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# A New Push on An Old Fundamental: Understanding the Patterns of Outsourcing

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**Abstract**

For what kind of intermediate input/service do firms often go outsourcing? This paper develops a model of two-stage production in which economies of scope are central to the production of both the intermediate and final good. The model is able to explain the patterns of outsourcing from the degree of product differentiation, economies of scope, and economies of scale in production of the intermediate input relative to that of the final good. The recent surge of outsourcing activities is explained by a new push (progress in the general purpose technology, e.g., information technology) on an old fundamental (economies of scope in production).

*Key Words*: Outsourcing, Economies of Scope, Vertical Disintegration, Vertical and Horizontal Specialization

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## 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 designing, data processing, special components, assembly, and minor parts and components, etc.[1] Why do firms engage in very different outsourcing business, some require high-skilled labor and are very specialized but others are very simple and minor. For what kind of intermediate input/service do firms often go outsourcing? Can we say anything about the characteristics/attribute of the goods or services in outsourcing? The purpose of this paper is to address these questions and understand the patterns of outsourcing.

To answer these questions and explain the recent surge in outsourcing activities, it is important to understand the fundamental economic force behind outsourcing. Although it is true that outsourcing is a means of cutting costs to stay competitive, it is not the underlying economic force. A review of outsourcing activities in the automobile industry will reveal the driving force behind the trend of outsourcing business. 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, rather than economies of scale, in production. The success of Ford, and its relatively inexpensive automobile, was based on mass production of a single, basically unchanging, product. In 1923 General Motors (lead by Alfred P. Sloan), however, introduced the 'car for every purse' policy (i.e., different cars for people with different incomes) and started annual model changes. To meet the competition of low-cost cars and 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

[1] See details in *WTO Annual Report 1998* (p.36), cited by Grossman and Helpman (2002).

[2] Henry Ford introduced the '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). The discussion in the rest of this paragraph benefits a great deal from Raff (1991) and Cusumano (1985).

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. 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 the 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.

Building on the work by Eaton and Schmitt (1994), I develop a model of two-stage production in which economies of scope are central to the production of both the intermediate and final good. Outsourcing comes as a natural result of vertical disintegration in production. The key conflict of economic forces lies in the difference in the efficient level economies of scope between the two stages of production. The trade-off between production efficiency and the market transaction cost determines whether the vertically-integrate or vertically-disintegrated production will be the efficient outcome. The model is able to explain the patterns of outsourcing from the degree of product differentiation, economies of scope, and economies of scale in production of the intermediate input relative to that of the final good. The recent surge of outsourcing activities is explained by a new push (progress in the general purpose technology, e.g., information technology) on an old fundamental (economies of scope in production).

The main results of the paper are as follows. First, it is shown that in the absence of economies of scope, vertically-integrated production is more efficient than vertically-disintegrated production. The reason for the result is that without economies of scope in production of differentiated products, these two production structures are effectively the same but under vertical disintegration it requires additional costs for market transaction. Secondly, when there are economies of scope in production, there is a trade-off between production efficiency and market transaction cost. It is shown that vertical disintegration

(and hence outsourcing) is more likely to occur if an intermediate input belongs to one of these two opposite cases: (i) the intermediate input is highly differentiated/specialized, or has a very low degree of economies of scope, or a very low degree of economies of scale in production; (ii) it has a very small attribute space (close to a homogenous good), or has a very high degree of economies of scope, or a very high degree of economies of scale in production. Thirdly, a reduction in transaction cost *always* increases outsourcing but a technology progress may not. However, continuous progresses in general purpose technology that has a persistently biased effect on economies of scope in one stage of production (e.g., final goods) over the other (e.g., intermediate goods) lead to more outsourcing activities.

Outsourcing became the most significant industrial phenomenon in the 1990s and has widely spread across industries and national boundaries.[3] A development of rigorous theories in this area began only recently. 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 contract although globalization still plays an important role in explaining outsourcing. 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 (2002a, 2002b) 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. The current model focuses only on a particular issue - economies of scope in production, which as the paper argues is a fundamentally important economic force behind the wide-spread outsourcing activities. The model allows us to discuss how outsourcing activities are affected by the degree of

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

[4] E.g., see Jones (2000), Chen, *et al. (2003),* and the collections in Jones and Kierzkowski (2001) and Cheng and Kierzkowski (2001). Zhao (2001) explains outsourcing of multinationals by domestic unionization.

product differentiation, economies of scope, and economies of scale 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. We first derive the equilibrium for both the vertically-integrated and vertically-disintegrated production structures, and then find the efficient equilibrium outcome. Section 3 characterizes the equilibrium of vertically-disintegrated production and the patterns of outsourcing. Section 4 provides some concluding remarks and thoughts about possible extensions of the model.

