1, ..., n_x \tag{18}$$

and the entire continuum of goods is produced. Therefore, the profit of each firm becomes

$$\begin{aligned} \pi_i &= 2\int_0^{L/(2n_x)} [p_i(x) - MC_i(x)]q_i(x)dx - K \\ &= 2\int_0^{L/(2n_x)} [r_x(L/n_x - x) - r_x x]\phi dx - K \\ &= \frac{\phi r_x}{2}(\frac{L}{n_x})^2 - K \end{aligned} \tag{19}$$

Free entry will drive π_i down to zero. Ignoring the integer 'issue', we obtain the equilibrium number of firms,

$$n^o_x = L(\frac{\phi r_x}{2K})^{1/2} \tag{20}$$

To calculate the average cost of the intermediate good, it is important to notice that the attribute space for the final good does not have to be the same as that for the intermediate input. In general, the distance of $|y_j - Y_i|$ is not the same as that of $|x_j - X_i|$. Suppose the length of the circumference of the attribute space for the intermediate good is θL, as illustrated in Figure 1. If $\theta < 1$ (*resp.* $\theta > 1$), the attribute space of the intermediate input is smaller (*resp.* greater) than that of the final good.

From (4-5) the average cost of the intermediate good becomes,[9]

$$\begin{aligned} \tilde{c}^y \equiv \tilde{c}^y_i &= \frac{k + 2\int_0^{\theta L/(2n^o_x)} q_i(y) r_y y dy}{2\int_0^{\theta L/(2n^o_x)} q_i(y)dy} \\ &= \frac{k + 2\int_0^{\theta L/(2n^o_x)} (\phi r_y y/\theta)dy}{2\int_0^{\theta L/(2n^o_x)} (\phi/\theta)dy} \end{aligned} \tag{21}$$

[9]Notice that for the attribute space of intermediate input y, the length of the circumference becomes θL, and the density ϕ/θ.

$$= \frac{k + (\theta r_y K)/(2r_x)}{(2\phi K/r_x)^{1/2}}$$
$$= k(\frac{r_x}{2\phi K})^{1/2} + \frac{\theta r_y}{2}(\frac{K}{2\phi r_x})^{1/2}$$

Using (18) and (20-21), we obtain the equilibrium price of good x:

$$p^o(x) \equiv p_i^o(x) = k(\frac{r_x}{2\phi K})^{1/2} + \frac{\theta r_y}{2}(\frac{K}{2\phi r_x})^{1/2} + r_x[(\frac{2K}{\phi r_x})^{1/2} - x], \qquad i = 1, ..., n \tag{22}$$

where $x \in [0, (\frac{K}{\phi r_x})^{1/2}]$.

2.2 Production Efficiency and Vertical Disintegration (Outsourcing)

Now consider the case in which production is vertically-disintegrated and there are independent firms and markets for the intermediate input. To avoid any unnecessary strategic action in the intermediate-input market and focus on the fundamental economic force in production (i.e., production efficiency), I assume that firms that produce the intermediate input follow the average-cost pricing rule. Furthermore, there is a transaction cost: final-good producers have to incur additional costs in purchasing the intermediate input.

2.2.1 Equilibrium without economies of scope

When there are no economies of scope, only the basic products are produced and therefore in equilibrium the number of the basic final-good products has to equal to that of the basic intermediate-input products. Furthermore, minimum-cost production requires that the basic intermediate product Y_i is designed to exactly fit the production of X_i. Thus, the equilibrium is exactly the same as in Section 2.1.1 except now firms have to pay transaction costs for the input they purchase. Therefore, vertically-integrated production structure will dominate vertically-disintegrated production structure.

Proposition 1 *In the absence of economies of scope, the vertically-integrated production structure is more efficient than the vertically-disintegrated production structure.*

Although it is intuitive, Proposition 1 provides a benchmark for the subsequent discussion about the central role that economies of scope will play in outsourcing.

2.2.2 Equilibrium with economies of scope

When there are economies of scope in production, the number of the basic intermediate products does not have to equal to that of the basic final products. Suppose there are n_y firms in the intermediate-input market and they are located symmetrically along a circumference θL in attribute space. Therefore, for a representative firm i, which produces variants located symmetrically from its basic intermediate input Y_i, the total cost of production is

$$\begin{aligned} C((\mathbf{y}, \mathbf{q_i^y}); Y_i) &= k + 2\int_0^{\theta L/(2n_y)} q_j(y) r_y y dy \\ &= k + 2\int_0^{\theta L/(2n_y)} (\phi r_y y/\theta) dy \\ &= k + \frac{\theta \phi r_y}{4}(\frac{L}{n_y})^2 \end{aligned} \tag{23}$$

and the average cost of each variant becomes

$$\begin{aligned} \overline{c}_i^y &= \frac{C((\mathbf{y}, \mathbf{q_i^y}); Y_i)}{2\int_0^{\theta L/(2n_y)} q_j(y) dy} \\ &= \frac{k + (\theta\phi r_y/4)(L/n_y)^2}{2\int_0^{\theta L/(2n_y)} (\phi/\theta) dy} \\ &= (kn_y + \frac{\theta\phi r_y L^2}{4n_y})/(\phi L) \end{aligned} \tag{24}$$

