Economies of Scope and Patterns of Outsourcing

Zhihao Yu*
Carleton University

Abstract

The paper suggests that the evolution of modern technologies in manufacturing, from economies-of-scale to economies-of-scope, plays a key role in the increasing outsourcing activities. It is shown that the *divergence* in the degrees of economies-of-scope and the attribute space of the products *between* different stages of production is the fundamental economic force behind the recent trend of outsourcing activities. It also finds that outsourcing occurs in the following two opposite scenarios: either (i) the degree of economies-of-scope is very high and the attribute space is very small (i.e., close to a homogenous good); or (ii) the degree of economies-of-scope is very low and the attribute space is very large (i.e. highly specialized input/service). Furthermore, technology progress that reduces market transaction costs always increases outsourcing; technology progress that improves production techniques, however, could either increase or decrease outsourcing.

JEL Classification No.: L22, F2
Key Words: Address Model/Spatial Competition, economies-of-scope, Outsourcing

---

*Department of Economics, Carleton University; Research Fellow of the Leverhulme Centre for Research on Globalization and Economic Policy (*GEP*) at the University of Nottingham. I wish to thank Nicolas Schmitt and John Sutton for valuable comments. Thanks are also extended to the participants at the Annual Meeting of the Academy of International Business, the Far East Meeting of the Econometric Society, the Royal Economic Society annual meeting, and the Conference on "New Dimensions in International Trade" at Kobe University, seminar at Wilfrid Laurier University. The usual disclaimer applies. Financial support from the Social Sciences and Humanities Research Council of Canada is gratefully acknowledged.
Correspondence: Department of Economics, Carleton University, 1125 Colonel By Drive, Ottawa, Ont. K1S 5B6, Canada; Tel: 1-613-520-2600 ext. 3763; Fax: 1-613-520-3906; Email: zhihao.yu@gmail.com or zhihao_yu@carleton.ca

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. This raises a number of critical questions. Why do modern manufacturing 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? In this paper we attempt to answer these questions and better understand the patterns of outsourcing.

Outsourcing is often viewed as a means for firms to cope with increasing competition by looking for cheaper suppliers. However, while cost reduction is a motive, it is not the underlying economic force behind outsourcing activities. This paper develops a simple model of two-stage production in which the evolution of modern production technology (from economies-of-scale to economies-of-scope) play a key role in 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.

There are have been two major evolutions in modern manufacturing. The first was the arrival of economies-of-scale production technology, which requires a large fixed cost in production. The key to the success of the economies-of-scale technology is to produce a massive amount of products to achieve low average costs of production. For example, the Ford Motor Company was a perfect example of succeeding in economies-of-scale production in the automobile industry. Its relatively inexpensive automobiles was based on mass production of a single, and basically unchanging, product. In the 1920s when workers in the Ford Motor Company were getting the highest pay in the industry, Ford did not seek outsourcing to reduce costs,[1] nor did the technical improvements/progresses in economies-of-scale technology lead to outsourcing.

The second major evolution in modern manufacturing was the arrival of *economies-of-scope*

[1]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).

production technology. In the automobile industry, for example, in the early 1920s the General Motors Company started a major innovation in producing automobiles by focusing on *economies-of-scope*, rather than economies-of-scale, in production. In 1923 General Motors introduced the policy of 'a car for every purse' (i.e., different cars for people with different incomes) and started annual model changes. To make model changes relatively cheap, 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 of focusing on economies-of-scope was further advanced by Japanese carmakers (i.e. Toyota and Nissan) after the Second World War. 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. This 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 success of economies-of-scope production was also fueled by the progress in the CAD (computer-aided-design) technology, which has made model changes and product improvement much easier than ever before.

The evolution of modern manufacturing was one of the main subjects of research interests in the industrial organization literature over a decade ago. Important contributions in the literature include Milgrom and Roberts (1990), and Milgrom, Qian and Roberts (1991). These studies show that firms could 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. The focus of these studies is on flexible manufacturing, complementarities in production, and the theory of firm organization, rather than the outsourcing phenomenon.[2]

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

[2]The implication of flexible manufacturing for market structure has been investigated extensively by MacLeod, et al (1988), Eaton and Schmitt (1994), and Norman and Thisse (1999).

[3]See evidence of international outsourcing in Hanson (1996), Slaughter (1995), and Feenstra and Hanson (2003), among many others. Feenstra (1998) provides an excellent overview of this topic.

pursuing rigorous theories for outsourcing. Most studies in the literature use the approaches based on the theories of incomplete contracts and transaction costs, and focused on the impact of globalization on outsourcing.[4]

In this paper we use an address model of spatial competition and focus on the impact of evolutions of modern manufacturing (i.e. from economies-of-scale to economies-of-scope) on outsourcing. The spatial model allows us to gain new insights on the patterns of outsourcing and, in particular, on how outsourcing activities are affected by the degrees of product differentiation and economies-of-scope in production of the intermediate input relative to those of the final good. In addition, the address helps better understand the fundamental economic force behind outsourcing.