## 2. THE MODEL

### 2.1. Vertically-integrated (In-house) Production

In this model I extend the address model of Eaton and Schmitt (1994) to a two-stage production structure, in which technology in both production stages exhibits economies of scope. As in the standard circular model, 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 buy only one unit of the good and the utility from purchasing one unit of good $x$ at price $p(x)$ for consumer $i$, for instance, is

$$U_i(x, p(x)) = V - p(x) - t|x - x_i^*| \tag{1}$$

where $x_i^*$ describes the consumer's most preferred 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 all consumers consume the good in equilibrium. There are $\phi L$ consumers whose preference of attributes for the most preferred good is uniformly distributed along the circumference, and hence $\phi$ is the population density.

To produce one unit of output requires one unit of an intermediate input, and the technology in both production stages exhibits economies of scope. Specifically, a firm must first incur a fixed cost to develop a *basic product* and then can produce variants by modifying

the basic product, in both stages of production. Suppose that $X_i$ denotes the location in the attribute space of basic product $i$, and $Y_i$ that of the basic intermediate product corresponding to $X_i$. Similarly, we use $y_j$ and $x_j$ to denote variant $j$'s locations in the space of the final and intermediate products, respectively.

Assume that each firm owns only one basic product and 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 $i$. This can be described by

$$(\mathbf{x}, \mathbf{q_i^x}) = [(x_1, q_1), (x_2, q_2), ..., (x_m, q_m)].$$

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

$$\begin{aligned} C((\mathbf{x}, \mathbf{q_i^x}); X_i) &= K + (m-1)S + \sum_{j=1}^{m} q_i(x_j)(\tilde{c}_i^y + c_x + r_x|x_j - X_i|) \qquad (2) \\ &= K + (m-1)S + C((\mathbf{y}, \mathbf{q_i^y}); Y_i) + \sum_{j=1}^{m} q_i(x_j)(c_x + r_x|x_j - X_i|), \ K > 0, r_x > 0 \end{aligned}$$

where $\tilde{c}_i^y$ is the average cost, and $C((\mathbf{y}, \mathbf{q_i^y}); Y_i)$ the total production cost of intermediate input $y$ given by

$$C((\mathbf{y}, \mathbf{q_i^y}); Y_i) = k + (m-1)s + \sum_{j=1}^{m} q_i(y_j)(c_y + r_y|y_j - Y_i|), \qquad k > 0, r_y > 0. \qquad (3)$$

$K$ and $k$ denote the sunk cost of developing the basic final and intermediate product ($X_i$ and $Y_i$), and $S$ and $s$ the cost of switching from one variant to another. $c_y + r_y|y_j - Y_i|$ is the marginal cost of producing a 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 a unit of variant $x_j$ using input $y_j$. The further a variant ($x_j$ or $y_j$) is away from its basic product, the larger is the cost of modification.

It is important to note 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 identical to that of $|x_j - X_i|$. Suppose the length of the circumference of the attribute space for the intermediate good is $\theta L$, as illustrated in **Figure 1.** If $\theta < 1$ (*resp.* $\theta > 1$), the degree of product differentiation of the intermediate input is lower (*resp.* higher) than that of the final good. When $\theta = 0$, the intermediate input is a homogeneous good.

### 2.1.1 Equilibrium without economies of scope

When there are no economies of scope in production, a firm produces only a basic product. Then, (2) and (3) become:

$$C(X_i) = K + q_i^x(\widetilde{c}_i^y + c_x) \tag{4}$$

$$C(Y_i) = k + c_y q_i^y \tag{5}$$

where $q_i^x = q_i^y$ is the output, and $\widetilde{c}_i^y = C(Y_i)/q_i^y$ the average production cost of intermediate input $Y_i$.

Suppose there are $n$ firms symmetrically located along the circumference of a circle in attribute space. It is straightforward to show the following textbook results for the symmetric equilibrium under free-entry:

$$p_i^{x*} = L/n^* + \widetilde{c}_i^y + c_x, \qquad i = 1, ..., n \tag{6}$$

$$\widetilde{c}_i^y = \frac{kn^*}{\phi L} + c_y, \qquad i = 1, ..., n \tag{7}$$

$$n^* = L(\phi/K)^{1/2}. \tag{8}$$

Without loss of generality, we assume $c_x = c_y = 0$ [also using (8) and (7), and then (7) and (6)] and therefore, the average production cost of the intermediate input and the price of the final good become

$$\widetilde{c}_i^y = k/(K\phi)^{1/2}, \qquad i = 1, ..., n \tag{9}$$

$$p_i^{x*} = (K/\phi)^{1/2} + k/(K\phi)^{1/2}, \qquad i = 1, ..., n \tag{10}$$

### 2.1.2. Equilibrium with economies of scope

Following Eaton and Schmitt (1994), we focus on the case of *strong* economies of scope assuming that the switching cost $S$ is equal to zero. In doing so we reduce the number of parameters that describe economies of scope to one. For example, (2) now becomes,

