A Matching Model of Liberalisation of Trade in Services

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

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

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

Preliminary draft, comments are welcomed
April, 2001

We develop a matching model between service suppliers and customers within a context of ideal variety product differentiation. Following Grossman and Helpman (1999), a circle is used to represent a two-dimensional space of product specificity, while consumers' preferences are distributed along the circumference. Service suppliers in this model can select the degrees of specificity of their services to cater to the diverse preferences from their consumers. The model illustrates a source of gain from trade that arises from a closer match between customers' requirements and the degree of specificity of service providers. The model illustrates that trade liberalization improves the welfare of customers not only by increasing their chances of matching with the appropriate service providers but also by forcing service providers to deepen their degrees of specialization to their customers. Given the fact that customization is more important in services than in goods, deepening of service providers' degree of specialization is an important source of gain from service liberalization that merits further research.

JEL Classification: F1, F12, F13

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

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For correspondence, please contact: Dr. Clement Y. P. Wong, Department of Economics and Finance, 83 Tat Chee Avenue, Kowloon Tong, Kowloon, Hong Kong. Fax: (852)-2788-8806. Tel: (852)-2788-7948.

This paper is partially supported by the Competitive Earmarked Grant for Research (No. 9040320). We would like to thank Leonard Cheng, Kar-yiu Wong, and participants of the Greater China and the World Economy Conference at the City University of Hong Kong, July 17-18, 2000.

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by Clement Yuk Pang Wong, Jinhui Wu, Anming Zhang

1. Introduction

In recent years, trade in services has attracted a great deal of attention from policy makers, businessmen, and academics. Currently, services account for one quarter of all world trade. 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 international 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. These innovations have increased the scope for service trade and 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. Finally, the global trend of fragmentation of production process has also stimulated the demand for trade in services since many services such as telecommunications, distribution, and financial services are essential producer services.

In the light of the importance of trade in services, there is a need to understand the determinants of trade in services. In principle, trade in services can be motivated by the theory of comparative advantage that has been applied to trade in goods. Indeed, many authors subscribe to this view (Deardorff 1985, Hindley and Smith 1984, Sapir and Lutz 1981, Sampson and Snape 1984). However, whether the concept of comparative advantage can be applied in its entirety to trade in service remains an unsettled issue, just as the issue of how to define and measure services and trade in services themselves (Prieto 1989). Standard assumptions of the Heckscher-Ohlin trade models of immobile factors of production, differences in resource endowment and technology may not apply to trade in services. Delivery of services often involves the movement of factors of production, such as the movement of service providers themselves across national borders. It is common for services providers to access foreign markets through *commercial presence* or *presence of natural persons*. It is common that both modes of supply are adopted simultaneously as many firms find it necessary to dispatch their managerial and technical personnel to foreign markets. Prieto (1989) points out that service trade may depend on factors such as product qualities, skill of labour, and investment in telecommunication infrastructure. In fact, some authors (Nusbaumer 1987) stress the importance of *absolute* advantage rather than comparative advantages to explain trade in services that are highly differentiated and require specialised knowledge. Comparative advantage may be more appropriate to explain trade between developed and developed countries where there are significant difference in resource endowment. However, the fact that developed countries are responsible for over 80% of world trade in services, while developing countries account for barely one-fifth seems to cast doubt on the adequacy of comparative advantage as an explanation of trade in services.[1] To explain service trade between economies with similar factor endowments, it seems that the new theory of intra-industry trade that relies on imperfect competition and scale economies may be a suitable approach. In this paper, we construct a service trade model within the context of a monopolistic competitive market structure.

Most classical and neoclassical trade theories focus predominantly on supply-side difference between countries as the main determinants of trade. The demand side is ignored by the assumption of identical preferences and homogenous utility functions. In the new intra-industry trade models, a supply side assumption of scale economies is still needed to motivate international trade. The imperfect competition model developed in this paper abstract from scale economies and stresses instead on the "matching" demand and supply side as the motivation of trade.

The "new trade theories" that emphasize scale economies and product differentiation has shifted our attention to the demand side as a motivation of international trade. For example, Falvey (1981) and Falvey and Kierzkowski (1987) stress on "vertical" differentiation and consumers' income

[1] Barriers to trade in services in developing countries may be one of the explanations. The fact that developing countries are net importers and developed countries are net exporters of services seems to be consistent with comparative advantages.

as a cause of trade. In “horizontal” product differentiation, there are two main approaches. There is a "love of variety" approach (Krugman 1979, Helpman 1981) where all varieties of a product enter an individual’s utility function symmetrically in a Dixit-Stiglitz framework. In the "ideal variety" approach (Hotelling 1929, Lancaster 1966, 1980), it was assumed that consumers do have preference for an ideal variety and they demand goods not for their own sake but for the characteristics they possess. Although these models of horizontal differentiation highlight an increase in the number of product variety as a source of gain from trade, supply side considerations (scale economies) are still needed for intra-industry trade to take place. Our theoretical model in this paper follows the Lancaster's "ideal variety" framework. However, our model differs from previous work in two respects. First, by abstracting from scale economies as a necessary condition for trade, we show that the demand specification of horizontal product differentiation alone can provide an independent cause for trade. In fact, economies of scale are less important in the production of many services where customisation and quality, rather than standardization at low price, are required by customers. Even in some capital-intensive services sectors such as telecommunications, product differentiation is still very much alive, as we shall argue in the next session. In sum, product differentiation remains a key phenomenon in many services sectors.

