A Matching Model of Liberalisation of Trade in Services

Anming Zhang
Department of Economics and Finance
City University of Hong Kong
EFANMING@CITYU.EDU.HK

Jinhui Wu
Department of Economics and Finance
City University of Hong Kong
50001895@PLINK.CITYU.EDU.HK

Clement Yuk Pang Wong
Department of Economics and Finance
City University of Hong Kong
EFCWONG@CITYU.EDU.HK

First Draft, July 2000

We develop a matching model between service suppliers and customers in which service providers can select the degree of specificity of their services in order to cater to the diverse product preferences of the customers. A unit circle is used to represent a two-dimensional space of product specificity. The model is used to illustrate a source of gain from trade liberalisation that arises from a better matching of consumers' preferences to partially specialised services provided by service providers. Trade liberalisation improves the welfare of customers not only by increasing their chance of matching with a service provider specialising to serve them, but also forcing service providers to deepen their level of specification to their customers. Quite different from traditional analysis of gain from trade that focuses on price, the matching framework developed in this paper highlights the benefits of trade liberalisation from a service quality point of view. Given the importance of product varieties in services, this is an important source of gain from trade that merits further research.

JEL Classification: F1, F12, F13

Keywords: Trade in Service, Trade Liberalization, Product Specificity, Matching

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For correspondence, please contact : Dr. Anming Zhang, Department of Economics and Finance, 83 Tat Chee Avenue, Kowloon Tong, Kowloon, Hong Kong. Fax: (852)-2788-8806. Tel: (852)-2788-8801. This paper is partially supported by the Competitive Earmarked Grant for Research (No. 9040320).

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by Anming Zhang, Jinhui Wu, and Clement Yuk Pang Wong

1. Introduction

The services sector has become a major driving force in international trade in recent years. Currently, it accounts for one quarter of all world trade. Trade in services has attracted a great deal of attention in from policy makers, businessmen, and trade researchers. Between 1980 and 1997, world service exports grew 1.1 percent faster than world goods export, at an average annual rate of 7.8 percent (Urata and Kiyota, 2000).

The importance of services in trade indeed reflects a broader trend that services have become increasingly important in economic activities. According to the World Bank, the share of services in world output has increased from 55.6 percent in 1980 to 60.7 percent in 1996. There are several underlying reasons for the growing importance of services in general and of trade in services in particular. Technological innovations in some sectors such as telecommunications have substantially reduced the cost of service provision and increased their demand. Technological innovations have also rendered protectionist regulations in some service sectors obsolete, as evidenced by the telecommunications sector. More fundamentally, policy makers have come to realise that a competitive service sector is an element for economic growth. This realisation has led to the inclusion of services in multilateral trade negotiations under the General Agreement of Trade in Services (GATS) at the Uruguay Round.

In the light of the importance of trade in services, there is an urgent need to understand the impacts of liberalisation of trade in services. For example, how does it affect the pattern of trade in goods itself, the geographical location of production, globalisation process, or the welfare of customers and firms? This paper focuses on the source of gain from service trade liberalisation.

Many sources of gain from trade liberalisation in services are no different from what we already know from traditional trade theories based on trade in goods. These include difference in technology, difference in factor endowments, more product variety, realisation of scale economies, and increased contestability of market competition. In this paper, we examine a source of gain from liberalisation in trade in services that arises from a more efficient matching between service providers and service customers. It offers a new perspective to assess the economic benefits that trade liberalisation can bring.

Of course, it can be argued that the matching theory developed in this paper can also be applied to trade in goods as well. Indeed, it is a common notion among economists that trade in services does not differ in any fundamental ways from trade in goods (see Deardoff 1985). This explains why most trade theories are built within the context of trade in goods. However, it is important to note that services do differ from goods in some fundamental ways. Unlike goods, services are intangible and non-storable. Second, the provision of many services is possible only if service providers and customers are located physically near each other. Therefore, the establishment of a commercial presence or movement of personals is more modes of supply in services than in goods.

The rest of this paper is organised as follows. Section 2 discusses the characteristics of product specificity in services and argues why the matching model is more relevant to services than to goods. Section 3 presents the matching model. Section 4 examines the impact of trade liberalisation on the matching process. Section 5 concludes the paper.

2. Product Differentiation, Supply Specificity in Services

The matching between service providers and customers in this paper takes place in a setting where a certain service is provided by a few providers. The service is characterised by product differentiation where each service provider produces a particular variety. On the demand side, there are numerous customers (far more than the number of service providers) with different preferences. The number of variety of services provided is not enough to completely satisfy every consumer. Consequently, only a minority of customers will be served by service provider whose service perfectly matches their product specification requirements. On the supply side, this means that service providers will have to adjust their services in order to serve customers whom they are not especially specialised for.

