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Abstract

An important source of trade with time zone differences is related to the "coincidence in time" aspect of service transactions. Trade across different time zones is gainful when fulfilling nighttime demand in one time zone by utilizing daytime supply in another time zone. This note emphasizes that, due to communications revolutions, new versions of periodic intra-industry trade based on the differences in time zones emerge.

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1 Introduction

Service transactions are often characterized by the requirement that there be a *double coincidence in both time and space* of the proximity of the buyer to the seller.[1] The nonstorable nature of services implies that production and consumption tend to occur at the same time and in the same location.

However, the new types of communications networks (e.g., the Internet), at reasonably low cost, break the necessity for the buyer and the seller to be in the same location, even though the coincidence in time may not be broken.[2] It also creates opportunities to take advantage of differences in time zones. Usually, time zone differences add significantly to the costs of doing business across countries and have a negative impact on world trade flows.[3] Still, for some kinds of service transactions, the practice of spreading work across different time zones enables more efficient production. In a recent contribution, Marjit (2007) argues for the inclusion of time zone differences as a determinant of trade patterns.[4]

[1] Hill (1977).

[2] Harris (1998). Related to this, Long, Riezman and Soubeyran (2005) discuss the link between services provision and fragmentation.

[3] According to this point, Stein and Daude (2007) consider time differences in the context of the location of foreign direct investment. They found that transaction costs associated with time zone differences are important for frequent real-time communications between headquarters and their affiliates.

[4] Jones, Kierkowzki and Lurong (2005) and Kikuchi (2009) also emphasize the role of

An important source of trade with time zone differences is related to the "coincidence in time" aspect of service transactions. Trade across different time zones is gainful when *fulfilling nighttime demand in one time zone by utilizing daytime supply in another time zone.* In general, nighttime wage rates are higher than daytime wage rates. Thus, the utilization of communications devices makes it possible to take advantage of not only the international wage rate differences but also daytime/nighttime wage rate differences.

It is important to note that these kinds of service trade can be interpreted as new versions of *periodic intra-industry trade.*[5] Traditionally, trade in (perishable) agricultural products, electricity and similar goods has been based on predictable, periodic fluctuations in countries' production of, or demand for, these commodities. As for agricultural products, for example, the cycle is seasonal, based on the *differences in climatic zones.* This note emphasizes that, due to communications revolutions, similar kinds of trade based on the *differences in time zones* emerge.

The next section presents the basic model. In section 3, the impact of technological advance in communications networks is examined. Section 4 presents concluding remarks.

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different time zones.

[5]Grubel and Lloyd (1975).

2 The Model

Suppose that there are two countries, Home and Foreign. They are located in different time zones and there is no overlap in daily work hours: when Home's daytime work hours end, Foreign daytime work hours begin (Figure 1). Except for differences in time zones, these two countries are identical. In this section we concentrate on what happens in the Home market in the absence of international trade.

We assume that the distribution of consumers is uniform along a line of unit length $z \in [0, 1]$, and with no loss of generality, we normalize the total mass of Home consumers to equal 1. Each consumer is endowed with the amount E of income to be spent on differentiated services.

There are two competing categories of services: *daytime services*, which are provided by hiring daytime labor, and *nighttime services*, which are provided by hiring nighttime labor. A variety of differentiated services can be produced within either category. Each consumer is assumed to purchase services from only one category (daytime or nighttime). The utility of consumers is assumed to be increasing in the variety of complementary services available in a particular category. We define the utility of an individual of type z by

$$U(z) = (1 - z)C^D \text{ if the individual chooses daytime services, and}$$
$$U(z) = zC^N \text{ if the individual chooses nighttime services,} \tag{1}$$

where C^D (C^N) is the quantity index of daytime (nighttime) services. A higher z indicates a consumer with a stronger preference towards nighttime services (Figure 2).[6] Quantity indices are defined in the Dixit-Stiglitz form

$$C^k = \left[\sum_{i=1}^{m^k} (c_i^k)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad k = D,\ N, \tag{2}$$

where m^D (m^N) is the number of daytime (nighttime) services and $\sigma > 2$ is the elasticity of substitution between every pair of products *within the same category*. Price indices for each group of products, which indicate the cost of increasing the quantity index by one unit, are defined as follows:

$$P^k = \left[\sum_{i=1}^{m^k} (p_i^k)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} = (m^k)^{\frac{1}{1-\sigma}} p^k, \quad k = D,\ N. \tag{3}$$

