A Simple Model of Service Trade with Time Zone Differences

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Abstract

This note proposes a two-country monopolistic competition model of service trade that captures the role of time zone differences as a determinant of trade patterns. It is shown that the utilization of time zone differences induces drastic change in trade patterns: Due to taking advantage of time zone differences, service firms learve larger countries for smaller countries.

Key Words: time zone differences; service trade; delivery cost

JEL Classification: D43, F12

1 Introduction

A tremendous change is taking place in the world economy: globalization, caused by the communications revolution and by the deterioration of barriers to international trade. It is now well recognized that there are many kinds of trade, particularly in service sectors such as banking, engineering, retailing, software development and so forth, which do not require physical shipments of products.[1] The rise of the Indian software industry provides a prime example. The programming problems of some U.S. corporations are e-mailed to India at the end of the U.S. workday. Indian software engineers work on them during their regular office hours and provide solutions. By the time the offices reopen in the U.S., the solutions have already arrived, mainly as e-mail attachments.[2] Ireland, pitching to host Europe's main international call centers, offers another example. Cairncross (1997, p. 219) emphasized the rise of the call-center service industry in Ireland, which is taking geo-

[1]Freund and Weinhold (2002) found that Internet penetration, which is measured by the number of Internet hosts in a country, has a positive and significant effect on service trade.

[2]In his recent bestselling book, *The World Is Flat*, Friedman (2006, pp. 31–32) also introduced "remote executive assistant service" in India: because of the time differences between India and the U.S., assistants in India can work on their assignments while U.S. customers sleep and have them back to the U.S. the next morning.

graphical advantage of being in between the U.S. and Europe. These types of service trade require two basic conditions. First, there must be a difference in time zones between the trading partners. Second, there must be good connections via communications networks (e.g., the Internet) which enable the services to be "transported" quickly with little cost. In other words, thanks to the communications revolution, time zone differences can become a primary driving force behind service trade. This seems to suggest that the focus on "market proximity" as an advantage in service provision should be accompanied by focus on a time zone (or remoteness) advantage.

In the existing literature on trade theory, however, relatively few attempts have been made to address the role of time zones. In a seminal contribution, Marjit (2007) examined the role of international time zone differences in a vertically integrated Ricardian framework. He showed that time difference emerges as an independent driving force of international trade besides taste, technology and endowment.[3] According to this line, we propose a two-country monopolistic competition model of service trade that captures the role of time zone differences.[4] Following Marjit (2007), we assume that two

[3]Jones *et al.* (2005, p. 309) also emphasized the role of time zone differences as a determinant of trade patterns.

[4]Kikuchi (2006) presented a different type of monopolistic competition trade model with time zone differences in which services are assumed to be an intermediate input.

countries are located in different time zones. Marjit studied the role of time zones in perfectly competitive markets with constant returns technology. In contrast, in this study we examine their role in monopolistically competitive markets with increasing returns technology, which enables us to include service firms' location decisions explicitly.

The key assumption is that domestic service production requires one workday and that products are ready for sale after one workday: domestic delivery bears significant costs. In contrast to this, the utilization of communications networks allows production in a foreign country where no-overlapping work hours and service trade via networks enable a quick delivery and low shipping costs. In other words, imported services whose production benefits from time zone differences realize higher value than domestically produced services. Although this assumption is at odds with that of the standard monopolistic competition model with trade costs (e.g., Krugman 1980),[5] it captures the idea that consumers would like to have services sooner than later. On the basis of the model outlined above, we will show that the utilization of communications networks induces drastic change in industrial structure due to firm relocation to take advantage of time zone differences.

In Section 2 we present basic model. In Section 3 we deal with the

[5]See, also, Evans and Harrigan (2005) in which transport time increases with the distance traveled.

question of trade patterns, which is followed by concluding remarks presented in Section 4.