The main results of the paper are as follows. First, we show that economies-of-scope in production is the necessary condition for outsourcing. Adoption of economies-of-scope technology in production could lead to outsourcing. Second, outsourcing occurs in the following two opposite scenarios in terms of production and characteristics of the good: either (i) the degree of economies-of-scope is very high and the attribute space is very small (i.e., close to a homogenous good), or (ii) the degree of economies-of-scope is very low and the attribute space is very large (i.e., highly specialized input/service). *Third*, although economies-of-scope is a necessary condition for outsourcing, the fundamental economic force behind outsourcing is the *divergence* in the degrees of economies-of-scope, and the attribute spaces of the products *between* different stages of production. *Forth*, the progress of the 'general-purpose-technology' (e.g., information technology, etc.) that reduces market transaction costs always increases outsourcing. However, if technology progress improves production techniques, it could either increase or decrease outsourcing activities. *Finally*, if technology progress is what we called 'pro-EOScope' (or 'anti-EOScope') and is persistently biased towards one stage of production, outsourcing will eventually occur.

The rest of the paper is organized as follows. Section 2 develops a model in which economies-of-scope play a key role in different stages of production in a vertically-linked production structure. We then examine both the vertically-integrated and vertically-disintegrated production structures, and derive the production-efficiency outcome. Section 3 characterizes the patterns of

[4]E.g. see McLaren (2000), Grossman and Helpman (2002, 2005), Antràs (2003), and Antràs and Helpman (2004).

outsourcing and discusses the impact of technology progresses on outsourcing activities. Section 4 discusses some alternative assumptions and the robustness of our results. Section 5 concludes the paper.

2 The Model

There are two goods in the economy, a differentiated product 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 the 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 L consumers, whose preference of attributes for the most preferred good is uniformly distributed along a circumference.

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.

To produce the differentiated product, it requires 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,[5] 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 they can produce

[5] For the sake of clarity, we assume only one intermediate input/component. The model can be easily generalized to use many intermediate components to produce the final good and our results will remain.

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; Similarly, we use Y_i and y_j for that of the intermediate good, respectively. This simple two-stage production structure is illustrated in **Figure 1**.

Assume that each firm owns at most only one basic product in each stage of production.[6] Therefore a firm is identified by a basic product. 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

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

We assume that the overall production cost takes the following form,

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

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,

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

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

Parameters K and k respectively denote the fixed costs of developing the basic final and intermediate product (X_i and Y_i). 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 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 $c_x = c_y = 0$.

[6] Even if firms can own more than one *basic product* at each stage of production, our results remain as long as there are additional organizational costs of having more than one *basic product* at each stage of production. This is similar to the common assumption in the literature that there are cost advantages for specialized firms. In Section 4 we relax this assumption.

Following the standard definition[7], the degree of economies-of-scope in the final-good production can be characterized by

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

The trade-off is between saving the fixed costs and incurring the modification costs. For economies-of-scope to exist, either K has to be large or r_x has to be small so that (6) is positive. 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

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

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.

2.1.1 Equilibrium with economies-of-scale

When production only has economies-of-scale but not economies-of-scope, a firm produces only the basic product. Then, (3) and (5) reduce to:

$$C(X_i) = K + q_i \tilde{c}_i^y \quad \text{and} \quad C(Y_i) = k \tag{8}$$

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 fit exactly 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, we obtain the following results (e.g. Tirole, 1988):

$$p_i = L/n^o + c_i^y \quad \text{and} \quad c_i^y = \frac{kn^o}{L}, \qquad i = 1, ..., n \tag{9}$$

[7] 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 the products independently, or jointly.

where

$$n^o = L(1/K)^{1/2} \tag{10}$$

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

$$c^y \equiv c_i^y = k/(K)^{1/2}, \qquad i = 1, ..., n \tag{11}$$

$$p \equiv p_i = K^{1/2} + k/(K)^{1/2}, \qquad i = 1, ..., n \tag{12}$$

2.1.2 Equilibrium with economies-of-scope

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

$$MC_i(x) = \widetilde{c}_i^y + r_x x \tag{13}$$

Following Eaton and Schmitt (1994), we assume $t > \widetilde{c}_i^y + r_x$ for all i. Using (1) and (13), it is not difficult to show 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 Eaton and Schmitt (1994), 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. In our model, this second most efficient firm is adjacent firm $i+1$, which is $L/n_x - x$ away from good x. Therefore, firm i's price for good x is (see **Figure 2**).

$$p_i(x) = MC_{i+1}(x) = \widetilde{c}_{i+1}^y + r_x|L/n_x - x|, \qquad 0 \le x \le L/(2n_x) \tag{14}$$

In the symmetric equilibrium with free entry, we obtain

$$\widetilde{c}^y \equiv \widetilde{c}_i^y = \widetilde{c}_{i+1}^y, \qquad i = 1, ..., n \tag{15}$$

$$p_i(x) = \widetilde{c}^y + r_x(L/n_x - x), \quad 0 \le x \le L/(2n_x), \quad i = 1, ..., n_x \tag{16}$$