Under average-cost pricing and free-entry, the average cost (i.e. the price) of intermediate input will be driven down to the minimum. Therefore, the equilibrium number of firms in the intermediate-input market is given by

$$\begin{aligned} n_y^o &= \arg\min \ (kn_y + \frac{\theta\phi r_y L^2}{4n_y})/(\phi L) \\ &= L(\frac{\theta\phi r_y}{4k})^{1/2} \end{aligned} \tag{25}$$

Substituting (25) into (24), we obtain the average cost of the intermediate input in the symmetric equilibrium,

$$\begin{aligned} \overline{c}^y &\equiv \overline{c}_i^y \\ &= [kL(\frac{\theta\phi r_y}{4k})^{1/2} + \frac{L}{2}(\theta\phi k r_y)^{1/2}]/(\phi L) \\ &= (\frac{\theta k r_y}{\phi})^{1/2} \qquad\qquad i = 1, ..., n \end{aligned} \tag{26}$$

Lemma 1 $\widetilde{c}^y \geq \overline{c}^y$, *the equality holds only when* $(kr_x)/(\theta K r_y) = 1/2$.

Proof: Using (21) and (26), we obtain

$$\begin{aligned} \frac{\widetilde{c}^y}{\overline{c}^y} &= (\frac{1}{2})^{0.5}(\frac{kr_x}{K\theta r_y})^{0.5} + (\frac{1}{8})^{0.5}(\frac{K\theta r_y}{kr_x})^{0.5} \\ &= \frac{1}{\Omega}(\frac{1}{2})^{0.5} + \Omega(\frac{1}{8})^{0.5} \end{aligned} \tag{27}$$

where $\Omega \equiv [(\theta K r_y)/(kr_x)]^{0.5}$. It is straightforward to show that (27) reaches the minimum, 1, at $\Omega = \sqrt{2}$. ■

With vertically-disintegrated production, however, there is a transaction cost in purchasing the intermediate input. Since our main interest is not about transaction cost,[10] I assume that the transaction cost in this model is in terms of the units of the intermediate input and it takes the form similar to the 'iceberg transport costs'. Specifically, to use one unit of the intermediate input in production, a final-good producer has to purchase $1+\tau$ units of the intermediate input. Thus, the cost for using one unit of the intermediate input is $\overline{c}^y(1+\tau)$.

Therefore, there exists a trade-off between production efficiency and the market transaction cost. Solving $\widetilde{c}^y \leq \overline{c}^y(1+\tau)$, we obtain the following result.

Proposition 2 *In the presence of economies of scope, the vertically-integrated structure is more efficient in production than the vertically-disintegrated structure if and only if* $(\theta K r_y)/(kr_x) \in [\Omega_L^2(\tau), \Omega_U^2(\tau)]$, *where* $\Omega_L^2(\tau) \equiv 2\{(1+\tau) - [(1+\tau)^2 - 1]^{0.5}\}^2$ *and* $\Omega_U^2(\tau) \equiv 2\{(1+\tau) + [(1+\tau)^2 - 1]^{0.5}\}^2$; *the converse holds, otherwise.*

Therefore, when $(\theta K r_y)/(kr_x)$ is either smaller than $\Omega_L^2(\tau)$ or greater than $\Omega_U^2(\tau)$, the equilibrium of vertically-disintegrated production (i.e., outsourcing) will dominate the equilibrium of vertically-integrated production.

Corollary *Outsourcing is the production-efficient equilibrium if* $(\theta K r_y)/(kr_x) < \Omega_L^2(\tau)$ *or* $(\theta K r_y)/(kr_x) > \Omega_U^2(\tau)$.

Figure 2 can be used to illustrate the results in Lemma 1 and Proposition 2, and why outsourcing occurs under the extreme values of $(\theta K r_y)/(kr_x)$. The key to understanding Lemma

[10] Transaction costs in outsourcing are one of the main issues of interest in McLaren (2000), and Grossman and Helpman (forthcoming).

1 is that the number of intermediate-input producers under vertically-integrated production is constrained to be the same as that of final-good producers, which in general could be either greater or smaller than under minimum-cost production. Specifically, with vertical disintegration, the number of basic intermediate products n_y^o in (25) is production-efficient (i.e., minimizing the costs). With vertically-integrated production, however, the number of basic intermediate products n_y is equal to n_x^o in (20), the equilibrium number of basic final products. Only when $n_x^o = n_y^o$ [i.e., when $(\theta K r_y)/(k r_x) = 2]^{11}$, we have $n_y = n_y^o$ and therefore $\tilde{c}^y = \bar{c}^y$, which is the minimum point of the $(\tilde{c}^y/\bar{c}^y)$-curve in Figure 2. When $n_y > n_y^o$ [i.e.,$(\theta K r_y)/(k r_x) < 2$], there are too many basic intermediate products and hence vertical integration involves too much fixed cost. When $n_y < n_y^o$ [i.e., $(\theta K r_y)/(k r_x) > 2$], there are not enough basic intermediate products and hence vertical integration involves too much modification cost in producing the variants.

