E C O N O M I C S   B U L L E T I N

# Time Zones, Outsourcing and Patterns of International Trade

Toru Kikuchi
*Kobe University*


## *Abstract*

This paper proposes a three-country model of business services trade that captures the role of time zones in the division of labor. The connectivity of business service sectors via communications networks (e.g., the Internet) is found to determine the structure of comparative advantage. That is, two countries with connected service sectors have a comparative advantage in the good that requires business services. It is also shown that the third country inevitably specializes in the good that does not require business services.


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# 1 Introduction

A tremendous change is taking place in the world economy: *globalization*, caused both 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 the business 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. This type of trade in business services requires two basic conditions: a difference in time zines between the trading partners and good connections via communications networks (e.g., the development of the Internet).[2] In other words, due to the communications revolution, time zone differences may become a primary driving force behind trade in business services.

In the existing literature on trade theory, however, relatively few attempts have been made to address the theme of communications networks and the role of time zones. In a seminal contribution, Marjit (2006) examines the role of international time differences in a vertically integrated Ricardian framework. However, the role of communications networks is downplayed in the analyses. This study, in contrast, focuses on another important aspect: the utilization of time differences *via communications networks* which allow business service producers in one country to collaborate (or outsource) with those in another country efficiently.[3] The utilization of time differences plays a

[1] Related to these phenomena, Cairncross (1997) wrote: 'More dramatic than the effect of falling transport prices on tangible goods will be the effect of falling communications costs on those intangible processes and products that can be distributed on-line.... The effects will come first in trade between businesses, such as data processing and business software. (Cairncross 1997, pp. 214–215)'

[2] See Marjit (2006) for discussion.

[3] Harris (1998) explored the ability of communications networks to remove barriers to

crucial role in economic activities in the world economy: if producers in one country fail to exploit differences in time zones, they may be excluded from the internationally connected network that is essential to certain types of trade. In other words, the neglect of time differences might work as a trade barrier for business services. The main purpose of this study is to illustrate, with a simple three-country model of monopolistic competition, how the utilization of time differences can affect the nature of trade patterns.

The next section presents the basic model. The nature of the trading equilibrium is considered in Section 3, followed by concluding remarks in Section 4.

## 2 The Model

In this model, there are three countries: Country 1, Country 2 and Country 3. Each country is endowed with $L$ units of labor, which is the only primary factor of production. The countries have identical technologies and the only differences are in time zones. There is no overlap in working hours: when Country 1's workday ends, Country 2's workday begins, and so on (See Figure 1). There are two consumption goods, Good $X$ and Good $Y$. Both goods are sold in perfectly competitive markets. Good $Y$ is produced under constant returns using only labor; units are chosen such that one unit of labor produces one unit of output.

Good $X$ is produced under constant returns using only differentiated business services as inputs. The production and the unit cost functions for Good $X$ are respectively:

$$X = \left( \sum_{i=1}^{n} x_i^{\rho} \right)^{1/\rho}, \quad 0 < \rho < 1, \tag{1}$$

$$C = \left( \sum_{i=1}^{n} p_i^{\rho/(\rho-1)} \right)^{(\rho-1)/\rho}, \tag{2}$$

where $n$ is the number of available business services, $x_i(p_i)$ is the quantity (price) of service $i$, and $\sigma \equiv 1/(1-\rho) > 1$ is the elasticity of substitution

the mobility of business services.

between every pair of services.[4] This production function has the property that as input differentiation increases, productivity rises.

Business services are supplied by monopolistically competitive *service firms*. Before starting production, $\alpha$ units of labor are required as a fixed cost of production. The central assumption is that each unit of a business service requires production in two stages: the second stage must start after the first stage has been completed. Each stage requires one unit of labor. Thus, if production occurs within a country, the cost function of the $i$-th service firm becomes

$$TC_i^A = \alpha + 2x_i, \quad i = 1, ..., n, \tag{3}$$

where superscript $A$ denotes the case of a 'communications autarky' (i.e., no outsourcing).