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

$$\pi_i \;=\; 2\int_0^{L/(2n_x)} [p_i(x) - MC_i(x)]q_i(x)dx - K$$

$$= \quad 2\int_0^{L/(2n_x)} [r_x(L/n_x - x) - r_x x]dx - K \tag{17}$$
$$= \quad \frac{r_x}{2}(\frac{L}{n_x})^2 - K$$

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

$$n_x^o = L(\frac{r_x}{2K})^{1/2} \tag{18}$$

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

Furthermore, notice that $n_y = n_x^o$ in vertically-integrated production. Using (4-5), we can obtain the average cost of the intermediate good:[8]

$$\begin{aligned} \tilde{c}^y \quad &\equiv \quad \tilde{c}_i^y = \frac{k + 2\int_0^{\theta L/(2n_y)} q_i(y) r_y y dy}{2\int_0^{\theta L/(2n_y)} q_i(y)dy} \\ &= \quad \frac{k + 2\int_0^{\theta L/(2n_x^o)} (r_y y/\theta)dy}{2\int_0^{\theta L/(2n_x^o)} (1/\theta)dy} \\ &= \quad \frac{k + (\theta r_y K)/(2r_x)}{(2K/r_x)^{1/2}} \\ &= \quad k(\frac{r_x}{2K})^{1/2} + \frac{\theta r_y}{2}(\frac{K}{2r_x})^{1/2} \end{aligned} \tag{19}$$

Using (16) and (18-19), we obtain the equilibrium price of good x:

$$p^o(x) \equiv p_i^o(x) = k(\frac{r_x}{2K})^{1/2} + \frac{\theta r_y}{2}(\frac{K}{2r_x})^{1/2} + r_x[(\frac{2K}{r_x})^{1/2} - x], \qquad i = 1, ..., n \tag{20}$$

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

2.2 Vertically-Disintegrated Production (Outsourcing) and the Production-Efficiency Outcome

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

[8]Notice that for the attribute space of intermediate input y, the length of the circumference becomes θL, and the density $1/\theta$.

intermediate-input market and focus on the fundamental economic force in production (i.e., production efficiency), we assume free entry and no cross-subsidizing in the intermediate input market so that the intermediate products are priced at average costs. Similar to Grossman and Helpman (2005), we also assume that final-good producers have to incur transaction costs in purchasing the intermediate input.

2.2.1 Equilibrium with economies-of-scale

When production only has economies-of-scale but not economies-of-scope, only the basic products are produced. Therefore, in equilibrium the number of the basic final-good products has to equal that of the basic intermediate-input products. Furthermore, minimum-cost production requires that the basic intermediate product Y_i is designed to fit exactly the production of X_i. Thus, the equilibrium is exactly the same as vertically-integrated production in Section 2.1.1, except that firms now have to pay transaction costs for the input they purchase. Therefore, vertically-integrated production will dominate vertically-disintegrated production.

Proposition 1 *Without economies-of-scope (i.e., with only economies-of-scale) technology, vertically-integrated production is more efficient than vertically-disintegrated production.*

2.2.2 Equilibrium with economies-of-scope

When there are economies-of-scope in production, the number of the basic intermediate products no longer has to equal 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. For a representative firm i, which produces variants located symmetrically from its basic intermediate input Y_i, the total cost of production is

$$\begin{aligned} C((\mathbf{y}, \mathbf{q_i^y}); Y_i) &= k + 2\int_0^{\theta L/(2n_y)} q_j(y) r_y y dy \\ &= k + 2\int_0^{\theta L/(2n_y)} (r_y y/\theta) dy \\ &= k + \frac{\theta r_y}{4}(\frac{L}{n_y})^2 \end{aligned} \tag{21}$$

and the average cost of each variant becomes

$$\overline{c}_i^y = \frac{C((\mathbf{y}, \mathbf{q_i^y}); Y_i)}{2\int_0^{\theta L/(2n_y)} q_j(y) dy}$$

$$= \frac{k + (\theta r_y/4)(L/n_y)^2}{2\int_0^{\theta L/(2n_y)}(1/\theta)dy} \tag{22}$$
$$= (kn_y + \frac{\theta r_y L^2}{4n_y})/L$$

Under free-entry, the average cost of intermediate input will be driven down to the minimum. Therefore, the equilibrium number of firms in the intermediate-input market is given by

$$n_y^o = \arg\min\ (kn_y + \frac{\theta r_y L^2}{4n_y})/L$$
$$= L(\frac{\theta r_y}{4k})^{1/2} \tag{23}$$

Substituting (23) into (22), we obtain the average cost of the intermediate input in the symmetric equilibrium,

$$\overline{c}^y \equiv \overline{c}_i^y$$
$$= [kL(\frac{\theta r_y}{4k})^{1/2} + \frac{L}{2}(\theta k r_y)^{1/2}]/L \tag{24}$$
$$= (\theta k r_y)^{1/2} \qquad i = 1, ..., n$$

Vertically-disintegrated production, however, requires transaction costs in purchasing the intermediate input. For simplicity, we assume that to use one unit of the intermediate input, a final-good producer has to purchase $1+\tau$ units of the intermediate input ($\tau > 0$, in units of output). Thus, the cost for using one unit of the intermediate input is $\overline{c}^y(1+\tau)$.