It may be argued that the model set up can be applied not only to services but to goods as well. However, we think that it is more suitable for services as their unique characteristics make it more feasible for service providers, as compared to goods producers, to cater to the diverse requirements from customers. In other words, service providers can satisfy numerous product specifications from their customers by adjusting the *specificity* of their services. This supply side flexibility is more common in the service sector than in the goods sector. In fact, casual observations show that tailor-made goods (beyond the few varieties offered by manufacturers) are rare and significantly more expensive. On the other hand, customisation seems to be the norm in services. A few distinguishing features of services explain why.

First, the provision of many services is possible only if service providers are located physically near the customers. Therefore, the establishment of a commercial presence or movement of natural persons is more common modes of supply in service trade than goods trade. This close proximity in turn makes it easier for service providers to tailor made their services to their customers. For example, in management consulting service, service provider work closely with their clients during service provision over a period of time.

More importantly, a couple of unique characteristics of services make service providers more capable to cater to diverse taste from customers. Many services are knowledge intensive. Usually, a lot of resource is spent on the accumulation of knowledge and experiences in a learning-by-doing fashion. After the service provider has completed the learning curve, additional services can be provided at very low marginal costs. The second feature is that services are intangible and non-storable. Therefore, service providers offer product variety to their customers at the time the service is being provided. In other words, production and consumption usually take place at the same time. Given these two features, providing product variety is more feasible in service sector than in goods sector. For example, a barber will provide different haircut styles to different customers without any increase in fixed cost.

3. The Matching Model

First we establish a service cost model in a closed economy, taking market structure of service sector and the features of service into consideration. Then we specify the profit function of service providers and the utility function of customers.

3.1 Service Cost

In our model, services are characterized by significant economies of scale and product differentiation. The scale economies can arise from the capital-intensive and or knowledge intensive nature of the service. As is common in many services, a lot of resource is spent on the accumulation of knowledge and experiences in a learning-by-doing manner. After the service provider has completed the learning curve, additional services can be provided at very low marginal costs. Variable costs are a function of technology available in domestic service sectors, domestic factor prices, and the degree of specificity of the service to customers. In this paper, we abstract from the fixed cost and consider variable cost only. We assume the technology and factor prices are same across countries, so the disparity of service cost among service providers is only arise from difference in their service specificity and the corresponding adjustment cost, not in comparative advantage or factor endowments.

The service is provided by a few service providers to numerous customers with diverse preferences and product requirements. We assume, as is usually the case, that the number of product requirement specifications from customers is greater than the number of varieties offered by the service providers. Hence, when service providers and customers match with each other, not all customers can find their ideal service providers. To capture product specificity, we follow Grossman and Helpman (1999) to adopt a two-dimensional representation of the space of customer's product requirement or service providers' service variety. The ideal services for various customers are arrayed along the circumference of a unit circle (see Figure 1). For example, the point labeled k represents the service requirement of customer k. If there exists a service provider who is specialised to serve customer k (which we would referred to as service provider k), then the *degree of specificity* of the service can be anywhere on the radius joining point k on the circumference and the centre of the circle point O. If the service provided perfectly fits customer k's requirement, the service provider k's service variety point will also be point k. However, if the service provider k chooses not to completely satisfy customer k's, the service provider k's service variety point will lie anywhere on the radius except point k. The less specific is the service to customer k, the closer is the service provider's service variety point (Point S in Figure 1) to the center of the unit circle.

As customers demand more product varieties than are available from service providers, there is a situation where a customer does not have a service provider who specializes to its preference. For example, there may not be a service provider *i* for customer *i*. As indicated in Figure 1, customer *i* may need to purchase the service of service provider *k* whose product specificity point (for customer *k*) is at Point *S*.

When a service provider fails to perfectly satisfy the product requirement of a customer (e.g. service provider *k* for either customer *k* or customer *i* in Figure 1), it must employ extra resources to make the service "fit" the requirement of each customer. This *adjustment cost* is proportional to the distance between the service requirement point of the customer and the service variety point of the provider. To be concrete, if service provider *k* would incur an adjustment cost related to the distance *kS* for customer *k* and the distance *iS* if it is to serve customer *i*.