$$C((\mathbf{x}, \mathbf{q_i^x}); X_i) = K + \sum_{j=1}^{m} q_i(x_j)(\tilde{c}_i^y + r_x|x_j - X_i|), \quad K > 0, r_x > 0 \tag{11}$$

where $r_x$ is the only parameter that captures the degree of economies of scope in producing the final good. The lower the value of $r_x$, the smaller the marginal cost in producing a variant and hence the higher the degree of economies of scope. Similarly (setting $s = 0$), the total and average production costs of the intermediate input become

$$C((\mathbf{y}, \mathbf{q_i^y}); Y_i) = k + \sum_{j=1}^{m} q_i(y_j) r_y |y_j - Y_i|), \quad k > 0, r_y > 0. \tag{12}$$

$$\tilde{c}_i^y = C((\mathbf{y}, \mathbf{q_i^y}); Y_i) / \sum_{j=1}^{m} q_i(y_j) \tag{13}$$

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 $x$. Thus,

$$\begin{aligned} MC_i(x) &= \tilde{c}_i^y + r_x|x - X_i| \\ &= \tilde{c}_i^y + r_x x \end{aligned} \tag{14}$$

Similar to Eaton and Schmitt, we focus on the case in which $t > \tilde{c}_i^y + r_x$ for all $i$. Since each firm can produce each good along the continuum circumference $L$, a price equilibrium involves a complete price schedule for each firm. As shown by these authors, in such a Bertrand equilibrium the most efficient firm (e.g., in producing good $x$) sets the price for the good equal to the marginal cost of the second most efficient firm and makes the sale of the good. Therefore, we obtain

$$p_i^*(x) = MC_{i+1}(x) = \tilde{c}_{i+1}^y + r_x|L/n - x|, \qquad 0 \le x \le L/(2n) \tag{15}$$

Since $t > r_x$, the consumer will always choose to buy her most preferred good in the equilibrium. **Figure 2**, which is similar to Figure 1 in Eaton and Schmitt (1994), illustrates this point. Suppose there are two neighboring basic products, $X_i$ and $X_{i+1}$, owned by firm $i$ and firm $i+1$. The dashed lines represent their marginal costs of production for any good in attribute space and the solid line represents the equilibrium price schedule. The dot-dashed lines are the indirect indifference curves of the consumer whose most preferred good is $x$. Since $t > r_x$, the slope of the indifference curves is greater than that of the price schedule and therefore, the consumer buys good $x$ obtaining the highest level of utility (i.e., the lowest obtainable indifference curve).

In the free-entry symmetric equilibrium, we obtain

$$\widetilde{c}^y \equiv \widetilde{c}_i^y = \widetilde{c}_{i+1}^y, \qquad i = 1, ..., n \tag{16}$$

$$p_i^*(x) = \widetilde{c}^y + r_x(L/n - x), \quad 0 \leq x \leq L/(2n), \qquad i = 1, ..., n \tag{17}$$

and the entire continuum of goods is produced and each consumer purchases her most preferred product. Therefore, the profit of each firm becomes

$$\begin{aligned} \pi_i^* &= 2\int_0^{L/(2n)} [p_i^*(x) - MC_i(x)]q_i(x)dx - K \\ &= 2\int_0^{L/(2n)} [r_x(L/n_x - x) - r_x x]\phi dx - K \\ &= \frac{\phi r_x}{2}(\frac{L}{n})^2 - K \end{aligned} \tag{18}$$

As Eaton and Schmitt (1994, pp.880) shows, the equilibrium profit of firm $i$ is independent of the ownership structure of the basic products, which is a reassurance of our earlier assumption that each firm owns one basic product.

Free entry will drive $\pi_i^*$ down to zero. Ignoring the integer problem, we obtain the equilibrium number of firms,

$$n^* = L(\frac{\phi r_x}{2K})^{1/2} \tag{19}$$

Similar to (13) and (12), the average cost of the intermediate good becomes,[5]

$$\begin{aligned}
\widetilde{c}^y &\equiv \widetilde{c}_i^y = \frac{k + 2\int_0^{\theta L/(2n^*)} q_i(y) r_y y dy}{2\int_0^{\theta L/(2n^*)} q_i(y) dy} \\
&= \frac{k + 2\int_0^{\theta L/(2n^*)} (\phi r_y y/\theta) dy}{2\int_0^{\theta L/(2n^*)} (\phi/\theta) dy} \\
&= \frac{k + (\theta r_y K)/(2r_x)}{(2\phi K/r_x)^{1/2}} \\
&= k(\frac{r_x}{2\phi K})^{1/2} + \frac{\theta r_y}{2}(\frac{K}{2\phi r_x})^{1/2}
\end{aligned} \tag{20}$$