Given a Dixit-Stiglitz specification with constant elasticity $\sigma$, each service firm sets its price as

$$p^A = 2\sigma/(\sigma - 1). \tag{4}$$

With free entry and exit, the level of output that generates zero profits is given by

$$x^A = (\alpha/2)(\sigma - 1). \tag{5}$$

Alternatively, each firm can 'outsource' the second stage to the next country. In this case, each firm can complete its production earlier and reduce working hours: it is assumed that $1+\beta$ ($\beta < 1$) units of labor are required for one unit of service. This captures the idea that specialization in order to take advantage of time differences reduces marginal production costs.[5] Although we do not explicitly model the time aspect of production, this seems to be a reasonable assumption.[6]

Another important assumption is that outsourcing requires communications between the outsourcing country and the insourcing country via a

[4] This specification follows that of Ethier (1982). See, also, Kikuchi (2003).

[5] In what follows, we use 'outsourcing' and 'the utilization of time differences' interchangeably.

[6] In an alternative approach, Marjit (2006) incorporated a rate of discount due to delayed product completion.

communications network: each firm has to both send and receive its product via a network. To get on the network, each service firm has to pay a fixed fee ($\gamma$).[7] These assumptions are summarized in the following cost function:

$$TC_i^O = \alpha + \gamma + (1+\beta)x_i, \quad i = 1, ..., n, \tag{6}$$

where superscript $O$ denotes the case of 'outsourcing.' The costs of communicating across national borders can be offset by a lower marginal production cost.[8]

With outsourcing, each service firm sets its price as

$$p^O = [(2-\delta)\sigma]/(\sigma - 1), \tag{7}$$

where $\delta \equiv (1-\beta)$ represents the reduction in marginal costs. With free entry and exit, the level of output that generates zero profits is given by

$$x^O = [(\alpha+\gamma)/(2-\delta)](\sigma - 1). \tag{8}$$

Now consider the supply function of Good $X$. Under communications autarky, this supply function becomes

$$C^A = n^{1/(1-\sigma)}p^A = [p^A(x^A)^{1/\sigma}]X^{-1/\sigma}. \tag{9}$$

The curve $SS$, showing the above condition, is depicted in FIGURE 2(a). Note that this curve is truncated because labor endowments limit the number of service providers.

Alternatively, with outsourcing, the supply function becomes

$$C^O = n^{1/(1-\sigma)}p^O = [p^O(x^O)^{1/\sigma}]X^{-1/\sigma}. \tag{10}$$

[7] This implies ($a$) that there are aggregate constant returns in providing communications services, and ($b$) that the pricing of communications services is done on an average-cost basis. It may be natural to assume that the connection fee is a function of factors such as the number of users, market structure and so forth (See Harris, 1998). In this study, to make the model tractable, the assumptions about network technology are drastically simplified.

[8] Note that this correponds to Jones and Kierzkowski's (1990) concept of 'fragmentation.'

Comparing (9) and (10), one can obtain the relative cost of Good $X$.

$$RC \equiv \frac{C^O}{C^A} = \left(\frac{2-\delta}{\delta}\right)^{1-(1/\sigma)} \left(\frac{\alpha+\gamma}{\alpha}\right)^{1/\sigma}. \qquad (11)$$

This index captures important aspects of the utilization of time differences: while the reduced prices of services due to outsourcing have a positive effect, the reduced range of services due to additional fixed connection costs have a negative effect. The overall effects are determined by the tension between these two countervailing effects. Now it is possible to state the important conditions for outsourcing.

**Proposition 1:** *If $RC < 1$ holds, it is more profitable to outsource than to maintain a communications autarky.*

Before turning to the trading equilibrium, consider the situation in which there is no trade in goods or business services (i.e., no outsourcing). In this case, each country must produce all of the goods and services it will use, which means that the price of Good $X$ ($P$) must be equal to cost $C^A$. On the demand side, it is assumed that the representative consumer has Cobb-Douglas preferences over Good $X$ and Good $Y$, with share coefficients $\mu$ and $1-\mu$. Thus, $PX = \mu L$ must be satisfied: the curve $DD$, showing the above condition, is also depicted in FIGURE 2(a). Clearly the autarky equilibrium without outsourcing occurs at point $A$.