Let us turn to the cost structure of differentiated services. In each group, differentiated services are provided by monopolistically competitive firms. One of the central assumptions is that each firm must be established and managed by an *entrepreneur*. We assume that there are M entrepreneurs in

[6]Note that the line in Figure 2 represents consumers' preferences toward each type of service and does not represent their working hours.

Home:

$$m^D + m^N = M.$$

Each entrepreneur has to decide what type of services to provide. There are two options: (1) hire Home daytime labor at wage rate w^D and provide a daytime service; or (2) hire Home nighttime labor at wage rate w^N and provide a nighttime service. To establish intra-day wage differences, we impose the following condition:

$$w^D < w^N. \tag{4}$$

We treat these wage rates as exogenous.

In order to simplify the analysis, we assume that the production of one unit of any service requires one unit of labor. Given a Dixit-Stiglitz specification with constant elasticity σ and a wage rate w^k ($k = D,\ N$), each firm in category k sets its price p^k as

$$p^k = \frac{\sigma w^k}{\sigma - 1}, \quad k = D,\ N. \tag{5}$$

From (4), the following holds:

$$p^D < p^N. \tag{6}$$

That is, due to intra-day wage differences, nighttime services are more expensive than daytime services. Then the operating profit of each type of service firm becomes:

$$\pi^k = \frac{w^k x^k}{\sigma - 1}, \quad k = D,\ N. \tag{7}$$

In the long run, there is no incentive for entrepreneurs to move from one category to another. Therefore, $\pi^D = \pi^N$ holds, and from (7), we can obtain the following condition:

$$w^D x^D = w^N x^N. \tag{8}$$

Let us denote the number of consumers who purchase daytime services as $\hat{z}$. Given $\hat{z}$, we can obtain the relative number of each category of services as follows:

$$\frac{m^D}{m^N} = \frac{\hat{z}}{1-\hat{z}}. \tag{9}$$

Now turn to the equilibrium number of consumers who purchase daytime/nighttime services. Using (1), $\hat{z}$ is derived as

$$\hat{z} = \frac{1}{1+\left(\frac{P^D}{P^N}\right)} = \frac{1}{1+\left(\frac{m^D}{m^N}\right)^{1/(1-\sigma)}\left(\frac{w^D}{w^N}\right)}. \tag{10}$$

Substituting (9) into (10), one can obtain the equilibrium proportion of consumers who purchase daytime services:

$$\frac{\hat{z}}{1-\hat{z}} = \left(\frac{w^D}{w^N}\right)^{-\frac{\sigma-1}{\sigma-2}}. \tag{11}$$

Combining (11) with (4), one can obtain an interesting result regarding the equilibrium share of daytime services without trade.

Proposition 1: *The equilibrium share of consumers who purchase daytime services is negatively related to the wage premium for the night shift.*

It is important to note that Proposition 1 is closely related to the concept of "indirect network effects" in the IO literature.[7] Since the prices of nighttime services are higher than those of daytime services, ceteris paribus, consumers prefer to purchase a daytime services bundle, which further reduces the market size for nighttime services.

3 The Impact of Technological Advances in Communications Networks

Now let us consider the impact of technological advances in communications networks. In our scenario, daytime (resp. nighttime) service firms in one country can provide (export) their services as nighttime (resp. daytime) services for the other country. Consumers can purchase both domestic services and imported services. Note that, at nighttime, if one country imports services which utilize the other country's daytime labor, the price of imported services is lower than the price of domestic nighttime services. This increases the attractiveness of a bundle of nighttime services.