Therefore, the equilibrium price of any good $x$, located away from a basic product at distance $x$ becomes

$$p_i^*(x) = k(\frac{r_x}{2\phi K})^{1/2} + \frac{\theta r_y}{2}(\frac{K}{2\phi r_x})^{1/2} + r_x[(\frac{2K}{\phi r_x})^{1/2} - x], \qquad i = 1, ..., n \tag{21}$$

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

## 2.2 Vertically-disintegrated Production and Efficient Equilibrium Outcome

Now consider the case in which production is vertically-disintegrated and there are independent firms and market for the intermediate input. To avoid any unnecessary strategic action in the intermediate-input market and focus on the fundamental economic force in production - production efficiency, I assume that firms that produce the intermediate input follow the average-cost pricing rule.[6] Furthermore, there is a transaction cost: final-good producers have to incur an additional cost in purchasing a unit of the intermediate input.

[5] Notice that for the attribute space of intermediate input $y$, the length of the circumference becomes $\theta L$, and the density $\phi/\theta$.

[6] It is not clear whether marginal-cost pricing would be superior to average-cost pricing, given that there is a fixed cost of production in this monopolistically competitive market. While the assumption simplifies the analysis and helps bring out the main insight, nevertheless it is a limitation of our analysis.

### 2.2.1 Equilibrium without economies of scope

When there are no economies of scope, only the basic products will be produced and therefore in equilibrium the number of the basic final-good products has to equal to that of the basic intermediate-input products (since an intermediate input does not have any value unless it targets a corresponding final product). Then, the equilibrium is exactly the same as in Section 2.1.1 except now firms have to pay an additional transaction cost for each unit of input they buy from the intermediate-input market. Therefore, vertically-disintegrated production is not as efficient as vertically-integrated production.

**Proposition 1** *In the absence of economies of scope, the equilibrium of vertically-integrated production is efficient.*

### 2.2.2. Equilibrium with economies of scope

When there are economies of scope, the number of the basic intermediate-input products does not have to equal to that of the basic final-good products. Suppose there are $n_y$ firms in the intermediate-input market and they are located symmetrically along a circumference $\theta L$ in the attribute space. Then, the total cost for a representative firm, firm $i$, is

$$\begin{aligned} C((\mathbf{y}, \mathbf{q_i^y}); Y_i) &= k + 2\int_0^{\theta L/(2n_y)} q_j(y) r_y y dy \\ &= k + 2\int_0^{\theta L/(2n_y)} (\phi r_y y/\theta) dy \\ &= k + \frac{\theta \phi r_y}{4}(\frac{L}{n_y})^2 \end{aligned} \tag{22}$$

Average-cost pricing gives the following expression for the price of the intermediate input,

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

Free-entry will drive down this price to the minimum. Therefore, the equilibrium number of firms in the intermediate-input market is given by

$$
\begin{aligned}
n_y^* &= \arg\min\ (kn_y + \frac{\theta\phi r_y L^2}{4n_y})/(\phi L) \\
&= L(\frac{\theta\phi r_y}{4k})^{1/2}
\end{aligned} \tag{24}
$$

Thus, we obtain the price of the intermediate input in the symmetric equilibrium,

$$
\begin{aligned}
\overline{p}^y &\equiv \overline{p}_i^y = (kn_y^* + \frac{\theta\phi r_y L^2}{4n_y^*})/(\phi L) \\
&= [k(\frac{\theta\phi r_y}{4k})^{1/2} + \frac{L}{2}(\theta\phi k r_y)^{1/2}]/(\phi L) \\
&= (\frac{k\theta r_y}{\phi})^{1/2} \qquad\qquad i = 1, ..., n
\end{aligned} \tag{25}
$$

**Lemma 1** *$\widetilde{c}^y = \overline{p}^y$ when $(kr_x)/(K\theta r_y) = 1/2$; otherwise, $\widetilde{c}^y > \overline{p}^y$.*

**Proof:** Using (20) and (25), we obtain

$$
\begin{aligned}
\frac{\widetilde{c}^y}{\overline{p}^y} &= (\frac{1}{2})^{1/2}(\frac{kr_x}{K\theta r_y})^{1/2} + (\frac{1}{8})^{1/2}(\frac{K\theta r_y}{kr_x})^{1/2} \\
&= \Omega(\frac{1}{2})^{1/2} + \frac{1}{\Omega}(\frac{1}{8})^{1/2}
\end{aligned} \tag{26}
$$

where $\Omega \equiv [(kr_x)/(K\theta r_y)]^{1/2}$. It is straightforward to show that (26) reaches the minimum at $\Omega = (1/2)^{1/2}$. ■

Lemma 1 basically says that in general the minimum average production cost of the intermediate input in the equilibrium of vertically-integrated production is higher than that of vertically-disintegrated production. The intuition for the result is actually quite simple since under vertically-integrated production the number of firms producing the intermediate input is constrained by (i.e., equal to) the number of the final-good producers.