Therefore, comparing $\overline{c}^y(1+\tau)$ with $\widetilde{c}^y$ of (19) in Section 2.1.1, we obtain the following proposition.

Proposition 2 *With economies-of-scope technology,*

(**i**) *the production-efficient outcome is in-house production if* $(\theta K r_y)/(kr_x) \in [\Omega_L^2(\tau), \Omega_U^2(\tau)]$*; however,*

(ii) *the production-efficiency outcome is outsourcing if* $(\theta K r_y)/(kr_x) < \Omega_L^2(\tau)$*, or* $(\theta K r_y)/(kr_x) > \Omega_U^2(\tau)$*, where* $\Omega_L^2(\tau) \equiv 2\{(1+\tau) - [(1+\tau)^2 - 1]^{0.5}\}^2$ *and* $\Omega_U^2(\tau) \equiv 2\{(1+\tau) + [(1+\tau)^2 - 1]^{0.5}\}^2$.

Proof: Before comparing $\widetilde{c}^y$ with $\overline{c}^y(1+\tau)$, we first derive $\widetilde{c}^y/\overline{c}^y$. Using (19) and (24), we obtain

$$\frac{\widetilde{c}^y}{\overline{c}^y} = (\frac{1}{2})^{0.5}(\frac{kr_x}{K\theta r_y})^{0.5} + (\frac{1}{8})^{0.5}(\frac{K\theta r_y}{kr_x})^{0.5} \tag{25}$$
$$= \frac{1}{\Omega}(\frac{1}{2})^{0.5} + \Omega(\frac{1}{8})^{0.5}$$

where $\Omega \equiv [(\theta K r_y)/(k r_x)]^{0.5}$. It is easy to show that (25) reaches the minimum (equal to 1) at $\Omega = \sqrt{2}$. Now we compare $(\tilde{c}^y/\bar{c}^y)$ in (25) with $(1+\tau)$. It is not difficult to show that $\tilde{c}^y > \bar{c}^y(1+\tau)$ if $(\theta K r_y)/(k r_x) \in [\Omega_L^2(\tau), \Omega_U^2(\tau)]$, and $\tilde{c}^y < \bar{c}^y(1+\tau)$ *if* $(\theta K r_y)/(k r_x) < \Omega_L^2(\tau)$, *or* $(\theta K r_y)/(k r_x) > \Omega_U^2(\tau)$. ■

Proposition 2 is also illustrated in **Figure 3.** When $(\theta K r_y)/(k r_x) \in [\Omega_L^2(\tau), \Omega_U^2(\tau)]$, $(\tilde{c}^y/\bar{c}^y)$-curve is below $(1+\tau)$-line and we have the 'In-house Production' region. When $(\theta K r_y)/(k r_x) < \Omega_L^2(\tau)$ *or* $(\theta K r_y)/(k r_x) > \Omega_U^2(\tau)$, $(\tilde{c}^y/\bar{c}^y)$-curve is above $(1+\tau)$-line and we have the 'Outsourcing' region.

The intuitions for the results are as follows. First, notice that with vertically-disintegrated production (i.e. outsourcing), the number of basic intermediate products n_y^o in (23) is production-efficient; with vertically-integrated/in-house production, however, the number of basic intermediate products n_y is constrained to the same as n_x^o in (18) - the equilibrium number of basic final products, which in general could be either greater or smaller than n_y^o. Only when $n_x^o = n_y^o$ [i.e., when $(\theta K r_y)/(k r_x) = 2$][9], we have $n_y = n_y^o$, and therefore $\tilde{c}^y = \bar{c}^y$, which is the minimum point on the $(\tilde{c}^y/\bar{c}^y)$-curve in **Figure 3.** 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 vertically-integrated production involves too much fixed costs. 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 vertically-integrated production involves too much modification costs in producing the variants. Second, when there are transaction costs in purchasing the intermediate input, whether the production-efficient outcome is in-house production or outsourcing depends on the trade-off between the production efficiency vs. the market transaction cost of outsourcing. Therefore, as in **Figure 3,** 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 in-house production involves either too much fixed costs or too much modification costs.

Combining the results in Propositions 1 and 2, we have **Table 1** and the following Corollary.

Corollary 1 *Economies-of-scope is the necessary condition for outsourcing. Adoption of economies-of-scope technology in production leads to outsourcing if* $(\theta K r_y)/(k r_x) < \Omega_L^2(\tau)$ or

[9] From (18) and (23), we obtain

$$\frac{n_y^o}{n_x^o} = (\frac{\theta K r_y}{2 k r_x})^{1/2}. \tag{26}$$

$(\theta K r_y)/(k r_x) > \Omega_U^2(\tau)$.

3 Outsourcing

The advantage of using the address model of spatial competition is that it allows us to identify the patterns of outsourcing. The results in Proposition 2 reveal how outsourcing activities depend on various parameters. It is useful to further investigate the implication of these results.