When there is a transaction cost in purchasing the intermediate input, whether the equilibrium of vertically-disintegrated production (or outsourcing) will dominate the equilibrium of vertically-integrated production depends on the trade-off between the production efficiency vs. the market transaction cost of outsourcing. Therefore, as in Figure 2 outsourcing occurs where the $(\tilde{c}^y/\bar{c}^y)$-curve is above the $(1+\tau)$-line [i.e., $(\theta K r_y)/(k r_x) < \Omega_L^2(\tau)$ or $(\theta K r_y)/(k r_x) > \Omega_U^2(\tau)$] - that is, when the vertically-integrated production involves either too much fixed cost or too much modification cost.

3 Industrial Outsourcing

3.1 Patterns of Outsourcing

The above results have established that the divergence between the equilibrium numbers of basic final and intermediate products is the key factor for outsourcing to occur. From (28), further notice that the underlying economic force behind this lies in the divergence in the degrees of economies of scope and the attribute spaces of the two products. To identify the patterns of outsourcing and better understand the recent outsourcing phenomenon, it is useful to further investigate this 'relative vertical link'.

[11]From (20) and (25), we obtain

$$\frac{n_y^o}{n_x^o} = (\frac{\theta K r_y}{2k r_x})^{1/2}. \tag{28}$$

A low value of r_y (relative to r_x) means that the modification cost of producing the variants of the intermediate input is low relative to the final good; a high value of k (relative to K) means that the fixed cost of developing a basic intermediate product is relatively high. Both indicate that the degree of economies of scope in production of the intermediate input is high. Furthermore, a low value of θ (relative to 1) means that the attribute space of the intermediate input is relatively small[12]. All these three cases imply that the efficient number of the *basic products* of the intermediate input is relatively small and therefore they will be more efficiently provided by the market than by the in-house production.

On the other hand, a high value of r_y and a low value of k indicate that the degree of economies of scope in production of the intermediate input is low; a high value of θ means that the attribute space of the intermediate input is relatively large. They imply that the efficient number of the *basic intermediate products* is relatively large. Since extra costs are involved with owning more than one *basic product* and with integrated firms selling intermediate inputs to others, vertically-disintegrated structure in general will be more efficient in providing the intermediate input than the vertically-integrated structure.

Therefore, we obtain the following proposition.

Proposition 3 *The patterns of outsourcing are characterized by the following two extreme/opposite scenarios in terms of production and characteristics of the good: either (i) the degree of economies of scope is relatively very high (e.g., r_y is very small and/or k is very large) and/or the attribute space is very small (i.e., close to a homogenous good), or (ii) the degree of economies of scope is relatively very low (e.g., r_y is very large and/or k is very small) and/or the attribute space is very large (i.e., highly specialized good/service).*

3.2 Technology Progress and Outsourcing

Over the last two decades technological progresses have certainly played a very important role in the changes of production structure and outsourcing activities. Their exact impact requires further investigations. In this paper we focus on the '*general-purpose technology*' (such as information technology, etc.). Suppose the progress of the *general-purpose technology* lowers both

[12]When θ approaches to zero, the intermediate input becomes a homogeneous good (the attribute circumference of good y in Figure 1 shrinks to a point).

the market transaction cost (τ) and the modification costs of producing variants (r_x and r_y). From Proposition 3, a reduction in τ reduces the support $[\Omega_L^2(\tau), \Omega_U^2(\tau)]$ and hence will always increase outsourcing activities (it increases the outsourcing region in Figure 2).[13]

However, the effect of a reduction in r_x and r_y is more complicated for the following three reasons. First, since the extent of the impact of technology progresses is likely to be different between the two production stages, a reduction in r_x and r_y may decrease or increase the ratio of r_y/r_x. Second, whether a decrease (or an increase) in r_y/r_x will increase outsourcing activities depends on the initial value of $(\theta K r_y)/(k r_x)$. For example, if initially $(\theta K r_y)/(k r_x) < 2$ (say Point A in Figure 2), a decrease in r_y/r_x will increase outsourcing activities. However, if $(\theta K r_y)/(k r_x) > 2$ (say Point B in Figure 2), a decrease in r_y/r_x will decrease outsourcing activities. Last, for the same reason, the effect of an increase or a decrease in K and k is also complicated by the same issues discussed above.

To summarize,

Proposition 4 *(i) A technology progress that reduces market transaction costs always increases outsourcing.*

(ii) *A technology progress that improves production techniques, however, may increase or decrease outsourcing. Specifically, whether it will increase or decrease outsourcing depends on* (a) *whether it increases or decreases* $(\theta K r_y)/(k r_x)$ *and* (b) *whether* $(\theta K r_y)/(k r_x)$ *is greater or smaller than* 2

A new technology that reduces the modification costs of producing variants (r_x and r_y) may require a higher fixed cost of developing the *basic product* (i.e., K and k). In this case, the new technology reduces the ratio of r_x/K and hence it increases the degree of economies of scope in the final-good production. If a new technology that reduces the modification costs of producing variants (r_x and r_y) also decreases K and k, it would be a bit complicated to determine the changes in the degree of economies of scope according to the exact definition of (8). To facilitate the discussion, however, we call the effect on production technology 'pro-EOScope' (*resp.* 'anti-EOScope') if a technology progress decreases (*resp.* increases) the ratio of the modification cost over the sunk cost (r_x/K and r_y/k), which is equivalent to a reduction of (*resp.* increase in) the equilibrium number of the *basic products* as in (20) and (25). Therefore, we have the following

[13] A lower τ may also be caused by other factors such as a reduction of transport cost, etc.

result.