# 3 A Trading Equilibrium with Outsourcing

In this section, three countries are assumed to open their goods markets. Furthermore, the business service sectors in two countries (Country 1 and Country 2) are assumed to be connected while the third country is not connected. Let us call the former two countries 'connected countries.' These two countries can take advantage of time differences. Assume also that $RC < 1$ holds.

FIGURE 2 demonstrates how outsourcing affects the production structure of the world. FIGURE 2(a) shows the situation before outsourcing takes place, while 2(b) shows the situation afterward. The effect of using time difference is shown by the change in the supply curve. The extended curve $S'S'$ in FIGURE 2(b) reflects the enhanced division of labor between connected countries, while the curve for the third country remains unchanged. By taking into account a simple entry-exit process, connected counties will specialize in both Good $X$ and business services.

**Proposition 2:** *Comparative advantage in Good X is held by connected countries which can take advantage of time differences.*

Let us consider this more closely. In connected countries, the network provides opportunities for entry into the service sector because, with the increased division of labor due to outsourcing, the average cost of Good $X$ becomes lower and the export of Good $X$ is enhanced.[9] Thus, the size of connected countries' business service sectors will expand, while the size of the third country's service sector will shrink. The point is that there will be a *cumulative process* in which the increased connectivity via a network will enhance exports, and exports will enhance further specialization in the business service sector.

# 4 Concluding Remarks

This study highlights the role of time zones as a driving force behind trade. It is shown that a comparative advantage in the good provided using business services is held by the countries which are utilizing time differences and outsourcing (or insourcing) their production processes. Even more noteworthy is finding that there is a circular causation between increased connectivity via a network and trade creation.

[9] This is shown as a movement in the direction of the arrow along the curve $S'S'$ in FIGURE 2(b).

# References

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[5] Kikuchi, Toru (2003) 'Interconnectivity of Communications Networks and International Trade,' *Canadian Journal of Economics,* 36, pp. 155–167.

[6] Marjit, Sugata (2006) 'Trade Theory and the Role of Time Zones,' forthcoming in *International Review of Economics and Finance.*

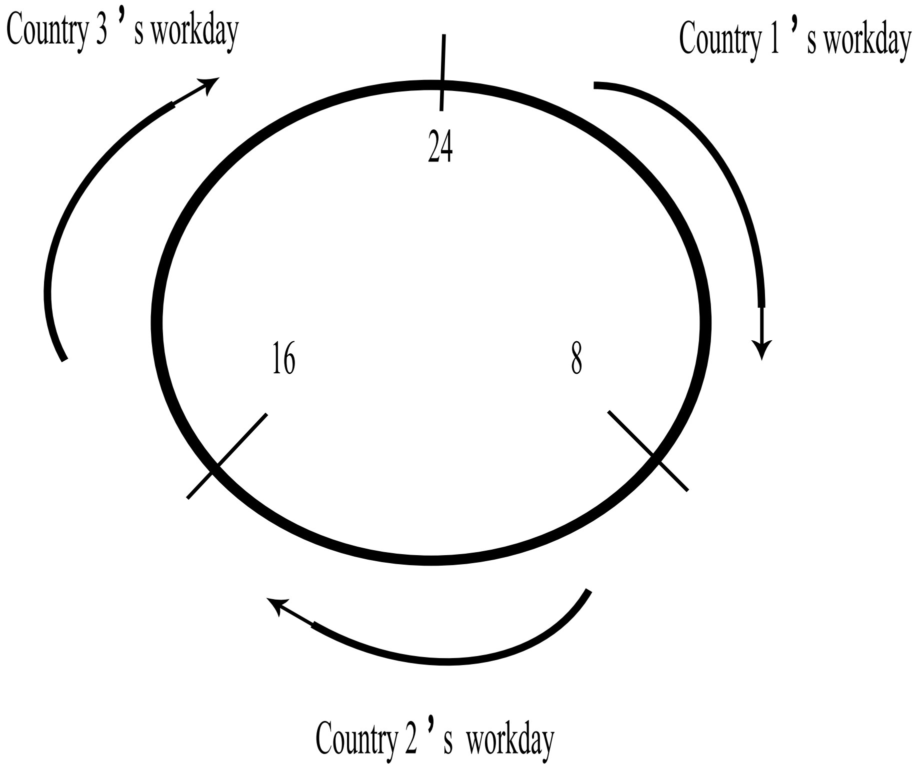
Country 3 ' s workday
Country 1 ' s workday
24
16
8
Country 2 ' s workday