Our model stresses on the behaviour of firms that optimally choose their product characteristics or product specificity. Firms that increase their product specificity towards some specific groups of customers also alienate themselves from the majority. Hence, they face a trade off between more profit from existing customers and a smaller overall market share. The implications of this trade off for the pattern of product specificity, degree of product specificity, and gain from trade are examined.

The rest of this paper is organised as follows. Section 2 discusses the special characteristics of services. Section 3 presents the set up of the matching model. Section 4 examines the impact of market liberalisation within an autarky world. Section 5 assesses the impact of trade liberalisation. Finally, section 6 concludes the paper.

2. Special Characteristics of Services

It is a common notion among economists that trade in services does not differ in any fundamental ways from trade in goods. However, services do differ from goods in some fundamental ways that necessitate a different approach in studying trade in services.

The most distinguishing features of services are, in contrast to goods, that they are intangible and non-storable. These two properties imply that they are consumed while they are produced --- a process that usually last for a period of time. For example, in management consulting service, service providers work closely with their clients with frequent visits, meeting, and sharing of information. On the other hand, there is a time gap between production and consumption in the trading of goods. The "simultaneity" of consumption and production in the provision of services demands that service providers and consumers be located near each other, either physically or through telecommunications network. These two special features of service provision increase the "feasibility" of customisation. For example, a customer is capable of providing immediate feedback to his service provider who can continuously adjust the quality of his service base on the feedback. The terms of product specifications (such as quality, delivery time, credit terms) can also be adjusted as the business environment change. In other words, service providers can satisfy numerous product specifications from their customers by adjusting the specificity of their services. 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. In fact, many services such as business services require specialised knowledge and cater to the specific needs of customers.

There is an exception to this "non-separation" condition: services that can be "embodied" in a physical object, like a computer diskette and videotape. In this case, production and consumption can be separated. For example, a customer can download an architectural design to his floppy disk and look at it later. However, many service output are customised to specific needs and requests from customers. Hence, the effective provision of services usually necessitates frequent communications between service providers and their customers. In many service sectors, it is common for service providers to use different modes of supply to complement each other in order to ensure effective delivery. For example, a management consulting report can be sent to a foreign customer. This can be followed by a teleconferencing meeting, a face-to-face meeting in an overseas office located in the importing country (commercial presence), or a temporary visit from the management-consulting firm.

Another salient feature of services is that they are knowledge and experience-intensive. Many services are actually experienced goods and this is why service industries are under more domestic regulation to cope with the asymmetric information between buyers and sellers. 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. Therefore, customisation is less expensive and therefore more feasible in services than in goods sector in general. For example, Markusen (1987) notes that many producer services such as management consulting require high learning cost initially. However, these services can be provided to additional users at a very low cost. Another example is in consumer services, a barber will provide different haircut styles to different customers without any increase in fixed cost or change in marginal cost. Even for capital-intensive services such as banking and telecommunications, there is still much room for customisation after a standard service is produced under economies of scale.

Third, many service such as management consulting, accounting, and financial, are used as intermediate inputs in the production of other goods. Therefore, they are they are quite idiosyncratic and highly specific to individual customer's unique taste. Even for services sold as final goods, consumers choose service providers according to a host of demand considerations, such as reliability, after-sale services, ability to offer related services, etc.

In sum, the unique characteristics of services seem to suggest that that a horizontal product differentiation demand specification along the line of Hotelling-Lancaster's "ideal variety" is most capable of portraying the characteristics of trade in services. The "love-of-variety" approach ala Dixit and Stiglitz (1977) may not be suitable, particularly for producer services.

3. The Matching Model

Consider a service that can be provided in many varieties. To keep the model simple, the service embodies only one "characteristics" which is a continuous variable and represented by the circumference of a product-variety circle as in Helpman (1981). Each consumer has his or her own "ideal" variety, which can be any point along the circumference. The consumers' taste for ideal variety is assumed to be distributed uniformly and continuously along the circumference of the product-variety circle.

On the supply side, we follow the approach of Grossman and Helpman (1999) to allow firms to choose the "specificity" of their services, which can either be located on the circumference of product-variety circle or at any point "inside" the circle. Consider the product-variety space in Figure 1. A service provider can choose to produces a "generic" service without specialising for any consumers by choosing its service specificity point at the centre of the circle (point *O*). Alternatively, a service provider can choose to produce a service is more specialised for some customers and less for others. In this case, the service provider can choose either to completely specialise in one variety or not. In the former case, the firm would choose a point (such as *k*) on the circumference for a consumer whose ideal variety is at point *k*. This firm is labelled firm *k*. In the latter case, the service provider chooses any product specificity points inside the circle excluding the center point *O*, such as point *S*. The firm here partially specialises for all customers. For the sake of convention, we call this service provider firm *k* by virtual since its specificity is closest to customer *k*'s ideal variety. Hence, in our notation, firm *k* either completely or partially specializes for customer *k*, but always partially specialise for all other customers.