With vertically-disintegrated production, however, there is a transaction cost in purchasing the intermediate input. For simplicity, I assume that the transaction cost is measured in units of the intermediate input and takes the form similar to ice-berg transport cost. Specifically, to use one unit of the intermediate input in production, a final-good producer has to buy $1+\tau$ units of the intermediate input. Alternatively, this also means that the price for using a unit of the intermediate input in production now becomes $\overline{p}_i^y(1+\tau)$, rather than $\overline{p}_i^y$. Therefore, there is a trade-off between production efficiency and the market transaction cost.

In this model, production efficiency (also the overall economic efficiency here) of the two equilibria hinges on the production costs of the intermediate input. Solving $\widetilde{c}^y \leq \overline{p}_i^y(1+\tau)$ gives us the following result, which is illustrated in **Figure 3.**

**Proposition 2** *When there are economies of scope in production, the equilibrium of vertically-integrated production remains efficient if and only if* $(kr_x)/(K\theta r_y) \in [\Omega_L^2(\tau), \Omega_U^2(\tau)]$, *where* $\Omega_L^2(\tau) \equiv \{(1+\tau) - [(1+\tau)^2 - 1]^{1/2}\}^2/2$ *and* $\Omega_U^2(\tau) \equiv \{(1+\tau) + [(1+\tau)^2 - 1]^{1/2}\}^2/2$*; Otherwise, the equilibrium of vertically-disintegrated production is efficient.*

Therefore, when $(kr_x)/(K\theta r_y)$ is either smaller than $\Omega_L^2(\tau)$, or greater than $\Omega_U^2(\tau)$, we have $\overline{p}_i^y(1+\tau) < \widetilde{c}^y$ and hence the equilibrium of vertically-disintegrated production dominates the equilibrium of vertically-integrated production. That is, vertically-disintegrated production (and hence outsourcing) becomes the efficient equilibrium outcome. The next section discusses in details the patterns of outsourcing and some comparative statics.

## 3. OUTSOURCING

### 3.1. Patterns of Outsourcing

The results in Proposition 2 are also useful for discussing the patterns of outsourcing. From Proposition 2, notice that vertical disintegration (or outsourcing) is more likely to occur if $(kr_x)/(K\theta r_y)$ is further away from 1/2, either very small or very large. We shall focus our discussion on three key parameters that describe the nature of the intermediate input and production technology. They are $\theta$ (product differentiation), $r_y$ (economies of scope), and $k$ (fixed cost of production - an indicator of economies of scale).

First, a high value of $\theta$ means that the intermediate input is highly differentiated (or specialized), and a low value indicates that the attribute space of the intermediate input is small. When $\theta$ approaches to zero, the intermediate input becomes a homogeneous good (the attribute circumference of good $y$ in **Figure 1** shrinks to a point). Our theory suggests that firms will more likely go outsourcing for these two very different types of intermediate input: either highly differentiated/specialized, or hardly differentiated.

Secondly, a high value of $r_y$ means that it is very costly for a firm to produce all the variants from its *basic product*. A low value of $r_y$ means, however, that the economies of scope is very high. Thus, a wide range of variants should be available more economically in the intermediate-input market although a vertically-integrated firm can also produce all the required variants of the intermediate input by itself. Therefore, it is more likely that firms will go outsourcing for those intermediate inputs whose economies of scope in production are either very low or very high.

Finally, if the fixed cost of production $k$ is high, vertically-integrated firms cannot fully explore the economies of scale in producing the intermediate input by themselves compared to the intermediate-input market. On the other hand, if $k$ is very low, there should exist many basic intermediate products (or suppliers) in the market and therefore, the cost of producing all the variants would be lower (since less modification is needed) compared to vertically-integrated production. The next proposition summarizes these results.

**Proposition 3** *Outsourcing is more likely to occur if an intermediate input belongs to one of these two opposite cases: (i) the intermediate input is highly differentiated/specialized, or has a very low degree of economies of scope, or a very low degree of economies of scale in production; (ii) it has a very small attribute space (close to a homogenous good), or has a very high degree of economies of scope, or a very high degree of economies of scale in production.*

In the above discussion we have focused on the parameters of the intermediate input. To better understand why outsourcing is more likely to occur under these two opposite scenarios, we shall note that what really matters here is the relative degree of the final good and the intermediate input in product differentiation ($\theta$ relative to 1), economies of scope ($r_x/r_y$), and economies of scale ($k/K$) in production. They determine the ratio between the efficient number of firms in the final-good production and that in the intermediate-input production.