Figure 1

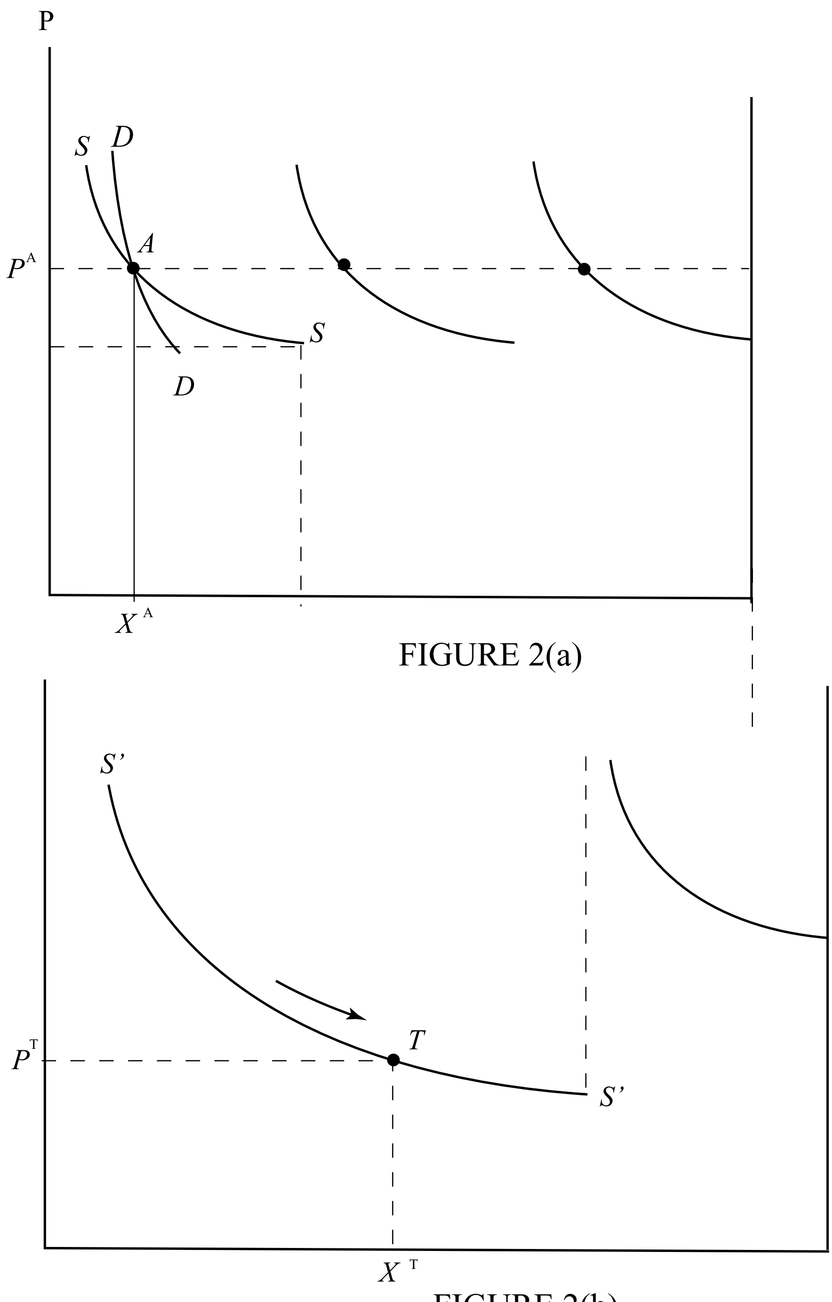


FIGURE 2(a)

FIGURE 2(b)