In order to focus on the matching process between consumers' ideal varieties and the specificity of service providers' output, we abstract from price competition. All service providers are assumed to charge the same price and they compete by adjusting the specificity of their service to satisfy consumers demand. Consumers will select the service provider whose product specificity is closest to their ideal variety. We also assume that each consumer only purchases one unit of services.

For a firm, the cost of serving a customer is assumed to be positively proportional to the discrepancy between the firm's product specificity and the customer ideal variety requirement. This cost arises from the use of imperfectly specialised inputs to serve the unique product requirements of the customers. This tends to lower the productivity of inputs and raise the cost of production. We call this a "production mismatch cost" which can be modelled as follows.

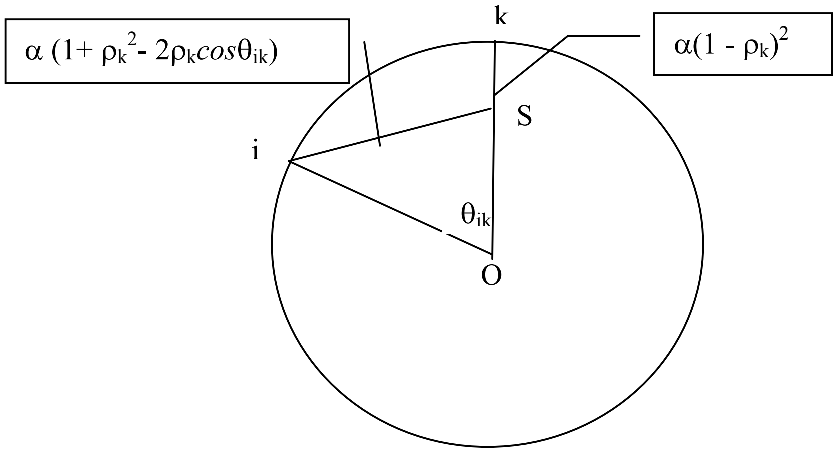


Figure 1 Production mismatch cost (Note: OS = ρ_k)

Consider a typical customers i in Figure 1 who purchases the service of firm k with a product specificity point at point S. Let the total cost (C_{ik}) for a firm k to serve any customer i be equal to the sum of two components. The first is the cost of producing a generic product α and the second is the production mismatch cost g_{ik} which is proportional to the square of the distance between customer's ideal variety point and the firm's product specificity point[2]. Specifically, the production mismatch cost is a function of two variables ρ_k and θ_{ik}.

$$C_{ik} = \alpha + g_{ik}(\rho_k, \theta_{ik}) = \alpha + \alpha(1 + \rho_k^2 - 2\rho_k \cos\theta_{ik})$$

ρ_k is the degree of specificity of firm k's output. This is represented by the distance from the centre of the product-variety circle to the specificity point of the firm. The value of ρ_k is between zero if the firm produces a generic product and one (the radius of the circle) if the firm completely specifies for customer k. The relationship between ρ_k and g_{ik} depends on where customer i is relative to firm k. This is captured by a second variable θ_{ik} which is the smaller angle (i.e less than 180°) between customer i's and customer k's ideal variety point, where customer k is the one that firm k either complete or partially specialises for, depending on the value of ρ_k. If consumer i happens to be customer k in Figure 1, θ_{ik}becomes zero degree and the production mismatch cost is reduced to:

[2] α is only a scaling parameter, and we assume that α=1 in some of our proofs for convenience.

$$C_{ik} = C_{kk} = \alpha + \alpha(1-\rho_k)^2, \quad \text{for } i = k.$$

Thus the profit function of a service provider k can be represented by the following expression:

$$Y_k = 2\int_0^{\bar{\theta}} [(P-\alpha)\frac{m}{2\pi} - \alpha(1+\rho_k^2 - 2\rho_k \cos\theta_{ik})]d\theta_{ik} - K$$

where $\bar{\theta}$ is the angle that spans one-half of firm k's customers, K is the fixed cost, and m is the number of domestic consumers. The service provider selects the optimal value of ρ_k (denoted by ρ^*_k hereafter) to maximum its profit.

On the demand side, each customer is assumed to be served by one service provider. Customer i utility U_i is given by:

$$U_i = V_i - P - \beta g_{ik}(\rho_k, \theta_{ik}), \; \beta > 0$$

where V_i is the utility derived from consumer i's ideal variety, P is the service price, which is assumed to be identical for all service providers, $\beta g_i(\rho_k, \theta_{ik})$ is a "consumption mismatch cost" which reduces the utility of the consumer by the extent to which the product actually consumed differs from his or her ideal variety.