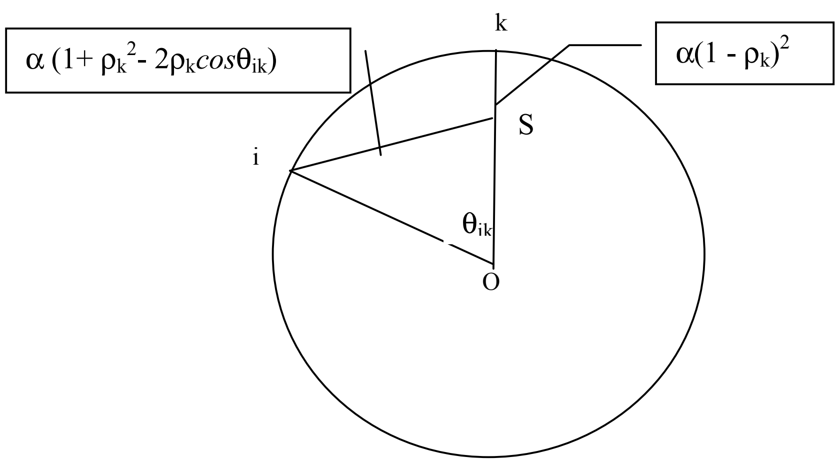

Figure 1 Extra cost of specialized service provider *k* to different customers ($OS=\rho_k$)

Without loss of generality, we assume that each service provider is specialized for one customer with the degree of ρ_k[1]. θ_{ik}[2] measures the degree of similarity between the requirement of consumer *k* and that of consumer *i*. For simplicity, we take the adjustment

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1 ρ_k is the distance between O and S in Figure 1 and $0 \le \rho_k \le 1$. If $\rho_k = 0$, the service is generic. $\rho_k = 1$, the service is perfectly specialized to customer k.

2 $\theta_{ik} \in [0, \pi]$. i and k are customer i's and k's service requirement points, i.e., points i and k on the circumference in Figure 1.

cost to be proportional to the square of the distance between S and i, based on α which is per unit service cost under perfectly specialization. For customer k, the service provider k needs to incur an adjustment cost of $\alpha(1-\rho_k)^2$ to make its service perfectly match the requirement of customer k. To serve customer i, service provider k's adjustment cost will be equal to $\alpha(1+\rho_k{}^2-2\rho_k \cos\theta_{ik})$. So the unit variable cost function (VC_{ik}) can be expressed as:

$$VC_{ik} = \alpha + \alpha(1+\rho_k^2 - 2\rho_k \cos\theta_{ik}) = \alpha + g_i(\rho_k, \theta_{ik}), \quad \text{for } i \neq k$$
$$VC_{ik} = VC_k = \alpha + \alpha(1-\rho_k)^2, \quad \text{for } i = k.$$

in which $g_i(\rho_k, \theta_{ik})$ is per unit adjustment cost of provider k needed to make service perfect fit customer i. For a given ρ_k, the larger the θ_{ik}, the greater the adjustment cost.

3.2 Profit Function of Service Providers

Suppose the service market is contestable even though it is provided by a few providers. Each service provider has no power to manipulate its service charge. No matter which service provider offers service to customer i, it can only charge P_i per unit. Assume that each customer can only be served by one service provider, i.e., the amount of service required by customers an indivisible package. As long as service providers reach agreement with customers, q_i is exogenous. Let the profit function of the domestic service provider specializing for customer k be given by:

$$\pi_k = \sum_{i=1}^{n} (P_i - VC_{ik}) q_i = \sum_{i=1}^{n} \{P_i - \alpha[1 + (1+\rho_k{}^2 - 2\rho_k \cos\theta_{ik})\} q_i$$

Given α and θ_{ik} (i=1, 2, 3, …, n), the total profit of the service provider is a function of ρ_k. It solves the optimal decision of ρ^*_k to get the maximum profit by taking the first order derivative with respect of ρ_k.

3.3 Utility Function of Customers

Customer i has the same total utility level (Vi) as long as the service is consumed and pay $P_i q_i$ for the service no matter who is the service provider. Hence, his utility is not determined by service charge, but by service quality instead. For the customers, service quality is uncertain because they do not know in advance with whom they will be matched to. Expected service quality will be inversely related to the adjustment cost imposed on the service provider. So we can formulate the expected utility function of consumer *i* as:

$$E(U_i) = V_i(q_i) - [p_i + E(g_i)]q_i$$

p_i is the shadow price of the service if it perfectly matches with the customer's requirement. Obviously, it does not influence the net utility of customers. If expected adjustment cost is high, service is expected to be relatively poor because service providers cannot transfer all adjustment cost to customers under contestable market and would reduce service quality. Therefore, high adjustment cost finally translates into low utility level.