In this case, Home's price indices for daytime/nighttime services become

$$\tilde{P}^D = (\tilde{m}^D)^{\frac{1}{1-\sigma}} p^D + (\tilde{m}^{*N})^{\frac{1}{1-\sigma}} p^{*N}, \quad (12)$$

$$\tilde{P}^N = (\tilde{m}^N)^{\frac{1}{1-\sigma}} p^N + (\tilde{m}^{*D})^{\frac{1}{1-\sigma}} p^{*D}, \quad (13)$$

[7]Chou and Shy (1990).

where "$\sim$" indicates a trading equilibrium value and "$*$" indicates values for Foreign.

Using (10), (12) and (13), one can obtain the condition for the equilibrium number of consumers who purchase daytime/nighttime services:

$$\tilde{z} = \frac{1}{1 + \left(\frac{\tilde{P}^D}{\tilde{P}^N}\right)} = \frac{1}{1 + \left(\frac{(\tilde{m}^D)^{\frac{1}{1-\sigma}} p^D + (\tilde{m}^{*N})^{\frac{1}{1-\sigma}} p^{*N}}{(\tilde{m}^N)^{\frac{1}{1-\sigma}} p^N + (\tilde{m}^{*D})^{\frac{1}{1-\sigma}} p^{*D}}\right)}. \tag{14}$$

From the pricing condition (5), it is clear that $p^D = p^{*D}$ and $p^N = p^{*N}$. Also, since these two countries are completely identical (except for time zones), there is symmetry in the trading equilibrium:

$$\frac{\tilde{m}^D}{\tilde{m}^N} = \frac{\tilde{m}^{*D}}{\tilde{m}^{*N}}. \tag{15}$$

Substituting (15) into (14), one can obtain $\tilde{z}$:

$$\tilde{z} = \frac{1}{2}. \tag{16}$$

Combining this with (9), the equilibrium number of each type of services can be obtained as follows:

$$\frac{\tilde{m}^D}{\tilde{m}^N} = \frac{\tilde{m}^{*D}}{\tilde{m}^{*N}} = 1. \tag{17}$$

Proposition 2: *In the trading equilibrium, half of the consumers purchase daytime services while the other half purchases nighttime services.*

As already noted, via trade liberalization (i.e., utilization of both communications networks and time zone differences), the relative attractiveness of a bundle of nighttime services becomes higher. So, some consumers begin to switch from purchasing daytime services to purchasing nighttime services: $\hat{z}$ decreases (Figure 2). From the entrepreneurs' perspective, this change implies an increase in the market size for nighttime services. Thus, some entrepreneurs begin to move from the daytime service sector toward the nighttime service sector: $\tilde{m}^N > m^N$.

It is important to note that, because of product differentiation, intra-industry trade in services occurs (Figure 3). For example, during Home's daytime (i.e., Foreign's nighttime), consumers in each country purchase both countries' services: Home daytime services and Foreign nighttime services. Since Home service providers have a cost advantage over their Foreign competitors ($w^D < w^{*N}$), Home becomes a *net exporter* of service during its daytime. On the other hand, during Home's nighttime (i.e., Foreign's daytime), Foreign becomes a net exporter of services. Thus, due to communications breakthroughs, periodic intra-industry trade occurs across countries.

4 Concluding Remarks

This study highlights the role of cross-border communications benefiting from time zone differentials as a driving force behind trade in services. It is shown that, by utilizing both communications networks and time zone differences, some entrepreneurs in one country change from being daytime service providers to being nighttime service providers.

Although these results are derived under the assumption that two countries are identical except for differences in time zones, it appears that something similar to this will occur in more general settings. The present analysis must be regarded as very tentative. Hopefully, it provides a useful paradigm for the consideration of how time zone differences work as a driving force for international trade.