4. Market liberalization in Autarky

In this section, we study the matching model in a closed economy where firms enter the market sequentially. Although we assume autarky, the results in this section can be applied to the case of trade liberalization when the domestic government opens its service sector to foreign service providers, for example in the form of joint-venture with local firms. Assuming perfect information, costless adjustments, free entry, and no collusion, the equilibrium of the product-differentiated industry is characterized by a Nash equilibrium. Starting with only one monopoly firm, we examine the impacts on firms' degree of product specificity and consumers' utility as the number of firm increases. We demonstrate that in equilibrium each firm will have the same degree of product specificity and their product specificity points are evenly spaced on the product characteristics circle. As the number of firm increases, the equilibrium degree of product specificity of the firms increases as well.

4.1 One-firm case

Proposition 1 A *monopoly service provider maximizes it profit by choosing a degree of specificity equals to zero and providing a generic service to all customers.*

The profit function of the monopoly firm is given by:

$$Y_k = 2\int_0^{\pi} [(P-1)\frac{m}{2\pi} - (1+\rho_k^2 - 2\rho_k \cos\theta_{ik})]d\theta_{ik} - K$$

First order condition implies $2\pi\rho^*_k = 0$. This gives that the optimal degree of specificity equals to zero. The result shows that in the absence of any competition, a monopoly service provider can minimize its production mismatch costs and maximize its profit by providing a generic service to all consumers.

4.2 Multi-firm case

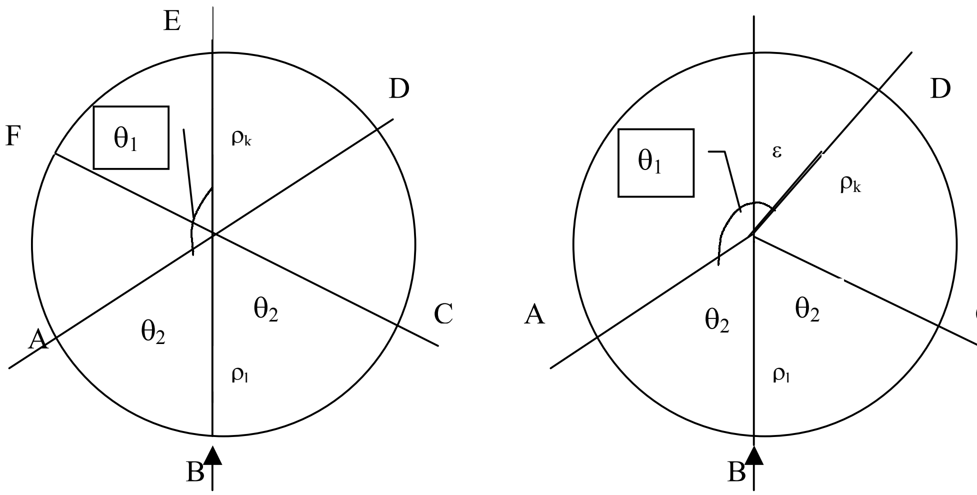
When the number of firms in the market exceeds one, quality competition forces firms to provide a specialized service to cater to some customers.

Proposition 2 *When the number of firms (n) exceeds one, the degrees of specificity of the firms are (i) the greater than zero, (ii) identical, and (iii) evenly spaced on the product characteristics circle.*

Two firm case

Suppose initially there is a monopoly firm *k* in the market providing a generic service to all customers (ρ_k=0). Then a new firm *l* enters the market with a degree of specificity of ρ_l which is greater than zero. As a firm that provides specialized services to some customers, firm *l* is able to capture those customers with whose ideal variety points are close to ρ_l. This can be illustrated by the customers along the arc ABC of the panel (a) of Figure 2. Firm *k* is left with customers distributed along the arc AFEDC. In response to the threat from firm *l*, firm *k* has to adjust its degree of specificity. Condition (iii) of proposition 2 implies that firm *k*'s new degree of specificity

ρ_k, whatever its value, is located on the diameter that goes through the specificity point ρ_l but lies on the other side of the diameter from ρ_l.



(a) **(b)**

Figure 2 Two-firm case

To show this result, let us consider two possible positions of ρ_k in Figure 2. In panel (a) circle, ρ_k lies on the opposite side of the diameter that goes through ρ_l. In the panel (b) circle, ρ_k and ρ_l are not lined up on a diameter. Instead, ρ_k lies at an angle of $(\pi+\varepsilon)$ degree measured in a "clockwise" direction from ρ_l[3]. Let the profit of firm k be Y_k in the panel (a) and Y_k'in panel (b). It can be shown from profit maximizing condition that Y_k is always greater than Y_k'. Therefore, firm k will always choose its degree of specificity opposite from that of ρ_l along the diameter.

$$Y_k = 2\int_0^{\pi-\theta_2} [(P-1)\frac{m}{2\pi} - (1+\rho_k^2 - 2\rho_k \cos\theta_{ik})]d\theta_{ik} - K_1$$

First order condition implies that $-4\rho_k(\pi-\theta_2)+4\sin\theta_2 = 0$. Therefore, the degree of specificity ρ^*_k and the maximum profit Y_k for firm k in panel (a) is given by:

$$\rho^*_k = \frac{\sin\theta_2}{\pi-\theta_2}$$

$$Y_k = 2\left[\frac{(\pi-\theta_2)^2[(P-1)\frac{m}{2\pi}-1]+\sin^2\theta_2}{\pi-\theta_2}\right] - K_1$$

[3] Please refer to Figure 2 panel (b). ε is the angle between any other product specificity of firm k and the one that is on opposite side of the diameter that goes through ρ_l.