The utility function degenerates if there is only one service provider *k* in the domestic market. In this case, the utility of customers *i* is directly related to the characteristics of the service provider *k*.

$$U_i = V_i(q_i) - (p_i + g_i[\rho_k, \theta_{ik}])q_i$$

4. Matching and Adjustment Costs under Liberalization

Suppose initially that there is no service trade and domestic customers only rely on domestic service providers. After trade liberalization, domestic customers can choose among domestic and foreign service providers. In former part of this section, we will argue that liberalization reduces expected adjustment cost if domestic service providers keep the degree of specialization constant, pushes customers onto a higher utility level. In the later part of the section, starting with uniformly distributed customer model and then extending to non-uniformly distributed model, we will show that customers can benefit from enhanced specialization after trade liberalization regardless of their service requirements.

Proposition 1 *Liberalization increases the customers' likelihood of matching with more fitting service providers and consequently lowers the expected adjustment cost and enhances customers' utility.*

Suppose there are M service providers and N customers in domestic market, where N is greater than M. Each consumer has different needs and each service provider is specialized for one and only one customer. When a customer needs to consume service, he will search for a service provider in the market through random matching. Therefore, the probability of a perfect match between a service provider *i* and a customer *i* is M/N, and some extra cost $\alpha(1 - \rho_i)^2$ will be needed. The probability that a consumer *i* cannot find a specialized service producer *i* and is matched with some service producer *k* is (1-M/N) and an extra cost $\alpha(1+ \rho_k^2 - 2\rho_k cos\theta_{ik})$ is incurred. We further assume that well-match is better than less well-match[3]. Thus, the expectation of the adjustment cost $E(g_i)$ of customers *i* if he chooses any service provider *k* is:

$$E(g_i) = \alpha[\frac{M}{N}(1-\rho_i)^2 + (1-\frac{M}{N})(1+\rho_k{}^2 - 2\rho_k\cos\theta_{ik})]$$
$$= \alpha\{\frac{M}{N}[(1-\rho_i)^2 - (1+\rho_k{}^2 - 2\rho_k\cos\theta_{ik})] + (1+\rho_k{}^2 - 2\rho_k\cos\theta_{ik})]$$
$$\because \alpha(1-\rho_i)^2 < \alpha(1+\rho_k{}^2 - 2\rho_k\cos\theta_{ik}),\ \ \alpha > 0$$
$$\therefore (1-\rho_i)^2 - (1+\rho_k{}^2 - 2\rho_k\cos\theta_{ik}) < 0$$

This demonstrates that expected adjustment cost is negatively related to the chance of matching with a specialized service provider (M/N), everything else constant.

If the scope of specificity of domestic service providers does not overlap with that of foreign providers, the number of service providers M^o[4] will exceed M.

$$\because M^o > M$$
$$\therefore M^o / N > M / N$$
$$\textit{Suppose}\ \text{the degree of specialization keeps constant after liberalization,}$$
$$\textit{then}\ \text{we have}\ E^o(g_i) < E(g_i)$$
$$\because U_i = V_i(q_i) - [p_i + E(g_i)]q_i;\ U^o{}_i = V_i(q_i) - [p_i + E^o(g_i)]q$$
$$\therefore U^o{}_i > U_i.$$

Before liberalization, domestic customers can only select the most suitable domestic service providers. Fewer choices in domestic market makes it more difficulty for domestic customers to find well-matched service providers. So customers expect higher adjustment cost of service providers and poor quality of service. With the advent of trade liberalization, however, service can be offered by a larger number of different providers

[3] The adjustment cost of well match is smaller than that of less well-match, that is, $\alpha(1+ \rho_k^2 - 2\rho_k cos\theta_{ik}) > \alpha(1 - \rho_i)^2$.
[4] Thereafter, variables with *o* on the right upper corner stand for variables after liberalization.

and increases the probability of successful match. With a larger M/N, expected adjustment cost declines, everything else constant. Thus the domestic customers will expect to enjoy high quality service and gain from liberalization.

The above result hinges on the assumption that the degree of specialization of domestic service providers remains unchanged after liberalization. Hence, we now proceed to examine the change of ρ_k. We assume that there exists only one domestic service provider specialized to customer k and n customers with different service requirements who are distribute along the unit circle. After the domestic service market is opened for trade, a foreign service provider specialized to customer l with degree of ρ_l [5] enters the domestic market. Let the cross-angle between customer l's ideal requirement point and any other customer i's ideal requirement point be denoted as θ_{il}[6], see Figure 2. First, let us look at a simple case in which customers are uniformly distributed along the circle and l is located just opposite to k on the circle, which means that two service companies are specialized for opposite customer requirements.

