Trade with Time Zone Differences: Factor Market Implications

Kikuchi, Toru and Marjit, Sugata and Mandal, Biswajit

Graduate School of Economics, Kobe University, Kobe, Japan, Centre for Studies in Social Sciences, Calcutta, India, Visva-Bharati University, Santiniketan, India

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Toru Kikuchi

Graduate School of Economics, Kobe University, Kobe, Japan

Sugata Marjit

Centre for Studies in Social Sciences, Calcutta, India

Biswajit Mandal

Visva-Bharati University, Santiniketan, India

Address for Correspondence

Sugata Marjit

Centre for Studies in Social Sciences

R-1 Baishnabghata Patuli Township

Kolkata-91

India

E-mail: smarjit@hotmail.com

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Abstract

The main purpose of this study is to illustrate, with a simple two-factor (skilled and unskilled labor) model, how a time-saving improvement in business-services trade benefitting from differences in time zones can have an impact on national factor markets. In doing so, we intend to capture the situation where the night-shift work in one country is replaced by the day-shift work in another country. In other words, we will show that, trade with time zone differences will result in shifts of the relative supplies and demands for skilled labor around the globe.

1. Introduction

In recent decades, trade in many kinds of intermediate goods and services has increased between developed and developing countries. Trade in intermediate goods has been in the core of economic research for a long time, but trade in intermediate service has occupied the front seat in economics literature in the recent past. There is no denying the fact that abundant supply of skilled urban workforce influences the pattern of trade in intermediate service which really does not require physical relocation of labor. Accordingly, offshoring of business services such as engineering, consultancy, software development, call centres, health care industry, electronic industry, online school of languages, media, hospitality industry etc, which do not need physical shipment of products, plays a major role in today's world trade. The availability of the global high-bandwidth network infrastructure has increased the feasibility of reducing costs by going offshore.

In addition difference in time zones has acted as a catalyst to *"virtual trade"* in intermediate services. Massive reduction in cost of information communication technology coupled with advantage of time zones differences between countries have invited new types of business-service trade. The semiconductor industry provides a prime example. According to Gupta and Seshasai (2004):[1]

> ...by involving specialized microchip design engineers located at multiple places around the world, a semiconductor chip design firm may create virtual "24-hour knowledge factories."... It provides the firm with access to high-talent designers who would otherwise have to move to a different country, or work at odd hours of the night... The creation of professional service teams that transcend geographic and temporal boundaries offers the potential to change the face of many industries.

As Gupta and Seshasai suggested, the creation of virtual "24-hour knowledge factory" seems to have a huge impact on production and trade structures.

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[1] See, also, Zaheer (2000), Gupta and Seshasai (2007) and Brown and Linden (2009).

Following Deardorf (2003), Marjit (2007) a voluminous literature has emerged in the past couple of years to corroborate such claim. Notable among them are Do and Long (2008), Grossman and Rossi-Hansberg (2008), Kikuchi and Marjit (2011), Matuoka and Fukushima (2010) etc. Marjit (2007) examined the role of international time zone differences in a one-factor, two-country vertically integrated Ricardian framework, where production process can be divided into two stages[2]. It has been shown in Marjit (2007) that, by utilizing time zone differences, two countries can save time via input trade and obtain mutual trade gains. It is important to note that the sources of trade gains are the realization of the quick delivery of time-sensitive products[3].

Our work is almost in line of Matsuoka and Fukushima (2010) that focuses on firm's decision regarding choice between in-house production and outsourcing. They have considered Krugman (1981) kind of structure where intermediate input can be differentiated. In this circumstances the paper emphasized on consumers' choice among day-shift and night-shift work where welfare largely depends on aggregate price index and hence on real wage. Nevertheless there are some important issues that immediately arise from the relationship between time zone differences and trade in business services: impact on factor markets, relative wage distribution, allocation of labor betwweb day-shift and night-shift work. These are not taken into account in Matsuoka and Fukushima (2010). The current paper tries to fill up this caveat.

Based on casual empiricism, we believe that time-saving technological improvement (e.g., the utilization of communications networks such as the Internet) can

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[2] Findlay (1978), Dixit and Grossman (1982), Sanyal (1983), Sarkar (1985), Marjit (1987), Kohler (2004a) and Grossman and Rossi-Hansberg (2008) are important contributions toward formalizing trade under multi-stage production. The concept of multi-stage production is closely related to the concept of fragmentation, which has been studied within a trade-theoretic framework by Jones and Kierzkowski (1990), Jones and Marjit (2001, 2009), Deardorff (2001), Kohler (2004b), Long, Riezman and Soubeyran (2005) and Do and Long (2008).