Likewise, we can compute the maximum profit of Y_k' of panel (b) in Figure 2.

$$Y_k' = 2\int_{-(\pi-\theta_2-\varepsilon)}^{\pi-\theta_2+\varepsilon}[(P-1)\frac{m}{2\pi} - (1+\rho_k^2 - 2\rho_k\cos\theta_{ik})]d\theta_{ik} - K_1$$

$$\rho^{**}{}_k = \frac{\sin(\theta_2-\varepsilon)+\sin(\theta_2+\varepsilon)}{2(\pi-\theta_2)}$$

$$\therefore Y_k' = \frac{4(\pi-\theta_2)^2[(p-1)\frac{m}{2\pi}-1]+[\sin(\theta_2-\varepsilon)+\sin(\theta_2+\varepsilon)]^2}{2(\pi-\theta_2)} - K_1$$

It can be shown that $\mathrm{Y_k} \geq \mathrm{Y_k'}$, since it implies that:

$$\frac{[\sin(\theta_2-\varepsilon)+\sin(\theta_2+\varepsilon)]^2}{2(\pi-\theta_2)} \leq \frac{2\sin^2\theta_2}{\pi-\theta_2}$$

Simplifying the above inequality gives: $\sin^2\theta_2 \geq \sin^2\theta_2\cos^2\varepsilon$. And this is definitely true for any θ_2 and ε.

Next, we proof condition (ii) of proposition 2. We assume a Cournot-type strategic interaction in which each firm sets its profit maximizing degree of specificity taking the other firm's degree of specificity as given. Let the half-market segment of firm *k* be the arc on the circumference correspond to angle θ_1 in the panel (a) circle of Figure 2. A customer *m* at point A is a "critical" consumer who is indifferent between the services from firm *k* and firm *l*. Let U_{mk} and U_{ml} be the utility that customer *m* derives from the services of firm *k* and firm *l* respectively. Since customer *m* is a critical customer, $U_{mk} = U_{ml.}$ This implies that θ_l is equal to Arcos[$(\rho_k - \rho_l)/2$]. The profit functions of firm *k* and firm *l* can be written as:

$$Y_k = 2\int_0^{\pi-\theta_2}[(P-1)\frac{m}{2\pi} - (1+\rho_k^2 - 2\rho_k\cos\theta_{ik})]d\theta_{ik} - K_1$$

$$Y_l = 2\int_0^{\theta_2}[(P-1)\frac{m}{2\pi} - (1+\rho_l^2 - 2\rho_l\cos\theta_{il})]d\theta_{il} - K_2$$

First order conditions with respect to ρ_k and ρ_l imply the following relation between them.

$$\theta_1 = \arccos\frac{\rho_k-\rho_l}{2} = \frac{\pi\rho_l}{\rho_k+\rho_l} \text{....................................(1)}$$

Since $\rho_k, \rho_l \in [0,1]$, $\dfrac{\pi\rho_l}{\rho_k+\rho_l} \in [0,\pi]$

Given any ρ_l there is a unique solution of ρ_k and vice versa. Since equation (1) can only be satisfied by setting ρ_l=ρ_k, the market is shared equally by the two firms in equilibrium.

To establish condition (i) of proposition 2, it is necessary to consider the possibility that firm l chooses to come into the market offering a generic service and capture half of the consumers from the incumbent monopoly. Let Y_l be the profit if gained if ρ_l=0 and $Y_l^{'}$ be the profit if ρ_l>0.

$$Y_l = 2\int_0^{\pi/2}[(P-1)\frac{m}{2\pi} - (1+\rho_l^2 - 2\rho_l \cos\theta_{il})]d\theta_{il} - K_2$$

$$\text{If } \rho_l = 0,\ Y_l = [(P-2)\frac{m}{2\pi} - 1]\pi$$

$$\text{If } \rho_l > 0,\ Y_l^{'} = [(P-2)\frac{m}{2\pi} - 1]\pi + 4\rho_l - \frac{\pi\rho_l^2}{2}$$

Obviously, $Y_l^{'} > Y_l$. The incoming firm will not offer generic service to domestic consumers.

Three-firm case

Suppose the market can accommodate three firms and two already exist initially. Since we have proved that the two incumbent firms are distributed symmetrically along the diameter, they will respond in the same manner when the third firm enters the market. We focus our attention on one of the two incumbent firms from now on. In Figure 3, *d* stands for the incumbent firm and *f* be the new entrant. γ is the angle between OC and Od. Suppose the consumer *i* at point A is the "critical" consumer who is indifference between the services provides by firm *d* and firm *f*.