Proposition 5 *If a technology progress is pro-EOScope (or anti-EOScope) and its effect on the production techniques is persistently biased towards one stage of production (either intermediate-good or final-good production), it will eventually increase outsourcing.*

This can also be illustrated in Figure 2. Regardless of where we start, from either Point A or C, a continuous decrease or increase in $(r_y/k)/(r_x/K)$ will in the end bring us to the outsourcing region. The automobile industry is probably a good example to apply this theory if we believe that technology progresses favor the degree of economies of scope in the final-good production in that industry. For example, the recent technology progress in CAD (computer-aided-design) has made model changes and product improvement much easier than ever before. These changes have certainly contributed to the surge of outsourcing activities in the automobile industry as discussed in the introduction of the paper.

4 International Outsourcing

Now consider a world with two countries, North/Home and South/Foreign. The consumer preferences of the two countries are the same and so are the product attributes (i.e., $L^* = L$ and $\theta^* = \theta$). The total population of the consumers now become $\phi^w L$, $\phi^w = (\phi + \phi^*)$, whose preferences of attributes for the most preferred good is also uniformly distributed along the circumference. Suppose the previous two sections describe the economy in the North, and we use an asterisk to denote the variables for the South.

Production technology in the South is different from the North. To produce one unit of the numeraire good requires $a^* > 1$ units of labor in the South. Suppose in the trading equilibrium both countries produce the numeraire good, a composite good representing the rest of all goods. Therefore, the wage rate in the South is less than one (i.e., $w^* = 1/a^* < w = 1/a = 1$). Following the literature (e.g., Grossman and Helpman, forthcoming; Antràs and Helpman, 2004), we assume that only the North is able to produce the final good but both countries can produce the intermediate input. To focus on the case of international outsourcing, suppose there is no transaction cost for purchasing the intermediate input from domestic suppliers (i.e., $\tau = 0$) but there is a transaction cost ($\tau^* > 1$) from foreign suppliers (or an additional cost compared to from the domestic suppliers).

Since $\tau = 0$, from Proposition 2 the equilibrium will always be outsourcing but whether it is domestic or international outsourcing depends on which country can more efficiently/cheaply provide the intermediate input. From (26), the average cost of the intermediate input for the North to supply it is

$$\bar{c}^y = (\frac{\theta k r_y}{\phi^w})^{1/2} \tag{29}$$

and for the South is

$$w^*\bar{c}^{y^*} = \frac{1}{a^*}(\frac{\theta k^* r_y^*}{\phi^w})^{1/2}. \tag{30}$$

Solving $w^*\bar{c}^{y^*}(1+\tau^*) < \bar{c}^y$, we have the following result.

Proposition 6 *International outsourcing is the production-efficient equilibrium if*

$$\frac{k}{k^*} > (\frac{r_y^*}{r_y})(\frac{1+\tau^*}{a^*})^2;$$

Otherwise, domestic outsourcing is the production-efficient equilibrium.

Proposition 6 can be illustrated by Figure 3. The area above the line of $(k/k^*) = (r_y^*/r_y)(\frac{1+\tau^*}{a^*})^2$ is the region of international outsourcing and below is domestic outsourcing. An increase in a^* or/and a reduction of τ^*rotates the line clockwise. Notice that $1/a^* = w^*$ is the wage rate in the South (or the relative wage, since $w = 1$). Therefore, the region of international outsourcing becomes larger when the wage in the South and the transaction cost of cross-border outsourcing is lower. Also notice that even if k^* is relatively large, we will have international outsourcing as long as r_y^* is very small (as Point A in Figure 3). This may explain why sometimes developing countries can often become the recipient countries for outsourcing business even though they are lagging in product development (i.e. k^* is large).

5 Discussion

The purpose of this paper is to show that the divergence of degrees of economies of scope between different stages of production is a fundamental economic force behind outsourcing. To make the point in a transparent way, I have considered a highly stylized model in which a firm owns at most only one basic product in each stage of production. Naturally, one wonders to what extent the main results are robust. In this section, I will relax this assumption to gain insight on this issue.[14]

First, we examine ownership structure of the basic products in final-good production. Notice that the profit of a firm in final-good production, as shown in Eaton and Schmitt's original model of one stage of production[15], is equal to the cost savings attributable to its basic product. This is independent of the ownership structure since in equilibrium goods are produced by the most efficient firm. Therefore, a firm does not gain in reducing costs in final-good production by having multiple basic products. If we assume that there are management costs associated with having multiple basic products, the symmetric equilibrium is that each firm will have just one basic product.