[3] For the reasons of importance of quick delivery of time-sensitive products, see, Hummels (2001), Deardorff (2003), and Kikuchi and Marjit (2011).

trigger a series of events that leads to a country-wide decline in night-shift work[4,5]. In the existing trade literature, however, relatively few attempts have been made to address the effect of trade with time zone differences on labor markets[6]. The main purpose of this study is to illustrate, with a simple two-factor (skilled labor and unskilled labor) trade model, how a time-saving improvement in business-services trade benefitting from differences in time zones can have an impact on national factor markets.

In a broader sense our work is also connected with the literature on global supply chains, formation of team world-wide and production etc. Antras et al (2006), Costinot et al (2012), Harms et al (2012) are some recent initiatives in this strand of papers. Antras et al (2006) talks about how the effect of globalization on organization of work, distribution of firms, wage distribution significantly depends on communication cost if agents of different countries are allowed to work together. Harms et al (2012), a bit in contradiction with the standard literature, claims why the relationship between communication cost and pattern of outsourcing is not always straight forward. Their arguments are based on the advantage of transporting final goods compared to intermediate goods. Whereas Costinot et al (2012) introduces the probability of making mistakes along the vertical stages of production to conclude that an efficient firm should specialize in the later stage of production. In a sense this theory can easily be extended for time-zone, skill differentiation and trade literature. Dettmer (2012) and Anderson (2012) are two recent empirical attempts to focus on the role of time zones on trade. Both these papers use Gravity model of model. Dettmer (2012) argues that time zone costs for cross-border services trade are significantly dependent on the ICT

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[4] For example, Hamermesh (1999) found a sharp decline in the proportion of evening and night work in the U. S. over the last twenty years.

[5] Here it is noteworthy that in developing countries like India still we find night-shift office in parallel with USA's day shift. The reasons are two pronged: a major chunk of skilled, english savvy youth do not find job in day shift work and hence are forced to try their luck in night shift where wage rate is high compared to India's day-shift unskilled wage but lower than day-shift skilled wage; this is also profitable for US companies as wage is much less compared to US market.

[6] A notable exception is Matsuoka and Fukushima (2010).

network. In order to save time firms export business services to countries in significant distant time zones when information and communication technologies infrastructure networks allow for doing so. On the other hand Anderson (2012) finds that time differences had a significant negative impact on overall trade, at least until recently. His arguments are two pronged: the negative impact of time differences is smaller where travel and communication would be expected to be less important for trade; time differences reduce communication flows, as measured by bilateral telephone traffic. He however points out that the negative impact of time differences on trade does appear to have fallen substantially in recent decades.

Our study is closely related to the literature on the role of the Internet on factor markets. In his seminal contribution, Harris (1998) developed a two-sector model in which the introduction of the Internet creates "virtual mobility" of skilled labor. He showed that the wage premium for skilled labor increases by introducing the Internet. His results are crucially dependent on the assumption of the increasing-returns-to-scale technology. Contrary to that, we will show that the increased wage premium for skilled labor occurs even under constant-returns-to-scale technology[7].

The rest of the paper is structured as follows. The next section presents the basic model. In section 3, the impact of technological advance in communications networks is examined. Section 4 talks about wage inequality. Section 5 presents concluding remarks.

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[7] One may argue whether there is any empirical evidence in support of the claim that skilled labors are benefitted compared to unskilled one. India's IT industry is a prime example of such story where english savvy, computer literate, specialized youths work for any foreign company without moving abroad. The most skilled group works in day-shift, and relatively mid-skilled group works in night-shift in tandem with foreign's day-shift. Both day and night-shift works in India are cost effective since wage rate is relatively low. NASSCOM study reveals that all these workers are regarded as either skilled (post-graduates, engineers, science graduates) or medium-skilled (arts, commerce and other graduates) workers. 22% of total employment goes to the skilled group whereas remaining 78% employees belong to the medium-skilled group. These workers are specific to certain work and get a good salary and hence they do not generally switch to other manufacturing sectors where the return is comparatively low. Thus all sectors other than IT and BPO (business process outsourcing) are naturally susceptible to any boom of IT industry that primarily depends on outsourced work.