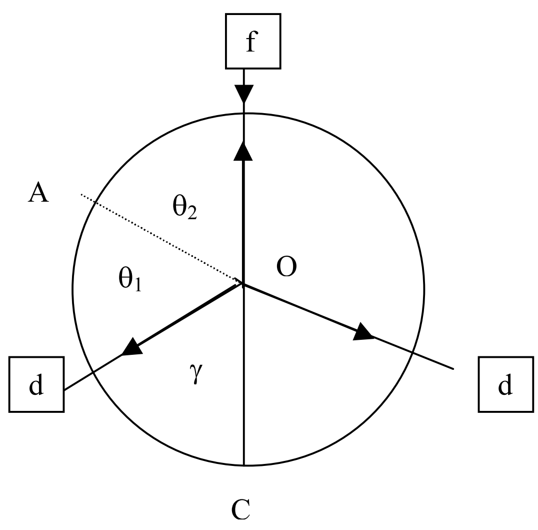


Figure 3 Three-firm case

Still consumer A is the indifference consumer.

$$Let \quad U_f = U_d$$

$$\because \theta_1 + \theta_2 + \gamma = \pi \quad \text{and} \ \theta_1, \theta_2, \gamma \in [0, \pi]$$

$$\therefore \frac{\rho_f^2 - \rho_d^2}{2} = \rho_f \cos\theta_2 + \rho_d \cos(\theta_2 + \gamma) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Profit function of existing firm and new coming firm are as following:

$$Y_f = 2\int_0^{\theta_2} [P - 1 - [1 + \rho_f^2 - 2\rho_f \cos\theta_{if}] d\theta_{if} - K_f$$

$$Y_d = 2\int_{-\gamma}^{\theta_2} [P - 1 - [1 + \rho_d^2 - 2\rho_d \cos\theta_{id}] d\theta_{id} - K_d$$

Take first order condition of profit function of new entrant with the respect of parameter γ *and* ρ_f, while take first order condition of profit function of the incumbent firm with respect of parameter ρ_d. We can obtain a group of equations.

$$\theta_1 = \gamma \ and \ \ \gamma \in [0, \pi/2] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

$$\rho_d \gamma = \sin\gamma \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$(\pi - 2\gamma)\rho_f = \sin 2\gamma \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Substituting (2) into (1) and using the relationship between θ_1, θ_2 and γ we have equation (5).

$$\frac{\rho_d^2 - \rho_f^2}{2} = \rho_f \cos 2\gamma + \rho_d \cos\gamma \ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Equation (5) is a quadratic function of $\cos\gamma$ and it has two solutions, but one is positive and the other is negative.

$$\cos\gamma = \frac{-\rho_d \pm \sqrt{\rho_d^2 - 8\rho_f \left(\frac{\rho_d^2 - \rho_f^2}{2} - \rho_f\right)}}{4\rho_f}$$

Since $\gamma \in [0, \pi/2]$, so $\cos\gamma \geq 0$, it has at most one solution.

And we can show when $\gamma = \pi/3$, (3), (4), *and* (5) can all be fulfilled.

$$\therefore \gamma = \pi/3 \ \text{and} \ \rho_f = \rho_d$$

The three firms are also symmetrically spaced on the plane of the circle.

Proposition 3 *As the number of firms in the market increases, the degree of specificity of the firms increases.*

Based on the above results, we can infer that all the service providers will symmetrically distributed on the plane of circle, that is, each provides different variety of service but has the same degree of specificity in a closed economy. Therefore, the generalized expression of the profit function of an individual firm j in a closed economy (Y^c_j)[4] is given by:

$$Y^c{}_j = 2\int_0^{\frac{\pi}{n}}[(P-1)\frac{m}{2\pi} - (1+\rho^2 - 2\rho\cos\theta_{ij})]d\theta_{jn} - K$$

$$\rho_c^{\ *} = \frac{n\sin\frac{\pi}{n}}{\pi} \ and \lim_{n\to\infty}\rho_c^{\ *} = 1$$

Although we cannot prove theoretically, our simulation exercises[5] shows that the equilibrium degree of specificity is a monotonically increasing function of the number of service providers (n) and it approaches one in the limit. The intuition is that the service providers are forced to offer more specialized service so as to maximize their profit, as their market share turns smaller with the increase of the number of service providers.

Substitute the ρ^*_c expression into the profit function, the number of firms the market can accommodate is a function of the fixed cost that the firm must incur when entering the market.

$$Y_j^{\ c}(n) = 2[\frac{(P-2)\frac{m}{2n} - \frac{\pi}{n} + n^2\sin^2\frac{\pi}{n}}{n\pi}] - K$$

By setting $Y^c_j(n)=0$, we can solve for the free-entry equilibrium n^c in a closed economy by setting profit to zero for each firm and the social welfare amounts to consumer surplus.

With the increase of $\rho_c^{\ *}$, the consumption mismatch cost will be higher for some consumers but lower for others. For example, the consumers in the arc AF and arc DC segments of the circle in panel (a) of Figure 2 are worse off in the two-firm case than in the monopoly case. On the other

[4] Hereafter, the superscript c of any variable represents closed economy case whereas the superscript o represents variables in a liberalized market.