3.1 Patterns of Outsourcing

From (6 -7), notice that a low value of r_y means that the modification cost of producing the variants of the intermediate input is relatively low. A high value of 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 means that the attribute space of the intermediate input is relatively small (i.e. close to a homogenous good)[10].

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 (i.e. highly specialized good). Therefore, we obtain the following proposition.

Proposition 3 *The patterns of outsourcing are characterized by the following two opposite scenarios in terms of production and characteristics of the good: either*

(i) *the degree of economies-of-scope is very high, or the attribute space is very small (i.e., close to a homogenous good); or*

(ii) *the degree of economies-of-scope is very low, or the attribute space is very large (i.e., highly specialized good/service).*

3.2 Technology Progress and Outsourcing

Technology progress over the last two decades has certainly played a very important role in the changes of production structure and outsourcing activities. Their exact impact requires further

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

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 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 3**).[11]

However, the effect of a reduction in r_y and r_x 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_y and r_x could either 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 $(\theta K r_y)/(k r_x) < 2$ (e.g. Point A in **Figure 3**), a decrease in r_y/r_x will increase outsourcing activities. However, if $(\theta K r_y)/(k r_x) > 2$ (e.g. Point B), a decrease in r_y/r_x will decrease outsourcing activities. 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) *Technology progress that reduces market transaction costs always increases outsourcing; however,*

(ii) *Technology progress that improves production techniques could either increase or decrease outsourcing.*

A new technology that reduces the modification costs of producing variants may require a higher fixed cost of developing the basic product. In that case, the new technology reduces the ratio of r_y/k (or r_x/K), and hence it increases the degree of economies-of-scope. We call the technology progress 'pro-EOScope' if it decreases the ratio of the modification cost over the fixed cost, and 'anti-EOScope' if it increases the ratio. Therefore, we have the following result.

Proposition 5 *If technology progress, which could be either pro-EOScope or anti-EOScope, is persistently biased towards one stage of production, outsourcing will eventually occur.*

Proposition 5 highlights that the *divergence* in the degrees of economies-of-scope *between* different stages of production is a driving force behind outsourcing activities. The result can

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

be illustrated using **Figure 3.** For example, regardless of where we start (either from Point A or from Point C), a continuous decrease or increase in $(r_y/k)/(r_x/K)$ will in the end lead to the outsourcing region.

4 Discussion

In deriving the main results in a transparent way, we 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 these results are robust. In this section, we relax this assumption to gain further insights on this issue.

We first examine ownership structure of the basic products in *final-good production.* Notice that the profit of a firm in final-good production 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 (see Eaton and Schmitt, 1994). Therefore, a firm does not gain in reducing costs in final-good production by having multiple basic products. When there are management costs associated with having multiple basic products, the symmetric equilibrium is that each firm will have just one basic product.

Next we consider ownership structure of the basic products in *intermediate-good production.* From (26), notice that

$$\frac{n_y^o}{n_x^o} = (\frac{\theta K r_y}{2kr_x})^{1/2}.$$

Therefore, we can also obtain the $(\widetilde{c}^y/\overline{c}^y)$-curve as a function of (n_y^o/n_x^o), which is the dashed U-shape curve-1 in **Figure 4**. If each firm owns two basic products in intermediate-good production, it is easy to show that the $(\widetilde{c}^y/\overline{c}^y)$-curve will become the dashed U-shape curve-2 in **Figure 4**. 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. Although **Figure 4** only draws these two 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 $(\widetilde{c}^y/\overline{c}^y)$-curve in the presence of multiple basic products is the contour of these curves, i.e., the solid curve in **Figure 4**. From a big perspective, this solid curve is qualitatively the same as the one in **Figure 3**. Therefore, our main results will still hold even when firms are allowed to have multiple basic products.

5 Concluding Remarks

In this paper we have developed a simple model of two-stage production in which economies-of-scope play an important role in a vertically-linked production structure. The model allows us to identify the general patterns of outsourcing and discuss how outsourcing activities are affected by the degree of product differentiation and economies-of-scope in production. It is also shown that the main insight of our results are robust even if we relax the key assumption in the model. Our results on the patterns of outsourcing can be easily formulated as some testable hypotheses, 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 sector of differentiated products. The model can also be generalized to the case with multiple sectors of differentiated products. Then, it can be used to explore the impact of variations across sectors on the relative prevalence of vertically-integrated production vs. vertically-disintegrated production (outsourcing).

References

Antràs, Pol 2003, "Firms, contracts, and trade structure", *Quarterly Journal of Economics* 118, 1375-1418.

Antràs, Pol and Elhanan Helpman 2004, "Global Sourcing", *Journal of Political Economy,* 112, 552-580.

Davis, Edward W., "Global outsourcing: Have U.S. managers thrown the baby out with the bath water?" *Business Horizons,* July/Aug92, v35(4), pp.58-64.

Eaton, B. Curtis and Schmitt, Nicolas, "Flexible manufacturing and market structure", *American Economic Review* 84, September 1994, 875-888.

Grossman, G.M. and Helpman, E., 2002, "Integration vs. outsourcing in industry equilibrium" *Quarterly Journal of Economics* 117, pp85-120.