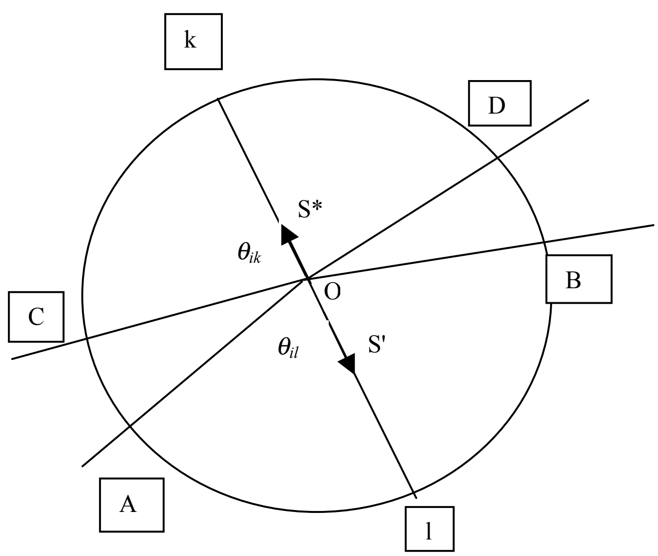

Figure 2 Uniformly distributed customers ($OS^*=\rho_k^{**}$, $OS'=\rho_l$)

Proposition 2 *If customers are uniformly distributed around the unit circle, the domestic service provider k would rather provide generic service to all customers before*

[5] ρ_l is determined before domestic country liberalizes its market and $\rho_l \geq 0$.

[6] Like θ_{ik}, $\theta_{il} \in [0, \pi]$

liberalization. After trade liberalization, it would deepen its specialization to customer k and customers located near k and l enjoy a higher utility; but those far away from k and l suffer. Overall, the total gain can exceed the total loss.

[Proof]

In the closed economy case, the domestic service provider *k* chooses the optimal degree of specialization ρ_k^* to maximize its profit.

$$\underset{\rho_k \geq 0}{Max}\,\pi_k = Max\sum_{i=1}^{n}\{P_i - \alpha[1+(1+\rho_k^{\ 2} - 2\rho_k\cos\theta_{ik})\}q_i$$

$F.O.C.$ with respect to ρ_k, $\dfrac{\partial \pi_k}{\partial \rho_k} = \sum_{i=1}^{n}(2\rho_k - 2\cos\theta_{ki})q_i = 0$

$$\because q_i \neq 0,$$

$$\therefore \rho_k^{\ *} = \frac{\sum_{i=1}^{n}(\cos\theta_{ik})}{n} = 0$$

$$\therefore U_i = V_i(q_i) - p_i q_i - g_i[\rho_k, \theta_{ik}]q_i = V_i(q_i) - (p_i + \alpha)q_i$$

ρ_k^* =0 means that the domestic service provider *k* offers the same (generic) service to all customers, and customers' utility has nothing to do with its service preference since adjustment cost of α is needed for every customers.

After trade liberalization, domestic customers choose between the domestic and foreign providers, depending on which provider has a lower adjustment cost.

$$\because U_i(\rho_k^{\ *} = 0) = V_i(q_i) - (p_i + \alpha)q_i$$

$$U_i^{\ o}(\rho_l, \theta_{il}) = V_i(q_i) - p_i q_i - g^o{}_i[\rho_l, \theta_{il}]q_i = V_i(q_i) - p_i q_i - \alpha(1+\rho_l^{\ 2} - 2\rho_l\cos\theta_{il})q_i$$

$$U_i^{\ o}(\rho_l, \theta_{il}) > U_i(\rho_k^{\ *} = 0) \ \ iff \ \ 1+\rho_l^{\ 2} - 2\rho_l\cos\theta_{il} < 1$$

$$\therefore \cos\theta_{il} > \rho_l / 2$$

$$\therefore \theta_{il} \in [0, \arccos(\rho_l / 2)]$$

Therefore, customers located on arc *AlB* Figure 2 with θ_{il} falling into the following interval will substitute away from the domestic service company to the foreign. n' customers left for domestic service provider and $n' < n$. The domestic service provider optimizes its profit by providing service to n' customers.

$$\underset{\rho_k \geq 0}{Max}\,\pi_k = Max\sum_{i=1}^{n'}\{P_i - \alpha[1+(1+\rho_k{}^2 - 2\rho_k\cos\theta_{ik})\}q_i$$

$F.O.C.$ with respect to ρ_k, $\dfrac{\partial \pi_k}{\partial \rho_k} = \sum_{i=1}^{n'}(2\rho_k - 2\cos\theta_{ik})q_i = 0$

$\because q_i \neq 0,$

$$\therefore \rho^{**}{}_k = \frac{\sum_{i=1}^{n'}\cos\theta_{ik}}{n'}$$

$\because n' < n,$ all the negative $\cos\theta_{\mathrm{ik}}$ can be cancelled out by the counterpart positive $\cos\theta_{\mathrm{ik}}$, and only positive $\cos\theta_{\mathrm{ik}}$ left.