The efficient number of firms in the final-good production, $n_x^*$, is given by (19). When each firm produces the intermediate input in-house, the number of the basic intermediate products, $n_y$, is equal to $n_x^*$. When the two stages of production are disintegrated, the efficient number of the basic intermediate products, $n_y^*$, is given by (24). From (19) and (24), we obtain

$$\frac{n_y}{n_y^*} = (\frac{2kr_x}{K\theta r_y})^{1/2}. \tag{27}$$

Notice that $n_y = n_y^*$ only if $(kr_x)/(K\theta r_y) = 1/2$. When $n_y > n_y^*$, there are too many basic intermediate products and hence vertically-integrated production involves too much fixed costs. When $n_y < n_y^*$, there are too few basic intermediate products and hence vertically-integrated production involves too much modification costs in producing all the variants. Therefore, whether the equilibrium of vertically-disintegrated production (or outsourcing) will dominate the equilibrium of vertically-integrated production depends on the trade-off between the above economic efficiency in production vs. the market transaction costs associated with outsourcing.

### 3.2. Transaction Cost and Technology Changes

From Proposition 2, a reduction in $\tau$ reduces the support $[\Omega_L^2(\tau), \Omega_U^2(\tau)]$.[7] Therefore, as transaction costs become smaller, outsourcing is more likely to occur.[8] Notice that this result holds regardless of whether the initial value of $(kr_x)/(K\theta r_y)$ is greater or smaller than 1/2.

The effect of technology changes, however, will depend on whether $(kr_x)/(K\theta r_y)$ is greater or smaller than 1/2. Suppose that the recent progress in the *general purpose technology* (e.g., information technology, etc.) reduces modification costs (i.e., $r_x$ and $r_y$) and hence increases the degree of economies of scope in production. But the impact is likely to be different for the production of the final good and the intermediate input. A technology progress favors economies of scope in the final-good production relative to the intermediate-input production if it reduces $r_x/r_y$. Therefore, a progress of GPT that favors economies of scope in production of the final good will increase outsoucing if $(kr_x)/(K\theta r_y)$ is smaller than 1/2 (Point A in **Figure 3**), and it will not if $(kr_x)/(K\theta r_y)$ is greater than 1/2 (Point B). The opposite would be true if a progress of GPT favors economies of scope in production of the intermediate input. Therefore, we have the following results.

**Proposition 4** *A reduction in transaction costs* ***always*** *increases outsourcing but a technology progress may not.*

However, when a technology progress is continuous and its effect is persistently biased towards one stage of production (i.e., $r_x/r_y$ continues to decrease or increase), eventually it will lead to the outsourcing equilibrium. The automobile industry is probably the best example to apply this theory if we believe that technology progresses favor economies of scope in the final-good production in the car industry (i.e., $r_x/r_y$ continue to decrease). Recent technology progresses (e.g., computer-aided-design) have made model changes and product

[7] When $\tau = 0$, the support reduces to zero since $\Omega_L^2(\tau) = \Omega_U^2(\tau) = 1/2$.

[8] This is similar to what is found in the literature that reductions of transaction costs may contribute to the recent surge of outsourcing activities. The discussion of the current paper is focused on other issues, however.

improvement much easier than ever before. These changes would certainly contribute to the surge of outsourcing activities in the automobile industry. To summarize,

**Proposition 5** *Continuous progresses in general purpose technology that has a persistently biased effect on economies of scope in one stage of production (e.g., final goods) over the other (e.g., intermediate goods) lead to more outsourcing activities.*

Persistent changes in the relative fixed cost of production, $k/K$, will have similar effects but since the focus of the current paper is on economies of scope, we leave the discussion about economies of scale to the reader.

## 4. CONCLUDING REMARKS

The paper develops a model of two-stage production in which economies of scope are central to the production of both the intermediate input and the final good. The intermediate input in the model can be interpreted as an intermediate good, service, or other production related activity. Therefore, we hope the model provides a relatively simple framework that is able to shed some light on the characteristics/attribute of wide-ranging outsourcing activities.

In this paper we have only considered to cases: one is a complete vertical integration and the other is a complete vertical disintegration. We do not allow vertically-integrated firms and specialized firms to co-exist. This simple dichotomy not only simplifies the analysis but also helps bring out the key insight. Nevertheless, this is a limitation of the paper and relaxing this assumption could be an interesting extension of the model.