Grossman, Gene and Elhanan Helpman, 2005 "Outsourcing in a global economy", *Review of Economic Studies,* 72, pp135-159.

Feenstra, Robert C. 1998, "Integration of trade and disintegration of production in the global economy", *Journal of Economic Literature,* v12(4), pp31-50.

Feenstra, Robert C. and Gordon H Hanson 2003, "Ownership and control in outsourcing to China: estimating the property-rights theory of the firm", *NBER Working Paper* No. 10198

Hanson, Gordon H. "Localization economics, vertical organization, and trade." *American Economic Review* 86, 1996, pp1266-78.

MacLeod, W.B., G. Norman and J.-F. Thisse 1988, "Price discrimination and equilibrium in monopolistic competition", *International Journal of Industrial Organization* 6, 429-446.

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

Milgrom, Paul and John Roberts, 1990, "The economics of modern manufacturing: technology, strategy, and organization", *American Economic Review* v80, p511-528.

Milgrom, Paul, Yingyi Qian, and John Roberts, 1991, "Complementarities, mormentum, and the evolution of modern manufacturing", *American Economic Review Papers and Proceedings,* May 1991, p84-88.

Norman, G. and J.-F. Thisse 1999, "Technology choice and market structure: strategic aspects of flexible manufacturing", *The Journal of Industrial Economics XLVII,* 345-372.

Pepall, L., D.J. Richards, and G. Norman, 1999, *Industrial Organization: Contemporary Theory and Practice*, Toronto: South-Western College Publishing,

Raff, Daniel M.G., "Making cars and making money in the interwar automobile industry: economies of scale and scope and the manufacturing behind the marketing", *Business History Review* 65 (Winter 1991), 721-53.

Tirole, Jean, 1988, *The Theory of Industrial Organization,*The MIT Press, Cambridge, Mass.

Appendix: Figures 1-4 and Table 1.