Now we consider ownership structure of the basic products in intermediate-good production and, as in Section 2, we focus on production efficiency rather than strategic issues.[16] Figure 2 is derived based on the assumption that each firm owns one basic product in intermediate-good production. From Section 2, notice that

$$\frac{n_y^o}{n_x^o} = (\frac{\theta K r_y}{2k r_x})^{1/2}. \tag{31}$$

Therefore, we can also obtain the $(\tilde{c}^y/\overline{c}^y)$-curve as a function of (n_y^o/n_x^o), which is the dashed U-shape curve-1 in Figure 4a.

If each firm owns two basic products in intermediate-good production, it is easy to show that the $(\tilde{c}^y/\overline{c}^y)$-curve will be like the dashed U-shape curve-2 in Figure 4a. Notice that the minimum point of curve-2 is higher than that of curve-1 as long as there are management costs of having multiple basic products. Similarly, if each firm owns three basic products in intermediate-good production, the $(\tilde{c}^y/\overline{c}^y)$-curve will be the dashed U-shape curve-3. The minimum point of curve-3 is higher than that of curve-2 if the management cost is convex in the number of basic products that each firm has. Although Figure 4a only draws these three curves, the same logic applies as the number of the basic products increases.

Then, similar to the relationship between the short-run and long-run cost curves in the standard production theory, the $(\tilde{c}^y/\overline{c}^y)$-curve in the presence of multiple basic products is the

[14]This section benefits from John Sutton's very helpful comments. Of course, any error is mine.

[15]As Eaton and Schmitt pointed out, their lemma 1 is a corollary of Lemma 1 in MacLeod et al (1988).

[16]The related literature on multi-product firms can be found in Klemperer (1992), Shaked and Sutton (1990), etc.

contour of these curves, i.e., the solid curve in Figure 4a. From a big perspective, this solid curve is qualitatively the same as the one in Figure 2.[17] Therefore, our main results will still hold even when firms are allowed to have multiple basic products.

6 Concluding Remarks

In this paper we present a model of two-stage production in which economies of scope in production (in conjunction with product differentiation) play a key role in a vertically-linked production structure. It identifies the *divergence* in the degrees of economies of scope and the attribute spaces of the products in different stages of production as the fundamental economic force behind outsourcing. The model allows us to discuss how outsourcing activities are affected by the degree of product differentiation and economies of scope in production of the intermediate input relative to that of the final good. The results in the paper can be easily formulated as some testable hypotheses about the patterns of outsourcing business and we hope they will attract the attention for further empirical investigations.

The paper provides a relatively simple framework that is able to shed some light on wide-ranging outsourcing activities across industries. In the paper we have considered the case with only one intermediate input and one sector of differentiated products. As mentioned earlier, the model can be easily generalized to the case with many intermediate inputs. It can also be generalized to the case with multiple sectors of differentiated products.[18] It then can explore the impact of variations across sectors on the relative prevalence of vertically-integrated or vertically-disintegrated production structures.

[17] From (27), we can also plot $\widetilde{c}^y/\overline{c}^y$ against $\ln(n_y^o/n_x^o)$. In that case, we obtain Figure 4b.

[18] With z sectors of differentiated products, for example, we can have the consumer preference in (1) as

$$V_i = \sum_{j=1}^{z} [v^j - t^j|x - x_i^{jo}| - p^j(x)] - I$$

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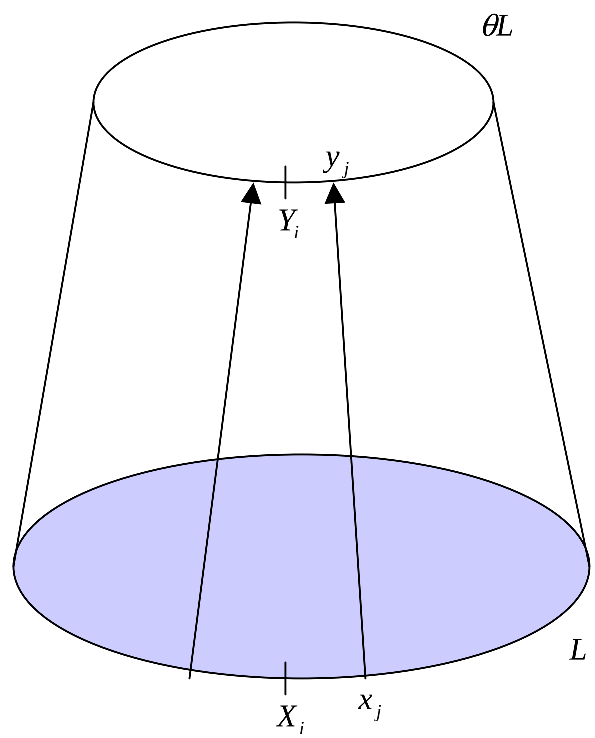