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Figure 1: Work Hours

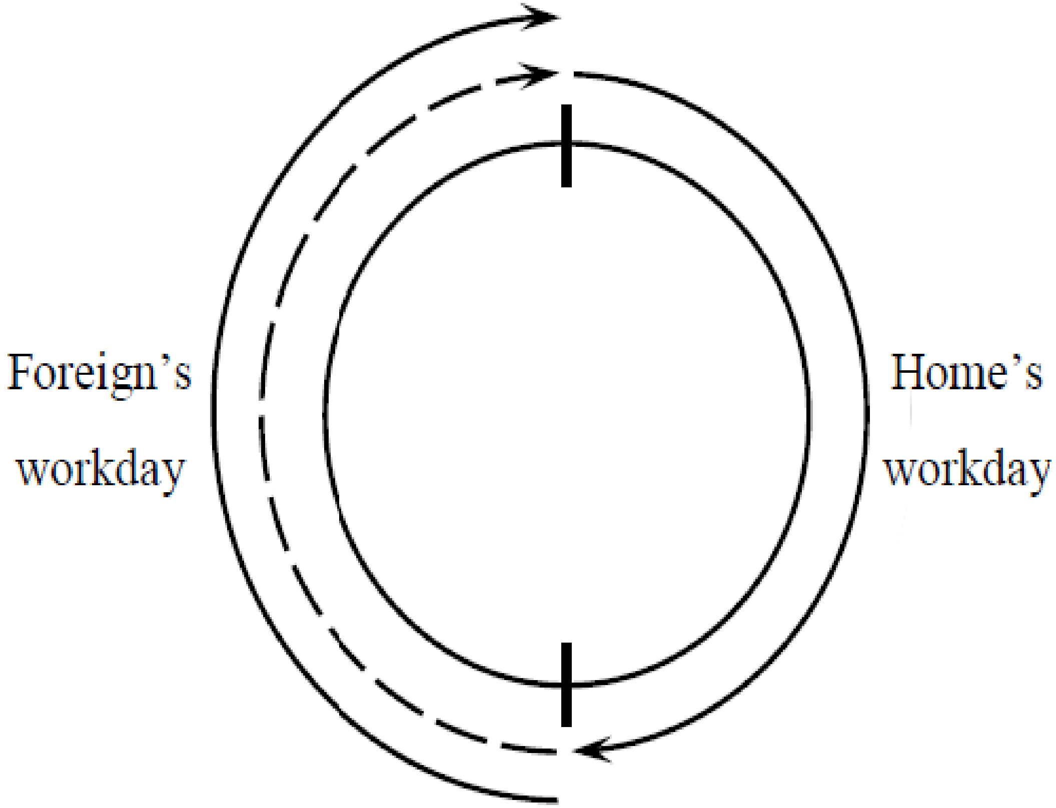

Figure 2: The Impact of Trade

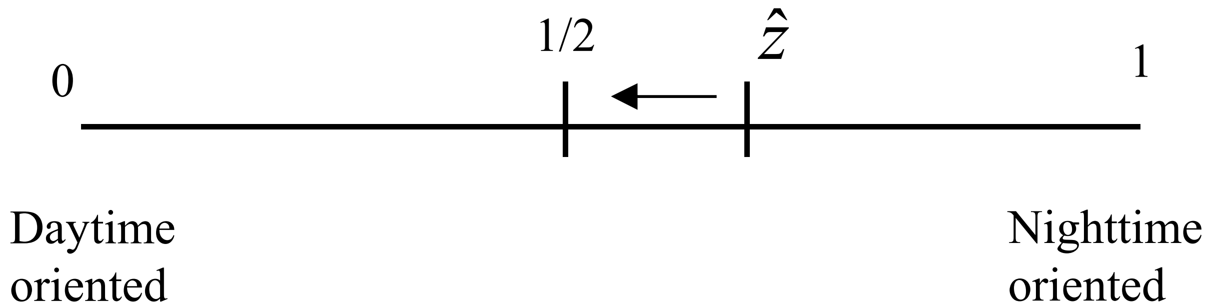

Figure 3: Trade Patterns