$\therefore \rho_k^{**} > \rho_k{}^* = 0$

The result shows that the domestic service provider deepens its specialization to customer *k* after trade liberalization. The logic follows in this way. The foreign service provider with a certain degree of specialization to some customer *l* attracts some domestic customers with similar service requirement as customer *l*. The domestic provider readjusts its specificity in pursuit of the maximum profit. Since it does not need to provide service to those customers who are quite different from *k*, it can now offer services more specialized for the remaining customers.

Nevertheless, not all the customers benefit from liberalization. It depends on θ_{il} *and* θ_{ik}. As we have proved earlier, customers with θ_{il} in interval [0, arccosρ_l/2] will be better off. Likewise, the necessity condition for those distributed on arc *AkB* to better off when $\rho_k{}^*$ increases from zero to $\rho_k{}^{**}$ after liberalization is:

$$U^o{}_i(\rho_k{}^{**}, \theta_{ik}) > U_i(\rho_k{}^* = 0),\ \mathit{iff}\ \ 1+\rho^{**}{}_k{}^2 - 2\rho^{**}{}_k\cos\theta_{ik} < 1$$

$$\therefore \cos\theta_k > \rho^{**}{}_k / 2$$

$$\therefore \theta_{ik} \in [0, \arccos(\rho_k{}^{**}/2)]$$

That is arc *CkD* in Figure 2. We can conclude that customers closer to *k* and *l* will profit from liberalization whereas customers distributed on arc *CA* and *DB* are worse off than before no matter they choose the domestic or the foreign service provider. How about the aggregate utility of domestic customers? Let us look at some examples with concrete figures.

Example 1

(1) Four customers *k, n, l,* and *t* uniformly distributed along the circle. Domestic service provider *k* and foreign service provider *l*. $\theta_k = \theta_l = 0°$, $\theta_{nk} = \theta_{tl} = 90°$, ρ_l=0.05, ρ_l=0.5, ρ_l=0.95.

Before liberalization $\rho_k^{*} = 0$, so the total utility is :

$$\sum_{i=1}^{4} U_i = \sum_{i=1}^{4} V_i - \sum_{i=1}^{4} p_i q_i - 4\alpha \sum_{i=1}^{4} q_i$$

After liberalization, $\rho_k^{**} = 1/3$, k and l gain whereas n and t lose.

if $\rho_l = 0.05$,

$$then \sum_{i=1}^{4} U_i^o = \sum_{i=1}^{4} V_i - \sum_{i=1}^{4} p_i q_i - 3.34\alpha \sum_{i=1}^{4} q_i > \sum_{i=1}^{4} U_i$$

if $\rho_l = 0.5$,

$$then \sum_{i=1}^{4} U_i^o = \sum_{i=1}^{4} V_i - \sum_{i=1}^{4} p_i q_i - 2.80\alpha \sum_{i=1}^{4} q_i > \sum_{i=1}^{4} U_i$$

if $\rho_l = 0.95$,

$$then \sum_{i=1}^{4} U_i^o = \sum_{i=1}^{4} V_i - \sum_{i=1}^{4} p_i q_i - 2.55\alpha \sum_{i=1}^{4} q_i > \sum_{i=1}^{4} U_i$$

Example 2

(1) Five customers k, m, n, s, and t uniformly distributed along the circle with θ_k=0°, $\theta_{mk} = \theta_{nk}$=72°, $\theta_{sl} = \theta_{tl}$ =36°. ρ_l=0.05, ρ_l=0.5, ρ_l=0.95.