Figure 1

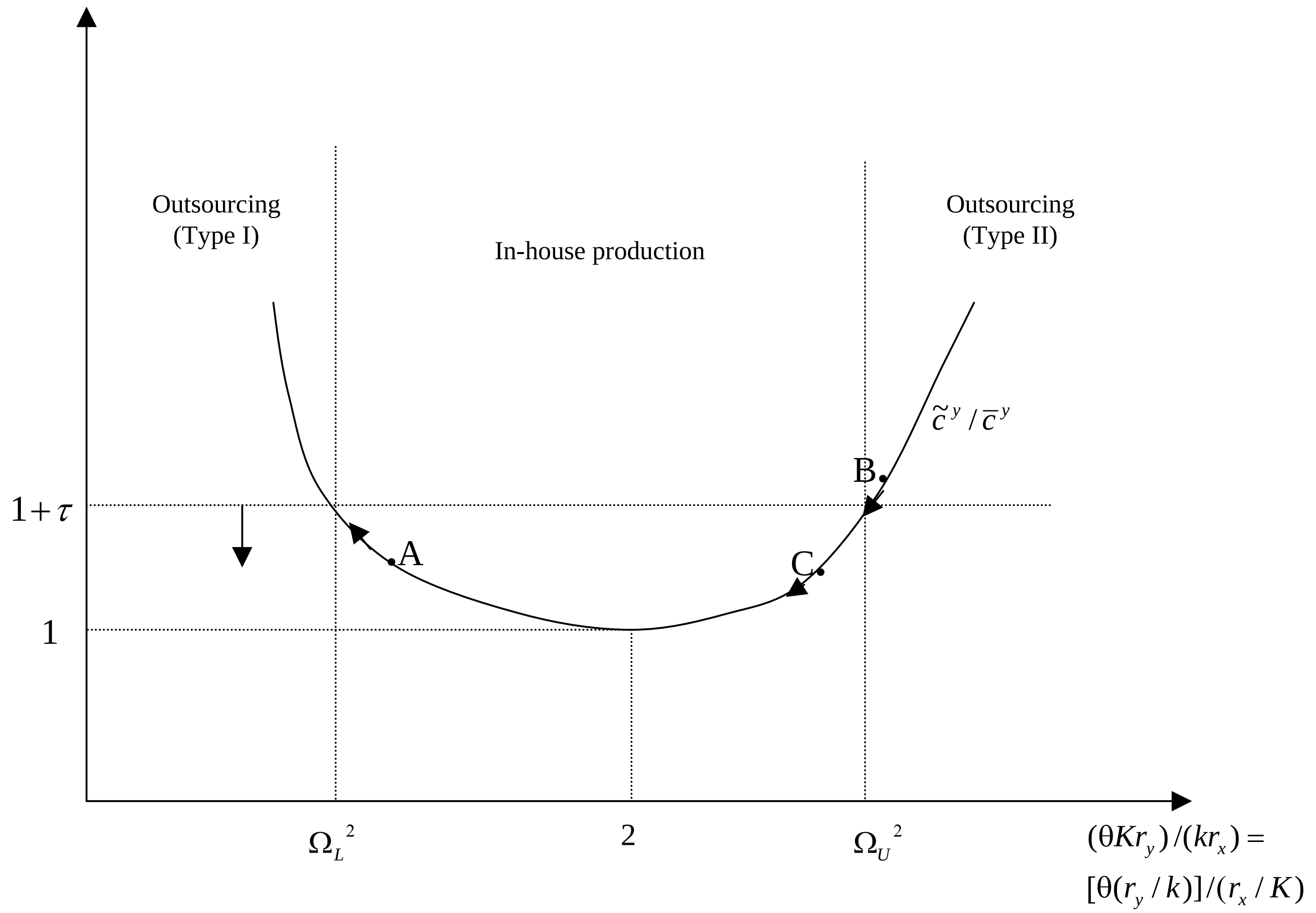

Outsourcing
(Type I)
In-house production
Outsourcing
(Type II)
$\tilde{c}^y / \bar{c}^y$
B
A
C
$1+\tau$
1
Ω_L^2
2
Ω_U^2
$(\theta K r_y)/(k r_x) =$
$[\theta(r_y / k)]/(r_x / K)$