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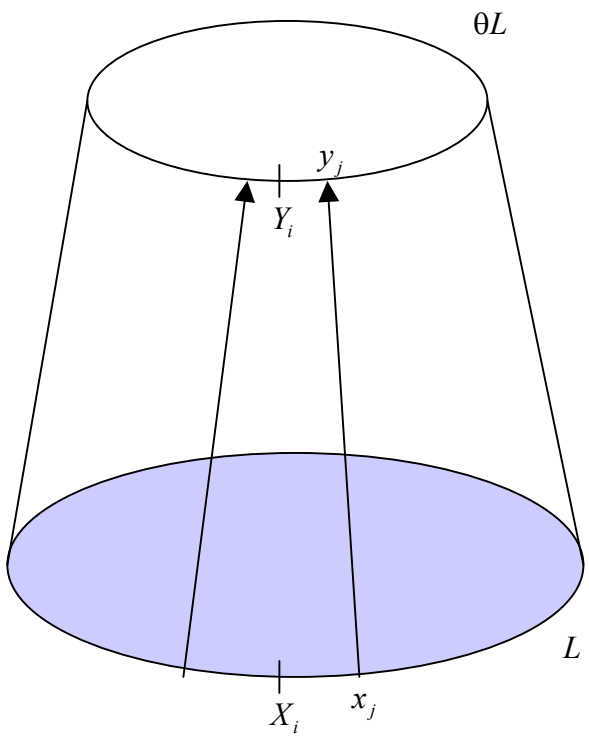


Figure 1

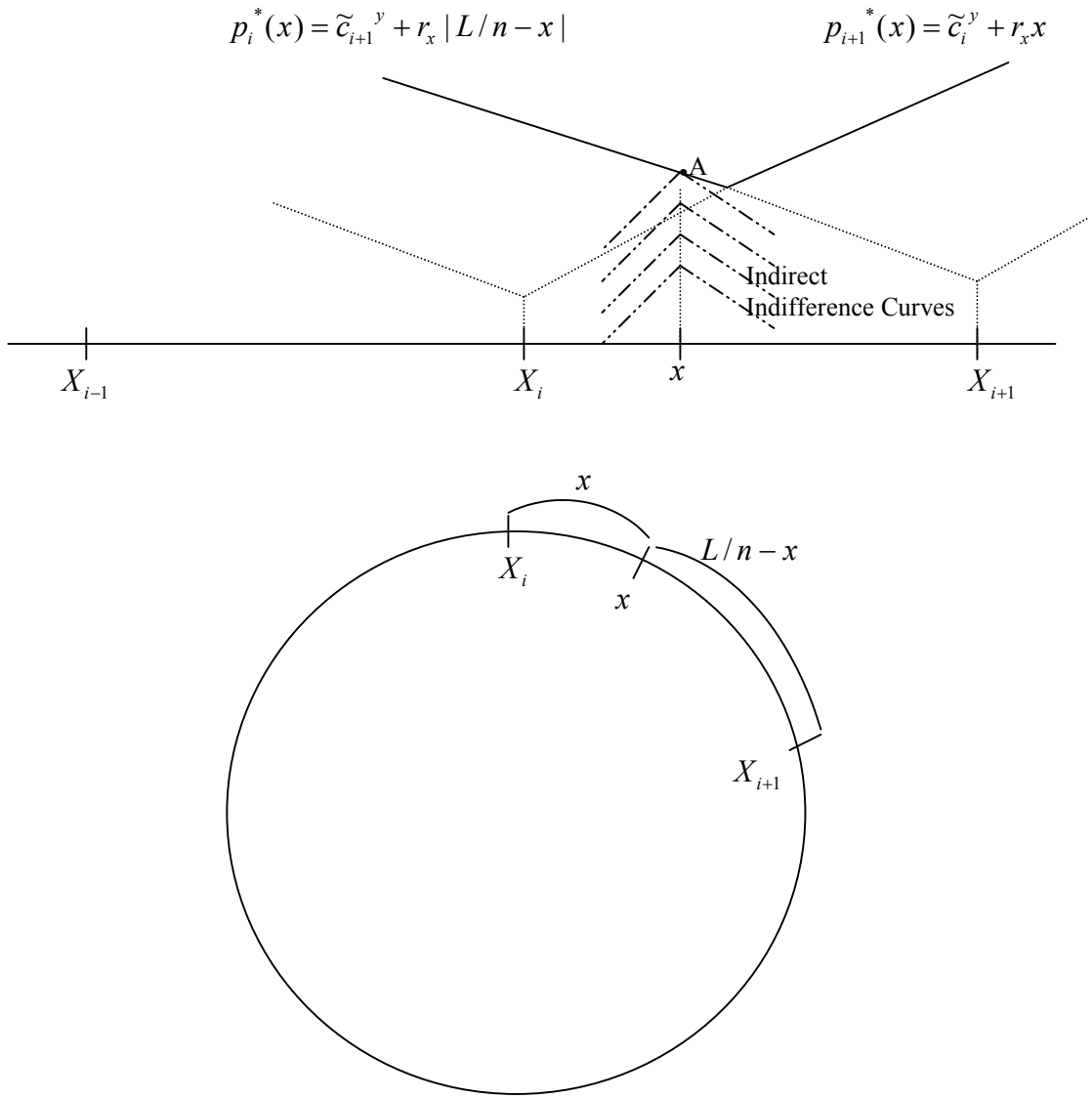
$p_i^*(x) = \tilde{c}_{i+1}^{\,y} + r_x \,|\, L/n - x \,|$
$p_{i+1}^*(x) = \tilde{c}_i^{\,y} + r_x x$
A
Indirect
Indifference Curves
$X_{i-1}$
$X_i$
$x$
$X_{i+1}$
$x$
$L/n - x$
$X_i$
$x$
$X_{i+1}$