Before liberalization $\rho_k^{*} = 0$, so the total utility is : $\sum_{i=1}^{5} U_i = \sum_{i=1}^{5} V_i - \sum_{i=1}^{5} p_i q_i - 5\alpha \sum_{i=1}^{5} q_i$

After liberalization, $\rho_k^{**} = 0.54$

if $\rho_l = 0.05$,

$$then \sum_{i=1}^{5} U_i^o = \sum_{i=1}^{5} V_i - \sum_{i=1}^{5} p_i q_i - 3.96\alpha \sum_{i=1}^{5} q_i > \sum_{i=1}^{5} U_i$$

if $\rho_l = 0.5$,

$$then \sum_{i=1}^{5} U_i^o = \sum_{i=1}^{5} V_i - \sum_{i=1}^{5} p_i q_i - 3.00\alpha \sum_{i=1}^{5} q_i > \sum_{i=1}^{5} U_i$$

if $\rho_l = 0.95$,

$$then \sum_{i=1}^{5} U_i^o = \sum_{i=1}^{5} V_i - \sum_{i=1}^{5} p_i q_i - 2.85\alpha \sum_{i=1}^{5} q_i > \sum_{i=1}^{5} U_i$$

From the two examples above, we can see the total gain can exceed the total loss after liberalization regardless of the number of customers in a wide range of ρ_l (0.05-0.95).

Hence, although not every domestic customer will be better off, participation by foreign service providers would most likely raise the total welfare of the domestic customers.

Q. E. D.

A more realistic case is that customers are non-uniformly distributed along the unit circle. It turns out that the same conclusion as the uniformly distributed case can be drawn. Let us make a reasonable assumption here. Since the domestic service provider was initially set up to offer service to domestic customers, it would choose to specialize to the densely populated portion of the circle. For simplicity, let us look at the example in Figure 3 where there are three customers *k, m* and *h*. Service provider *k* offers the degree of specificity of ρ_k to customer *k* which is between *m* and *h*. The similarity between *k* and *m*, *h* are denoted as θ_{mk}, θ_{hk} respectively[7].

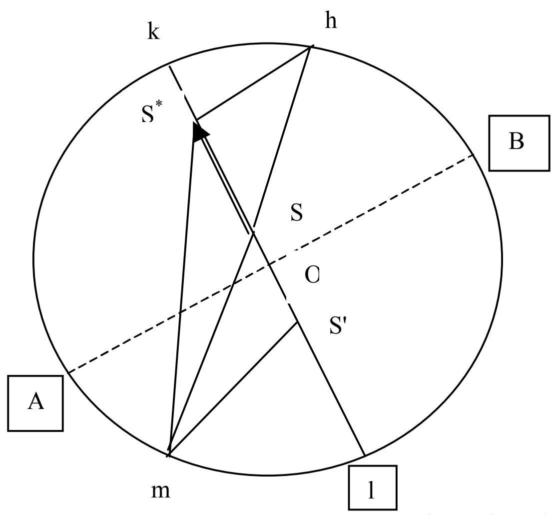

Figure 3 Non-uniformly distributed case (OS=ρ_k^*, OS*=ρ_k^{**}, OS'=ρ_l)

Proposition 3 *In case of non-uniformly distributed customers, customers away from k switch away from domestic service to foreign service after liberalization. This forces the domestic service provider to be more specialized to k, and customers closer to k and l tend to be better off and those away from k and l tend to be worse off. The aggregate effect can also be positive.*

[Proof]

Before liberalization, the domestic service provider would like to provide service to all three customers, and it select the proper ρ_k^* to maximize its profit.

$$\rho_k{}^* = \frac{\sum_{i=1}^{3}(\cos\theta_{ik})}{3} = \frac{\cos\theta_k + \cos\theta_{mk} + \cos\theta_{hk}}{3}$$
$$\because \theta_{mk} > \pi/2 > \theta_{hk} > \theta_k = 0$$
$$\therefore \left|\cos\theta_{mk}\right| < \cos\theta_k = 1, \quad \cos\theta_{hk} > 0$$
$$\therefore \rho_k^* > 0$$

Now, the entry of a foreign service provider specializing in product specification l with a degree of ρ_l. l is located on the opposite side of k on the circle, see Figure3.

$\because U^o{}_{ml} > U_{mk}$, $U^o_{kl} < U_{kk}$, $U^o{}_{hl} < U_{hk}$,
$\therefore$ m will substitue away from the domestic service provider to the foreign.
The domestic company only service two customers, and it will choose the new optimal point of $\rho_k{}^{**}$
$$\rho_k{}^{**} = \frac{1+\cos\theta_{hk}}{2}$$
$$\because \cos\theta_{mk} < 0$$
$$\therefore \rho_k{}^{**} > \rho_k{}^*.$$
$\therefore$ The foreign provider facilitates the specialization of the domestic provider.
$$\therefore U^o{}_k = V(k) - [p_k + (1-\rho_k^{**})^2]q_k > U_k = V(k) - [p_k + (1-\rho_k^*)^2]q_k$$
$$U^o{}_{hk} = V(h) - [p_h + (1 + \rho_k^{**2} - 2\rho^{**}{}_k \cos\theta_{hk})]$$
$$U_{hk} = V(h) - [p_h + (1 + \rho_k^{*2} - 2\rho^*{}_k \cos\theta_{hk})]$$
$$U^o{}_{hk} > U_{hk} \quad \mathit{iff} \quad \theta_{nk} \in [0, \arccos(\rho_k{}^{**} + \rho_k{}^*)/2]$$
If θ_{hk} falls into the above interval, all the domestic customers reach a higher utility level and all gain from liberalization.