2 The Model

Suppose there are two countries, Home and Foreign, and that they are identical in regard to tastes and technology.[6] There is only one factor of production, namely labor, and relative country size is measured by labor force size. Let L denote the size of the world's total labor force, and λL $(0 < \lambda < 1)$ denote Home's size. The two countries are located in different time zones and there is no overlap in working hours: when Home's workday ends, Foreign's workday begins (aee Figure 1). There are two sectors: a monopolistically competitive sector producing a large variety of differentiated services and a perfectly competitive sector producing a homogeneous good. The latter serves as the numeraire, and units are chosen such that one unit of labor produces one unit of output. The production of the numeraire is instantaneous in the sense that one unit of output can be produced within one workday.[7]

The central assumption is that there are positive costs for the delivery

[6] In this way, we rule out Ricardian comparative advantage.

[7] This assumption is taken from Marjit (2007).

of differentiated services. We assume that the production of each service requires one workday. Then, one unit of service which is produced in Home is ready for sale after one workday. In order to capture this point, we assume that domestic shipments of differentiated services incur the "iceberg" effect of delivery costs: for every t ($t > 1$) units shipped, only one unit arrives. Thus, the price of a Home service to Home consumers will be tp, where p is the producer's price for the service. In other words, we can interpret $(t-1)/t$ as a rate of discount. Although we do not explicitly model consumption behavior, this seems to be a reasonable assumption.

Another important assumption is that, if the utilization of communications networks becomes possible, a country can import differentiated services more quickly. For every t' units shipped, one unit arrives. The key assumption is the following condition:

$$t > t' > 1. \tag{1}$$

Note that this effect comes not from lower production costs in Foreign, but from the quick delivery. This assumption intends to capture the idea that production taking advantage of time zone differences increases the value of each service.

We assume constant expenditure shares between the differentiated services and the numeraire, and that the subutility for the former takes the

Dixit-Stiglitz (1977) form:

$$D = \left[\sum_{i}^{n} (d_i)^{(\sigma-1)/\sigma} + \sum_{j}^{n^*} (d_j)^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)},$$

where d_i (d_j) is the consumption level of the Home (Foreign) services, σ is the elasticity of substitution between differentiated services, and n (n^*) is the number of products available from Home (Foreign). The price index for the differentiated services that is dual to the subutility D is represented by

$$P = \left[\sum_{i}^{n} (tp_i)^{1-\sigma} + \sum_{j}^{n^*} (t'p_j^*)^{1-\sigma} \right]^{1/(1-\sigma)}. \tag{2}$$

The Home consumers' derived demand for a Home service is[8]

$$c = t(tp)^{-\sigma} P^{\sigma-1} \mu \lambda L, \tag{3}$$

where μ is the share of spending devoted to differentiated services. Similarly, the derived demand for a Foreign service from Home consumers is

$$c' = t'(t'p^*)^{-\sigma} P^{\sigma-1} \mu \lambda L. \tag{4}$$

A producer of a differentiated service has to commit α units of labor as a fixed cost and has constant marginal input β. With the total number of services available to consumers being very large, each producer chooses its constant markup price as

$$p = (\sigma\beta)/(\sigma - 1). \tag{5}$$

[8]Hereafter, the subscript j is dropped for simplicity.

Free entry ensures that the equilibrium output per service, x, is constant, common across countries, and independent of the level of delivery costs:

$$x = [\alpha(\sigma - 1)]/\beta. \tag{6}$$

Before turning to the trading equilibrium, we must draw attention to the autarky equilibrium (i.e., t' is prohibitively high due to the lack of communications networks). In autarky, the number of differentiated services in each country is given by $n^A = (\mu\lambda L)/\alpha\sigma$, $n^A = [\mu(1-\lambda)L)]/\alpha\sigma$ where A refers to the value in the autarky equilibrium. Units are chosen so that one country's autarky number of varieties equals its relative size, i.e., by setting $(\mu L/\alpha\sigma) = 1$, we obtain

$$n^A = \lambda, \quad n^{*A} = 1 - \lambda. \tag{7}$$

3 Service Trade via Communications Networks

Let us turn to the case of service trade via communications networks.[9] In this case, the service market equilibrium requires that supply equal demand for each Home service: $x = c + c'$. Substituting (3), the Foreign counterpart of

[9]It is natural to assume that there is an additional cost of the introduction of communications networks. However, to keep matters simple, assume that there are no additional costs. Kikuchi (2005) discusses implication of the fixed investment costs of communications networks as a determinant of trade.