Figure 2

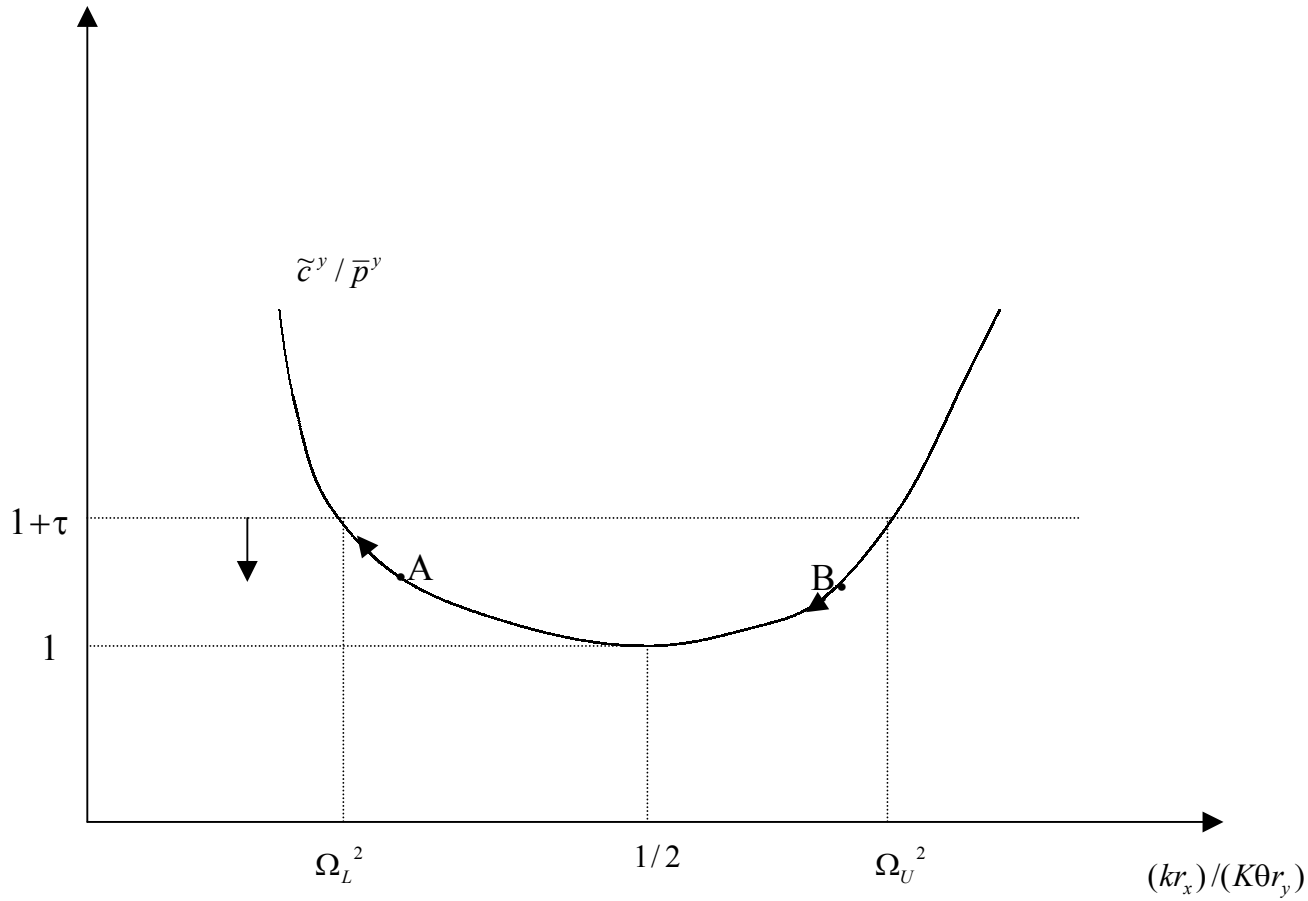


Figure 3