[5] The simulation result can be found in appendix 1 at the end of the paper.

hand, those consumers distributed along the arc FED and arc ABC are better off. Therefore, the total consumer surplus can either increase or decrease with the number of firms in the market.

Proposition 4 *An increase in the number of service providers improves consumer surplus and social welfare.*

From the general expression of ρ_c^*, the total utility of consumers in terms of the number of firms is given by:

$$\sum U^c = \sum (V_i - P) - \beta g_i^c = \sum (V_i - P) - 2n\beta \int_0^{\frac{\pi}{n}} (1 + \rho_c^{*2} - 2\rho_c^* \cos\theta) d\theta$$

$$= \sum (V_i - P) - 2\beta[\pi - \frac{n^2 \sin^2 \frac{\pi}{n}}{\pi}]$$

$$\frac{\partial \sum U^c}{\partial n} = 2\sin\frac{\pi}{n}(n\sin\frac{\pi}{n} - \pi\cos\frac{\pi}{n})$$

$$when \quad n \geq 2, \quad \frac{\partial \sum U^c}{\partial n} > 0.$$

The utility of consumers in the autarky economy is monotonically increasing with respect to the number of firms. The reason is that more service providers generally enlarge the chance of a consumer matching with a provider who can provide him high quality of service even though some are worse off.

5. Market Liberalization between Two Identical Economies

Following Lancaster (1980), we assume two identical economies to address service trade after they open their markets. To be specific, both countries possess identical production technology, resources endowment, demand specifications. In other words, every individual in one country can be paired off with an individual having the same preference in the other.

Proposition 4 *Market liberalization between two identical economies force all service providers to increase their degree of specificity, and the number of service providers available to consumers in each market is at least equal to twice the number available in the autarky case. Each country exports the service variety it has and imports those it is short of.*

When both countries open their markets, their circles of product characteristics overlap. The integrated market can be represented by a unit circle whose density of consumers is twice that of the individual autarky economy's. In this larger market, the number of firms is also doubled. The results from section 4 suggest that service providers will respond to an increase in the number of competitors by raising their degree of specificity. In the new equilibrium after opening of trade, all firms will be located symmetrically on the product-characteristics circle. Let the profit function of a firm j in an open economy with n number of firm can be $Y^{0}_{j}(n)$:

$$Y^{o}{}_{j}(n) = 4\int_{0}^{\frac{\pi}{2n}} [(P-1)\frac{m}{2\pi} - (1+\rho^2 - 2\rho\cos\theta_{ij})]d\theta_{ij} - K$$

$$F.O.C \quad \frac{\partial Y_j}{\partial \rho_o{}^*} = 0 \;\Rightarrow \rho_o{}^* = \frac{2n\sin\frac{\pi}{2n}}{\pi}$$

$\because n \geq 2$ after liberalization

$$\therefore \rho_o^* - \rho_c^* = \frac{2n\sin\frac{\pi}{2n}}{\pi} - \frac{n\sin\frac{\pi}{n}}{\pi} = 2\frac{n}{\pi}\sin\frac{\pi}{2n}(1-\cos\frac{\pi}{2n}) > 0$$

After liberalization, each provider is more specialized than before. Can all these firms survive? Substitute $\rho_o{}^*$ into the profit function of a representative firm, we can find the profit of each firm is bigger than before. Since the ideal service variety of consumers are more concentrated than before, the production mismatch cost is reduced and all the firms can survive.

$$Y_j{}^{o}(n) = 2[\frac{(P-1)\frac{m}{2n} - \frac{\pi}{n} + 4n^2\sin^2\frac{\pi}{2n}}{n\pi}] - K > Y_j{}^{c}(n^c)$$

Furthermore, the direction of trade by now is very clear, each country imports the different variety of service that it does not have in domestic country and exports those that it has. Let $Y_i^o(n)=0$, the number of service providers that can co-exist in each country can be solved out. Obviously, $n^o>n^c$. If there is a new firm, there will be another variety of service. Since firms in both countries have the same chance to join the market, it is uncertain that which is the import country and which is the export of this service.

Whether consumers in each country get better off if $\rho_o{}^*>\rho_c{}^*$? Let us compare the total utility of consumers in one country before (U^c) and after (U^o) liberalization but before new entry takes place.

$$\sum U^o = \sum (V_i - P) - \beta g_i^{\ o} = \sum (V_i - P) - 4n\beta \int_0^{\frac{\pi}{2n}} (1 + \rho_o^{\ *2} - 2\rho_o^{\ *} \cos\theta) d\theta$$

$$= \sum (V_i - P) - 2\beta[\pi - \frac{4n^2 \sin^2 \frac{\pi}{2n}}{\pi}]$$

$$\sum U^c = \sum (V_i - P) - \beta g_i^{\ c} = \sum (V_i - P) - 2\beta[\pi - \frac{n^2 \sin^2 \frac{\pi}{n}}{\pi}]$$

$$\sum U^o - \sum U^c = 4n^2 \sin^2 \frac{\pi}{2n} (1 - \cos^2 \frac{\pi}{2n}) \beta$$

Since $n \geq 2$ after liberalization,

then $\sum U^o > \sum U^c$

The total utility of consumers after liberalization is greater than before liberalization, so we conclude that consumers are better off after market opening. As shown before, because all the existing firms have excess profit after liberalization, new entrants will join the market as long as the profit can cover the sunk cost of entry. The solution shows that liberalized market can accommodate more service providers in each country. In other words, liberalization creates more opportunities for firms to differentiate their service and earn a higher profit. The newly entered firms will also offer differentiated service, thereby reinforcing the result that consumers will gain from liberalization. Under free entry assumption, all gain from trade appears as an increase in consumer surplus.