If θ_{hk} unfortunately falls out of the interval, the aggregate utility rise must fulfil:
$$U^o_{ml} + U^o_{nk} + U^o_k > U_{mk} + U_{nk} + U_k$$
For simplicity, let $\rho_l = \rho_k^*$
$$\because \cos\theta_{ml} = -\cos\theta_{mk}$$
$$\therefore \rho_k^{**2} - \rho_k^{**2}(\cos\theta_{hk} + 1) < \rho_k^{*2} - \rho_k^{*2}(2\cos\theta_{mk} + \cos\theta_{hk} + 1)$$

If this condition cannot be satisfied, then the total gain will be negative under current assumption. In fact, all can gain if domestic country allow more foreign service providers entering into domestic market. There must surely be some providers specialized near h which makes it benefit.

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[7] Generally, let $\theta_{mk} > \pi/2 > \theta_{hk} > \theta_k = 0$.

This model can be extended to the general case that the specificity of foreign company is more like that of domestic company, that is, l is located near k, as shown in Figure4. The result will be basically the same. In a closed economy, domestic service provider would like to take the best strategy ρ_k^* to provide service to all three customers. When foreign company enters, m will switch away from the domestic provider to the foreign provider, because $U^o_{ml} > U_{mk}$. h and k still choose domestic provider. If $\theta_{mk} > \pi/2 > \theta_{hk} > \theta_k = 0$, then we have $\rho_k^{**} > \rho_k^*$ and $U^o_{hk} > U_{hk}$, $U^o_k > U_k$. The entry of foreign company improves the utility of m, and forces domestic company to facilitate it specialization to k, which leads to a higher utility of h and k also.

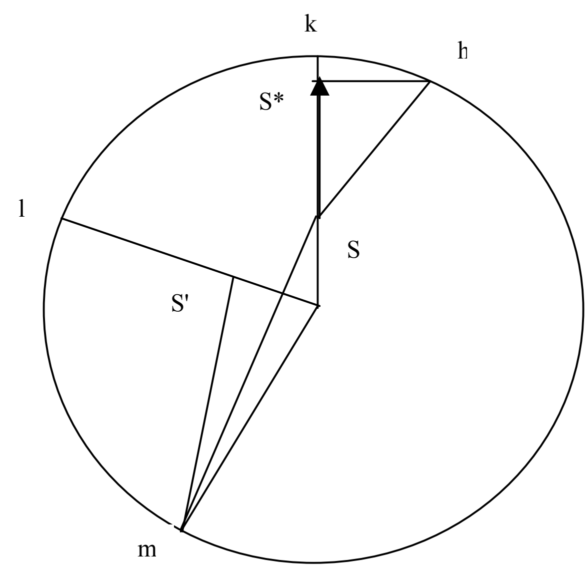

Figure 4 The foreign service provider has relatively similar specificity with the domestic service provider (OS=ρ_k^*,OS'=ρ_l, OS*=ρ_k^{**})

5. Concluding Remarks

In this paper, we develop a matching model between service suppliers and customers in which service providers can select the degree of specificity of their services in order to cater to the diverse product preferences of the customers. A unit circle is used to represent a two-dimensional space of product specificity. The model is used to illustrate a source of gain from trade liberalisation that arises from a better matching of consumers' preferences to partially specialised services provided by service providers. Trade liberalisation improves the welfare of customers not only by increasing their chance of matching with a service provider specialising to serve them, but also forcing service providers to deepen their level of specification to their customers. Quite different from traditional analysis of gain from trade that focuses on price, the matching framework developed in this paper highlights the benefits of trade liberalisation from a service quality point of view. Given the importance of product varieties in services, this is an important source of gain from trade that merits further research. The model can be extended to incorporate strategic game between domestic and foreign service providers when both domestic and foreign countries open their markets simultaneoussly. Another extension is to analyse the impact of trade liberalisation service providers themselves.

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