Figure 2

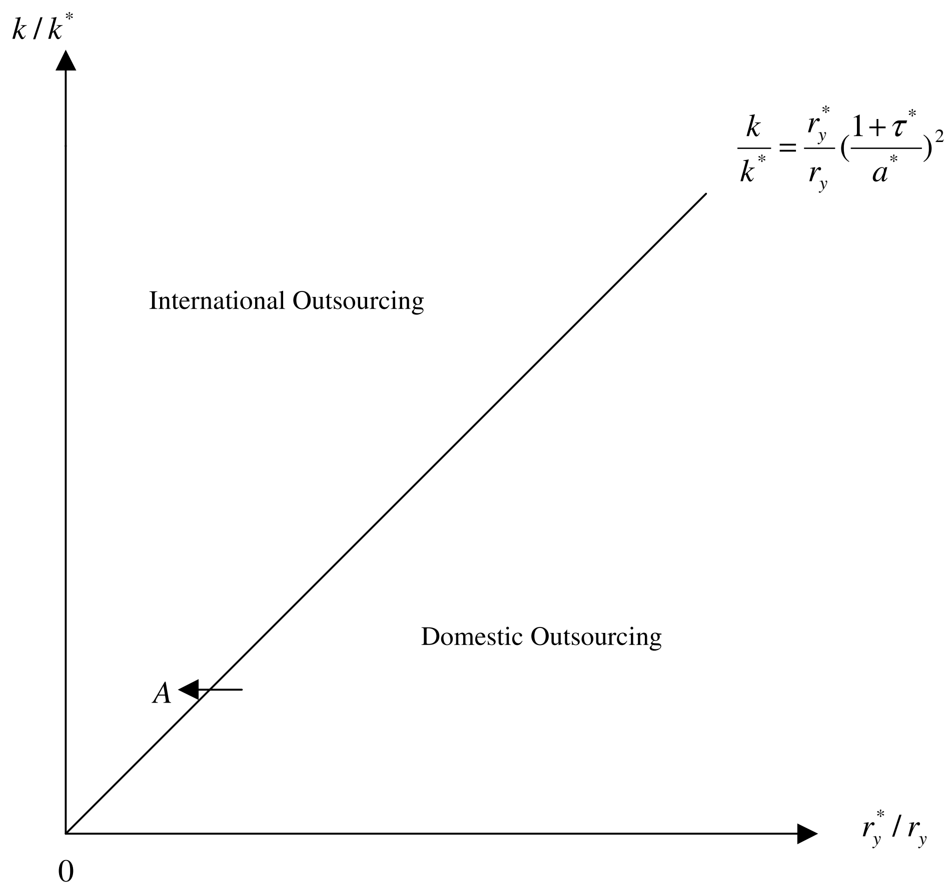
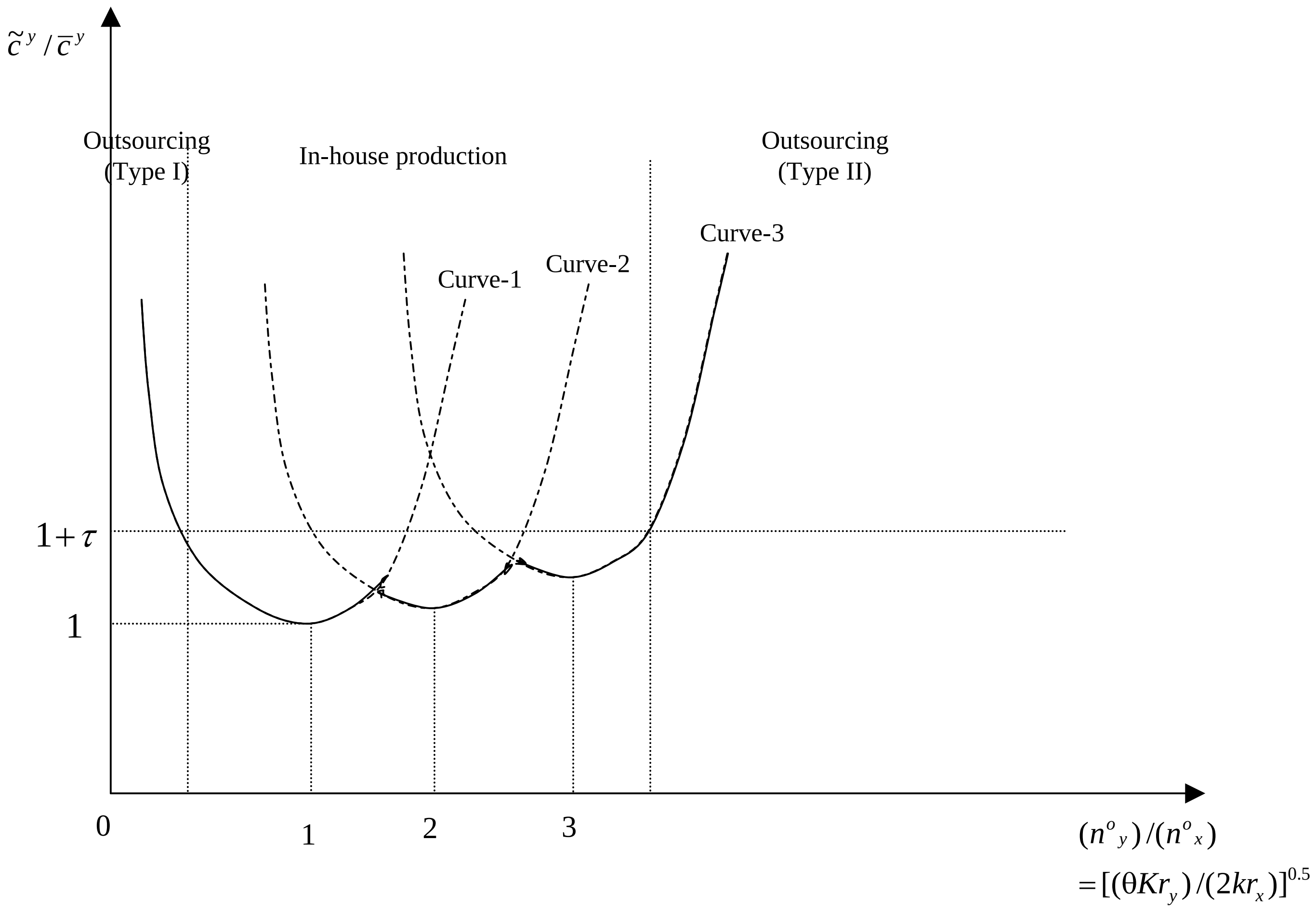
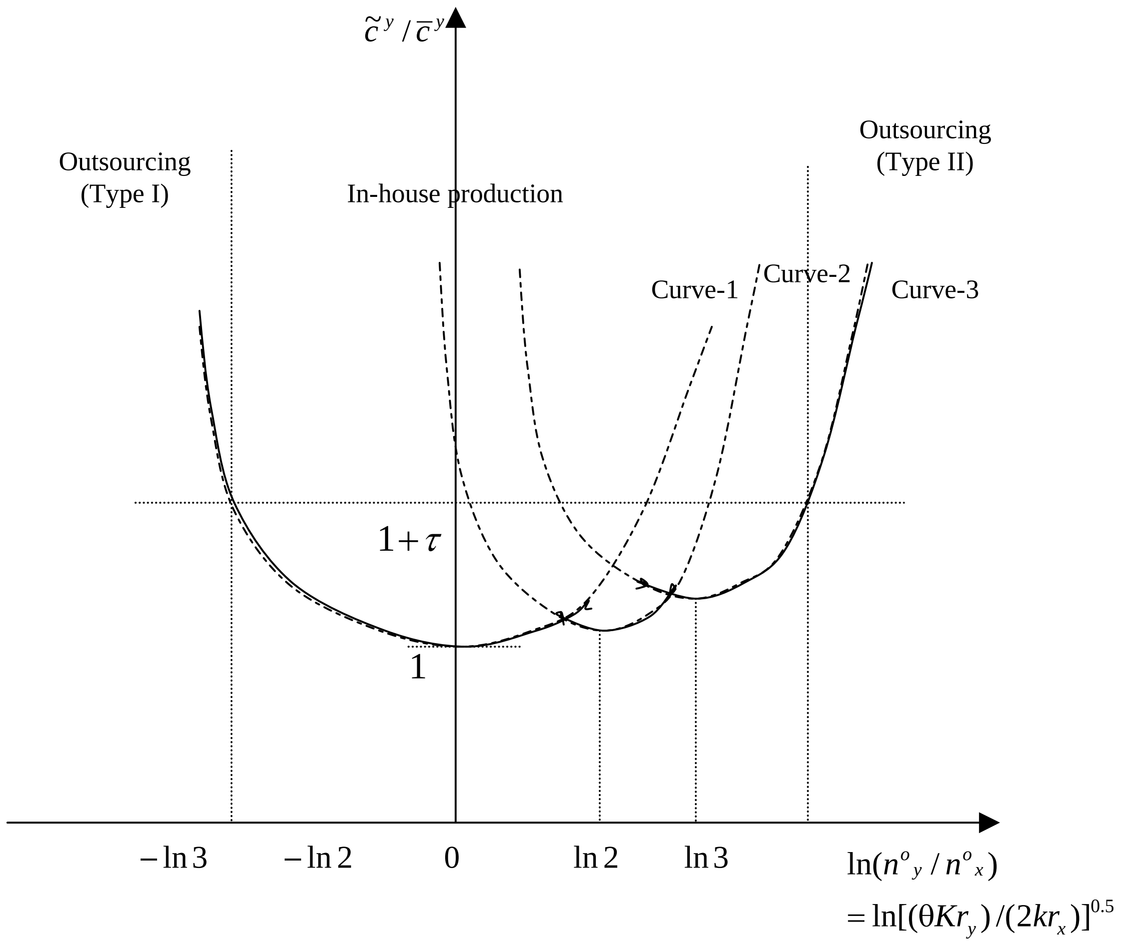

k / k^*
$\frac{k}{k^*} = \frac{r_y^*}{r_y} (\frac{1+\tau^*}{a^*})^2$
International Outsourcing
Domestic Outsourcing
A
0
r_y^* / r_y

Figure 3



$\tilde{c}^y / \bar{c}^y$
Outsourcing
(Type I)
In-house production
Outsourcing
(Type II)
Curve-3
Curve-2
Curve-1
$1+\tau$
1
0
1
2
3
$(n^o{}_y)/(n^o{}_x)$
$=[(\theta K r_y)/(2k r_x)]^{0.5}$

Figure 4a



$\tilde{c}^y / \bar{c}^y$
Outsourcing
(Type I)
In-house production
Outsourcing
(Type II)
Curve-1
Curve-2
Curve-3
$1+\tau$
1
$-\ln 3$
$-\ln 2$
0
$\ln 2$
$\ln 3$
$\ln(n^o{}_y / n^o{}_x)$
$= \ln[(\theta K r_y)/(2kr_x)]^{0.5}$

Figure 4b