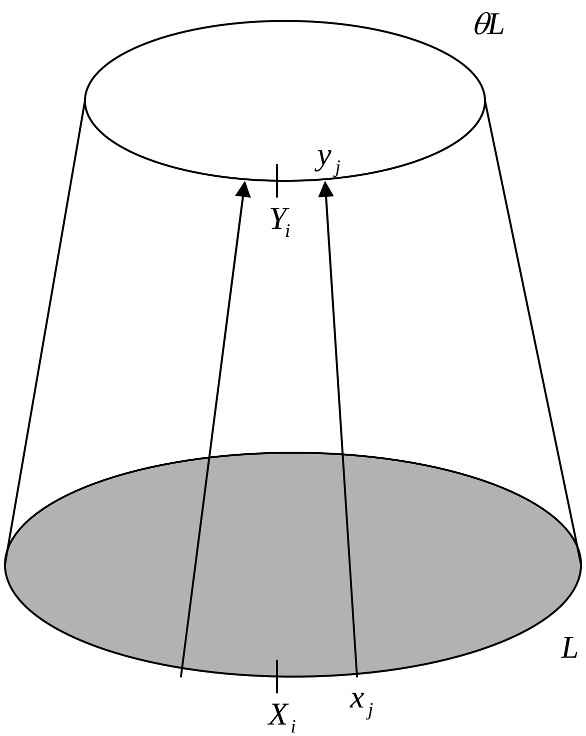


Figure 1

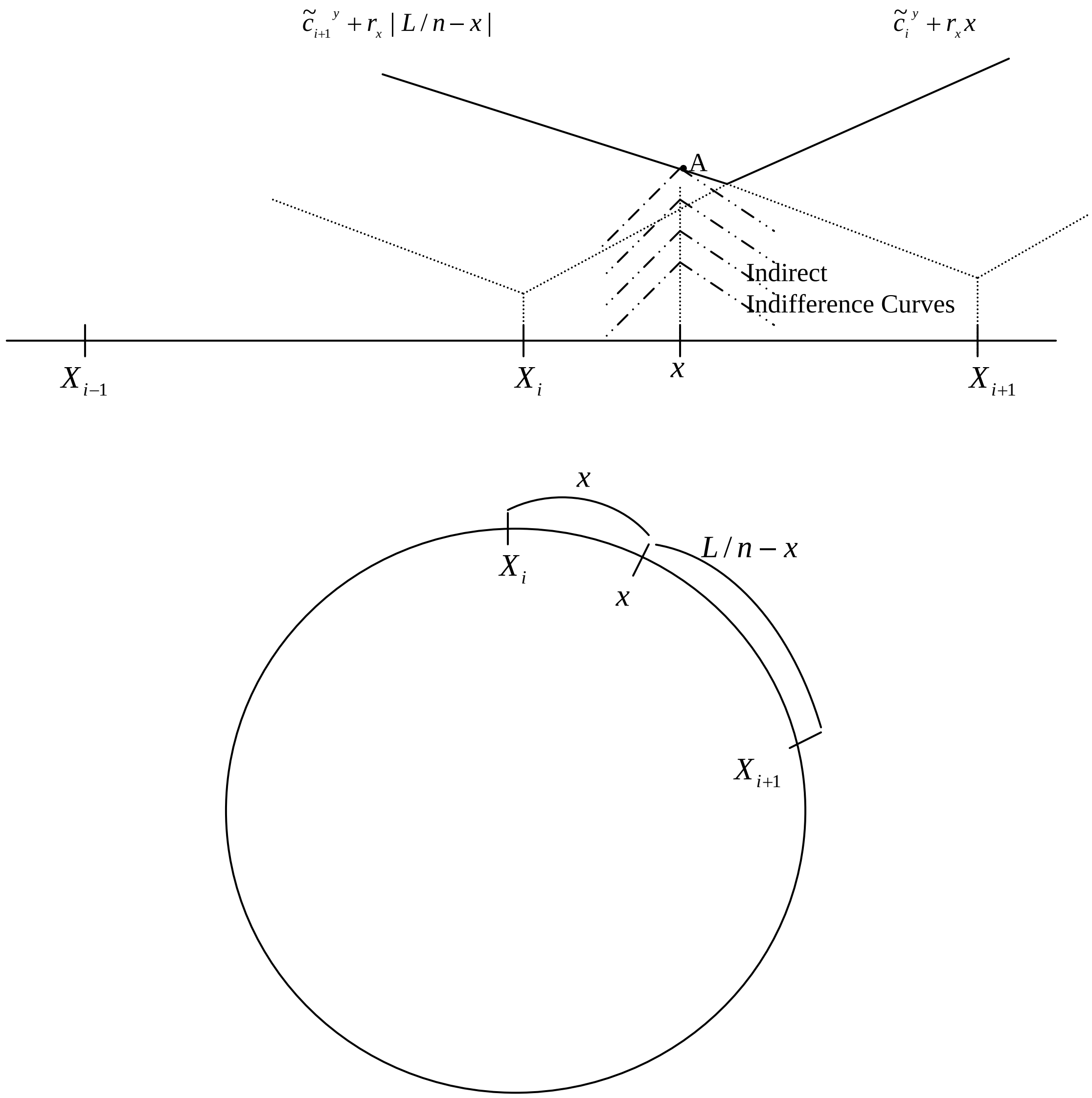
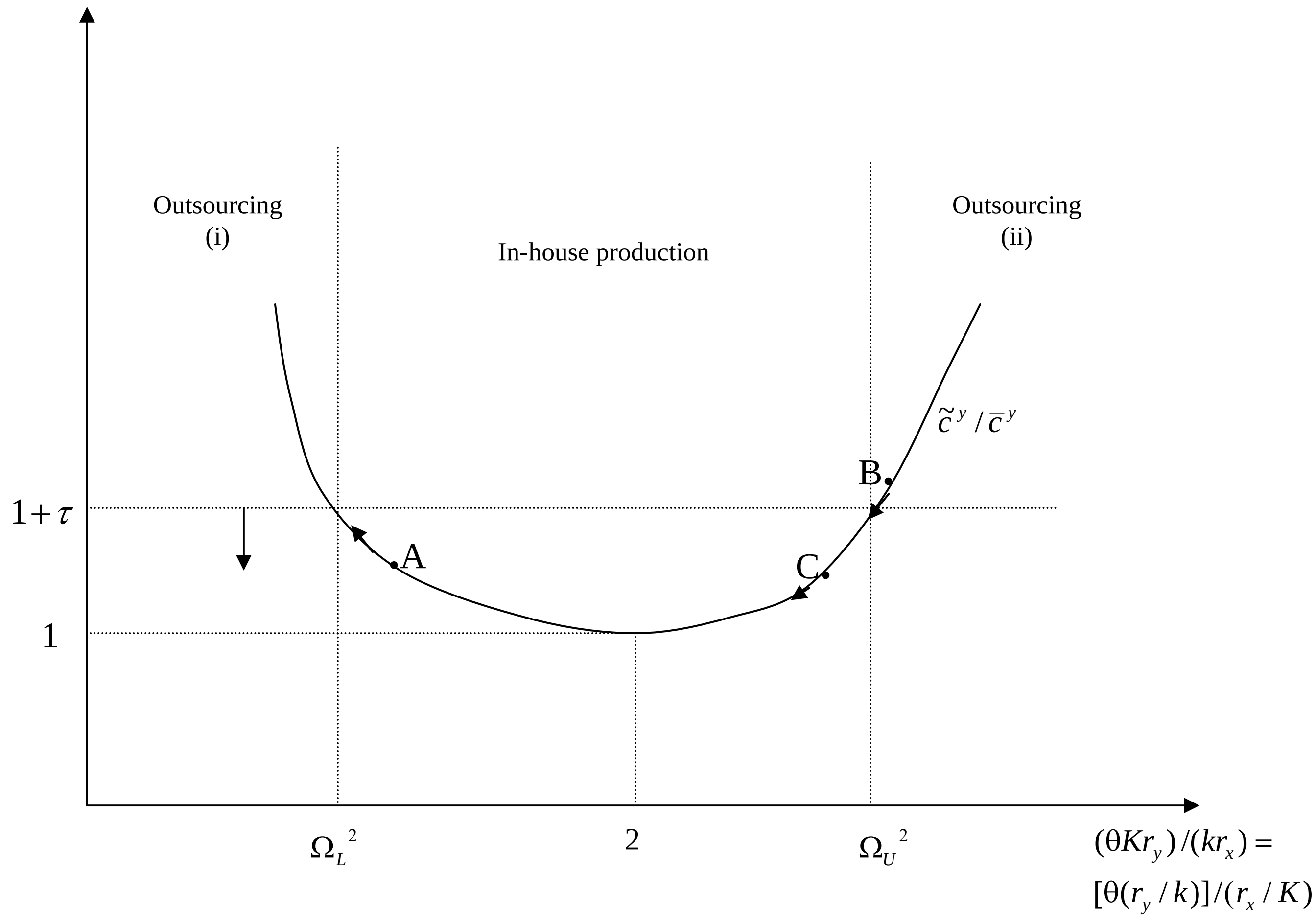
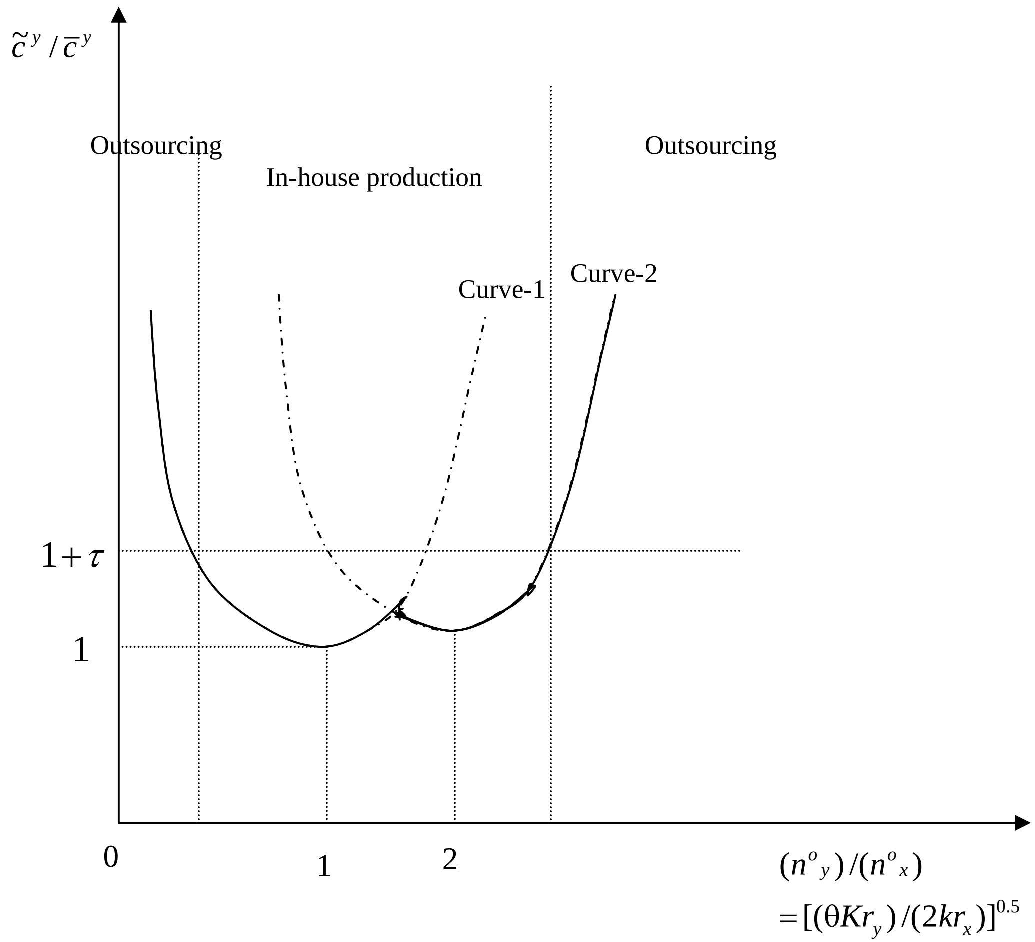

$\tilde{c}_{i+1}^{\,y} + r_x \,|\, L/n - x \,|$
$\tilde{c}_i^{\,y} + r_x x$
A
Indirect
Indifference Curves
X_{i-1}
X_i
x
X_{i+1}
x
$L/n - x$
X_i
x
X_{i+1}

Figure 2



Outsourcing
(i)
In-house production
Outsourcing
(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 3



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

Figure 4

Table 1

	In-house Production	Outsourcing
With Economies of Scope	Production-efficient Outcome if $(\theta K r_y)/(k r_x) \in [\Omega_L^2(\tau), \Omega_U^2(\tau)]$	Production-efficient Outcome if $(\theta K r_y)/(k r_x) \notin [\Omega_L^2(\tau), \Omega_U^2(\tau)]$
With Economies of Scale	Production-efficient Outcome	