(4), and (6) into this equation and denoting $\tau \equiv t^{1-\sigma}$ and $\tau' \equiv t'^{1-\sigma}$ $(\tau' > \tau)$ yields the following equilibrium condition for a Home product and its foreign counterpart:

$$1 = \frac{\tau\lambda}{\tau n + \tau' n^*} + \frac{\tau'(1-\lambda)}{\tau n^* + \tau' n}, \tag{8}$$

$$1 = \frac{\tau'\lambda}{\tau n + \tau' n^*} + \frac{\tau(1-\lambda)}{\tau n^* + \tau' n}. \tag{9}$$

Using (8) and (9), the equilibrium number of varieties can be obtained:

$$n = \frac{(1-\lambda)\tau' - \lambda\tau}{\tau' - \tau}, \quad n^* = \frac{\lambda\tau' - (1-\lambda)\tau}{\tau' - \tau}. \tag{10}$$

Using (7) and (10), the changes in Foreign production structure brought about by utilizing time zone differences can be shown as

$$n^* - n^{*A} = \frac{\tau'}{\tau' - \tau}(2\lambda - 1). \tag{11}$$

If Foreign is the smaller country (i.e., $\lambda > 1/2$), it will attract more service firms by utilizing communications networks. This outcome implies that producers prefer producing in the country *next to the larger country*, in order to take advantage of time zone differences.[10] This effect can be interpreted as a variant of *the home market effect*, which is emphasized in the trade literature.

Figure 2 helps to illustrate this effect. The 45 degree line and the downward sloping curve show the relationship between relative country size and

[10]Note that, due to product differentiation, some Home firms remain to provide its services for Home consumers irrespective of its price differentials.

the relative number of products in autarky and in trading equilibrium, respectively. The latter indicates that a relatively small country will have a more-than-proportional number of service firms in the trading equilibrium (see the upward arrow in the figure).[11] Although this result depends critically on the assumption on delivery costs [see, (1)], it demonstrates the idea that the utilization of communications networks induces dramatic change in service trade as firms take advantage of time zone differences, which has not appeared in the existing literature.

Before closing this section, it is worthwhile to note the Home's welfare gains from service trade liberalization, which can be measured by a change in the effective number of service varieties. Before trade, the effective number of Home varieties is $\tau\lambda$, while it becomes $(\tau' + \tau)\lambda$ by opening trade. Thus, the welfare gains due to opening trade is $\tau'\lambda$, which becomes larger as a reduction in the delivery costs becomes larger (i.e., a larger τ').

4 Concluding Remarks

Both deeper market integration and advances in digital technology have driven a particularly large decrease in the costs of service provision. In this

[11] Note that both countries will produce differentiated services only if λ lies in the range $(\tau/\tau') < [(1-\lambda)/\lambda] < (\tau'/\tau)$.

note, we propose a two-country monopolistic competition model of service trade that captures the role of time zone differences. We have shown that the utilization of communications networks induces drastic changes in industrial structure caused by firms taking advantage of time zone differences: service firms move away from larger countries in favor of smaller countries. Although these results are derived under the specific assumption that the delivery costs of imported services are lower than for domestically provided services, it appears that something similar to this will occur for the more general setting we consider here.

The present analysis must be regarded as tentative. Hopefully it provides a useful paradigm for considering how time zone differences affect both the structure of service provision and trade patterns. The model could be enriched with the inclusion of both FDI and outsourcing aspects in order to analyze the organization of firms.[12]

[12]See Helpman (2006) for a survey of the relevant literature.