In the case of non-identical demand specifications, our model implies an interesting result, which is quite different from most trade models that rely on cross-country difference as a cause of trade.

Corollary to Proposition 4 *The gain from trade is higher the more similar is the product variety distributions between the two countries.*

Consider an extreme case where the two economies are identical in all respects except that they have "complementary" demand structures. Consumers in one country are uniformly distribution on left half of the product variety circle only and none exists in the other half. The demand preference distribution in the other country is exactly the reverse, where consumers are distributed uniformly on the right half of the circle only. Suppose that both markets are served a monopoly before trade liberalization and each monopoly choose a certain non-zero degree of specificity. When trade is opened between these two economies, neither firm can take away the customers of the other. Trade liberalization din this case does not create an incentive for either firm to increase its degree of specificity. This result is in sharp contrast to the case when the economies have identical demand preference, where the extent of overlapping demand is greatest and this opens an opportunity for firms to increase their profits by increasing their product specialization. Hence, our theoretical result here provides an explanation of intra-industry trade between “similar” economies.

6. **Concluding Remarks**

In this paper, we exclude economics of scale and difference in resources and technology in developing a trade model of product differentiation and producer specificity to examine gain from trade in services. By allowing producers to select their degree of specificity, the model shows that demand side factor can explain trade and results in service providers deepening their specialization to consumers’ product requirements while offering at least doubled variety of service. These forces combined constitute a better matching between service providers and consumers, which serves as an independent source of gain from trade. Given the importance of product varieties in services, this is an important source of gain from trade that merits further research. Moreover, the direction of trade can be predicted in this model. To be specific, each country exchanges the service it provides with the other country.

The model can be extended in several ways. For example, consumers in our model are mainly passive. They can be modeled to choose whether to enter a market or not depending on the magnitude of the mismatch cost. Furthermore, the amount consumers can purchase can be greater than one. This will introduce economies of scale into the model as another source of gain from trade. Service consumers can be modeled as firms in our model as most services are intermediate inputs. Finally, we can explore the impact of domestic regulations and trade restrictions on service trade.

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Appendix 1 Simulation Result

Table 1. Close Economy VS. Open Economy
(P=3, m=200, K=100, V=5, β=20)

Close Economy VS. Open Economy

n	Y(I)	nY(I)	CS	SW(c)	Yi	nYi	CS	SW(O)
1	293.72	293.72	274.34	568.05	293.72	293.72	325.27	618.98
2	98.13	196.26	325.27	521.53	101.95	203.91	376.20	580.10
3	32.67	98.01	360.28	458.29	36.97	110.90	388.93	499.83
4	-0.30	-1.19	376.20	375.00	3.52	14.08	393.67	407.75
5	-20.16	-100.79	384.31	283.52	-16.86	-84.30	395.92	311.62
6	-33.43	-200.56	388.93	188.37	-30.56	-183.37	397.16	213.78
7	-42.92	-300.41	391.79	91.37	-40.40	-282.80	397.90	115.10
8	-50.04	-400.32	393.67	-6.65	-47.80	-382.43	398.39	15.97
9	-55.58	-500.25	394.98	-105.28	-53.57	-482.17	398.73	-83.44
10	-60.02	-600.21	395.92	-204.29	-58.20	-581.98	398.97	-183.01
11	-63.65	-700.17	396.62	-303.55	-61.99	-681.84	399.15	-282.69
12	-66.68	-800.15	397.16	-402.99	-65.14	-781.73	399.28	-382.45
13	-69.24	-900.12	397.57	-502.55	-67.82	-881.65	399.39	-482.26
14	-71.44	-1000.11	397.90	-602.20	-70.11	-981.58	399.47	-582.11
15	-73.34	-1100.09	398.17	-701.92	-72.10	-1081.53	399.54	-681.99
16	-75.01	-1200.08	398.39	-801.69	-73.84	-1181.48	399.60	-781.89
17	-76.47	-1300.07	398.58	-901.50	-75.38	-1281.45	399.64	-881.80
18	-77.78	-1400.07	398.73	-1001.34	-76.75	-1381.42	399.68	-981.74
19	-78.95	-1500.06	398.86	-1101.20	-77.97	-1481.39	399.71	-1081.68
20	-80.00	-1600.05	398.97	-1201.08	-79.07	-1581.37	399.74	-1181.63
21	-80.95	-1700.05	399.07	-1300.98	-80.06	-1681.35	399.77	-1281.58
22	-81.82	-1800.05	399.15	-1400.90	-80.97	-1781.33	399.79	-1381.55