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Figure 1

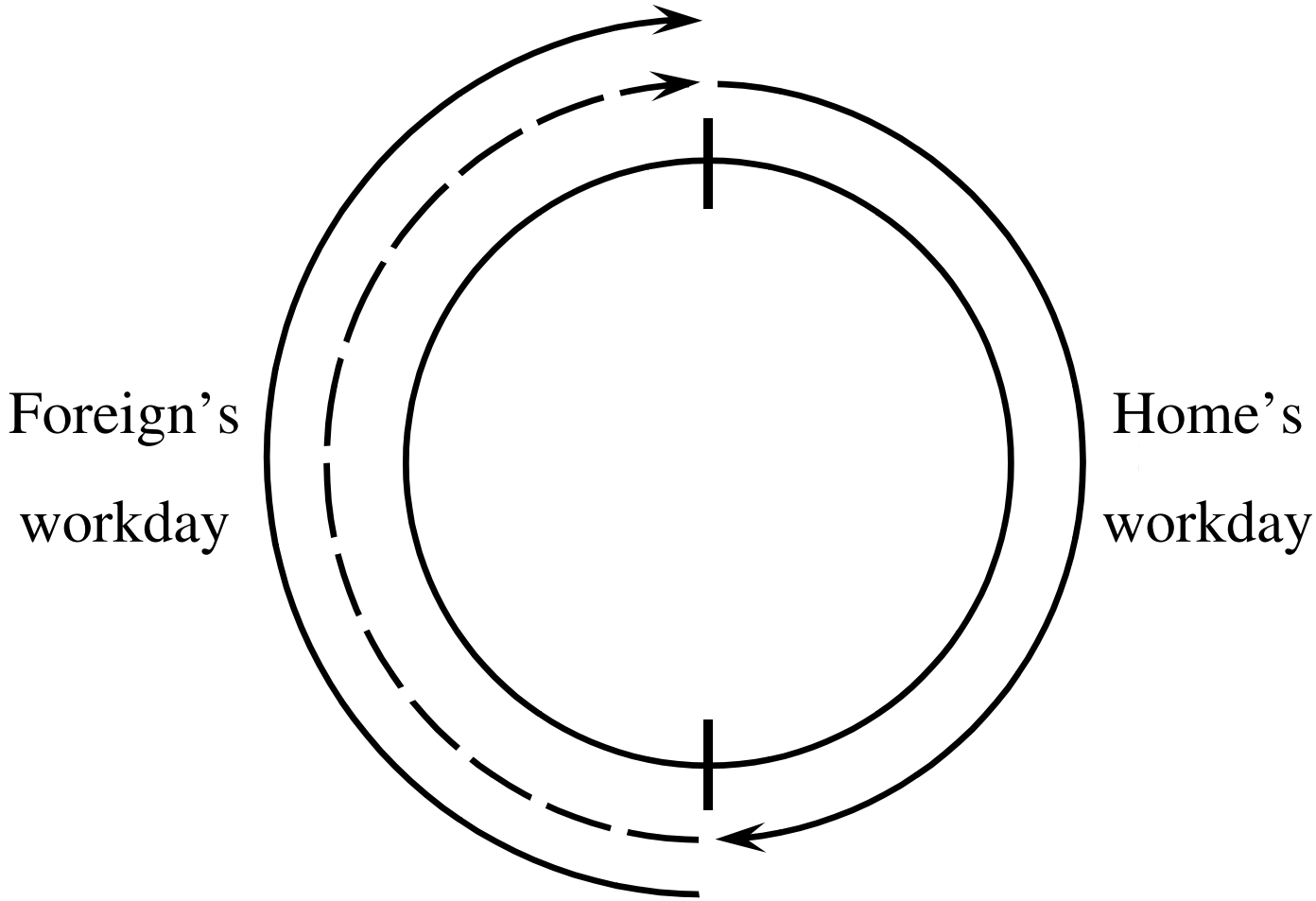
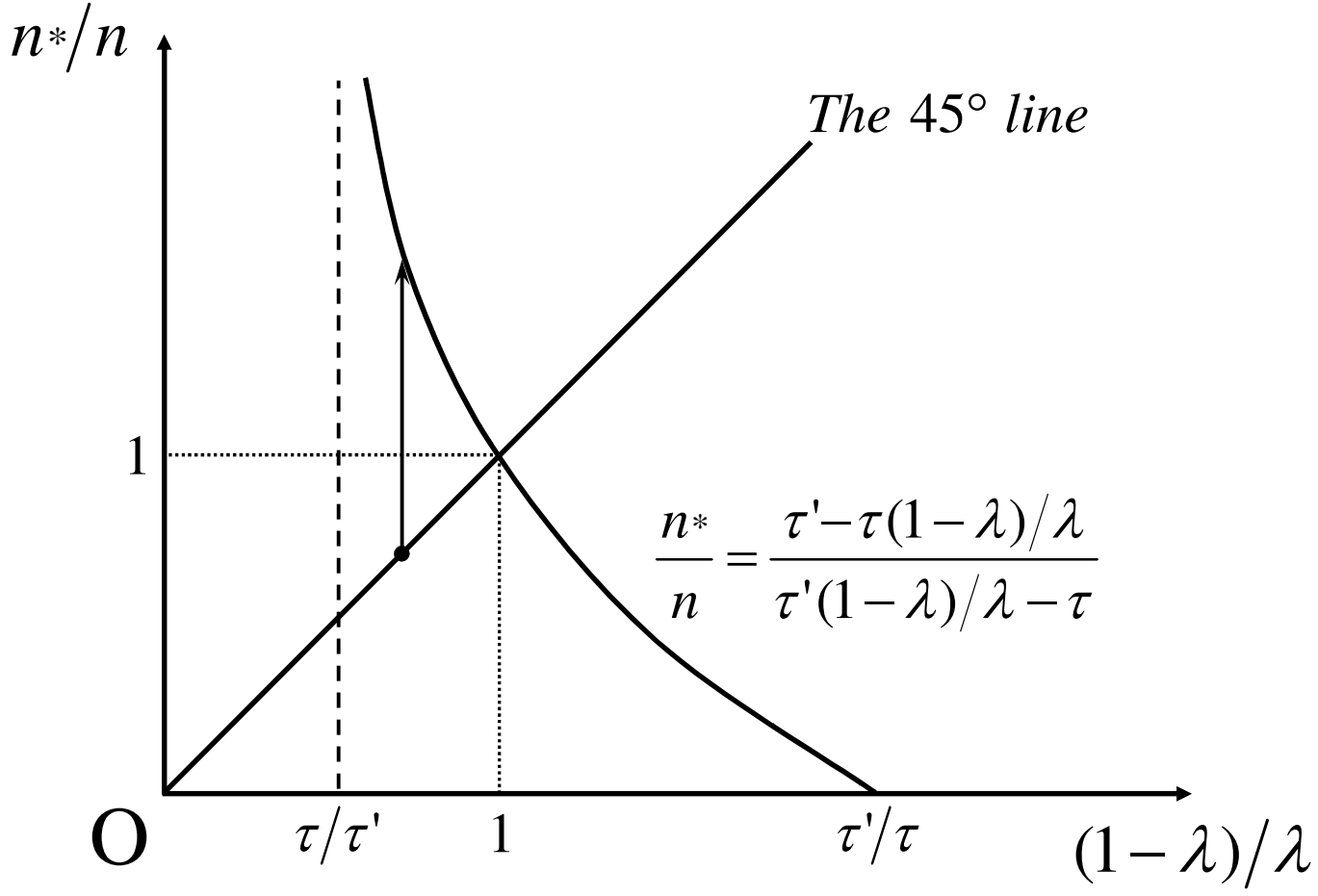


Figure 2


$n*/n$
The 45° line
1
$\frac{n*}{n} = \frac{\tau' - \tau(1-\lambda)/\lambda}{\tau'(1-\lambda)/\lambda - \tau}$
O
τ/τ'
1
τ'/τ
$(1-\lambda)/\lambda$