2. The Model

We have two small open economies, Home and Foreign, and the Rest-of the-World (ROW), which endowed with skilled and unskilled labor. These countries can produce the knowledge-intensive good X and the traditional good . We assume that the price of X and , P_X and P_Y are determined in the ROW and are beyond control of the countries we deal with. Markets are competitive and open every 24 hours. The central assumption is that one day (24 hours) is divided into *two periods*: day-shift working hours and night-shift working hours, both of which are 12 hours. Home and Foreign are located in different time zones and there is no overlap in daily working hours: when Home's day-shift working hours end, Foreign day-shift working hours begin. Except for time zone differences, these two countries are identical in terms of technology and factor endowments.

Production of Y is instantaneous in the sense that one unit of Y can be produced within day-shift working hours. Unskilled labor is a factor input specific to : the Y sector is a competitive constant returns industry using unskilled and skilled labor, with a production function

$$Y = F(L, \ S_Y) \tag{1}$$

where L is the total amount of unskilled labor, while S_Y denotes the employment level of skilled labor in the Y sector.

Following Marjit (2007), we posit that the production of the knowledge intensive good X necessarily involves two stages. Thus, to produce the good X, skilled labor has to be applied continuously for two periods. At the end of the first period some goods-in-process are obtained and additional labor is applied to these goods in process in the second period. As noted above, the key assumption is that each day is divided into two periods. Thus, if a producer of good X utilizes day-shift and night-shift skilled labor services continuously, a whole day is required for the preparation.

2.1 Communication Autarky

First, let us consider the equilibrium conditions under communications autarky (i.e., without communications networks). The technology of the knowledge- intensive good X is simplified by assuming that at each stage only one unit of skilled labor goes into the unit production process. We assume that each skilled worker has to choose whether day-shift work or night-shift work. To establish intra-day wage differences for skilled labor, we impose the following condition:

$$v^N = (1 + \theta)v^D, \quad \theta \geq 0 \tag{2}$$

where θ, which is given as exogenous, reflects the degree of dissatisfaction from night-shift work, and v^D (resp. v^N) is the wage rate for skilled labor working at day (resp. night), respectively[8]. Hence

$$v^N \geq v^D \ .$$

This phenomenon is typical in a job market. People do not generally prefer working at night because of several reasons (see Eels (1956), Kostiuk (1990), Lanfranchi et al (2002) for details). Hence a higher wage rate acts as a booster to induce people to work at night. This is true for similarly skilled workers. However, the medium-skilled workers may be happy with a wage rate less than that of skilled workers. This is precisely because of disutility of working in the night-shift.

Y has a standard downward sloping demand for skilled labor following usual first order condition. Return to skilled labor is denoted by

$$v^D = P_Y \, F_S(L, S_Y) \tag{3}[9]$$

On the other hand X uses only skilled labor with a constant productivity $\frac{1}{2+\theta}$ implying a flat labor demand function. Therefore, v^D in X is determined as

$$v^D = \frac{P_X}{2+\theta} \tag{4}$$

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[8] Hamermesh (1999) developed a model in which the value of positive θ is endogenously determined for workers' undesirable hours.

[9] Unskilled wage $W = P_Y \, F_L(L, S_Y)$. What we have here is a combination of Ricardian and Specific Factor structure.

Equation (3) and (4) determine the equilibrium allocation of skilled labor S_Y following condition

$$\frac{P_X}{P_Y} = \frac{F_S(L, S_Y)}{\left(\frac{1}{2+\theta}\right)} \tag{5}$$

Factor market clearing requires that

$$S_X^D + S_X^N + S_Y = S \tag{6}$$

where, S_X^D (resp. S_X^N) is the employment level of day (resp. night) shift labor in X, and S is the total endowment of skilled labor.

Note that in equilibrium the day-shift wage rate in the X sector must be equalized to the wage rate for (day-shift) skilled labor in the Y sector. Mobility of skilled workers between X and Y guarantees this equality.

To produce one unit of X, both one unit of day-shift skilled labor service and one unit of night shift skilled labor service must be applied. As we have mentioned before, night-shift work indicates some sort of dissatisfaction denoted by θ. This jacks up the night wage rate and hence the cost of production. Thus one can obtain the unit cost of the good X under communication autarky as (where C_{AUT} represents cost in communication autarky)

$$C_{AUT} = v^N + v^D$$
$$C_{AUT} = (2 + \theta)v^D \tag{7}$$

Since X is competitive

$$P_X = C_{AUT} = (2 + \theta)v^D \tag{8}$$

However, the question that naturally comes into the analysis is: why does not the economy or sector X try to avoid the dissatisfaction of night-shift work. This can be done by waiting and storing the half finished product until next day. This is called 'idle night organization mode' of production. This phenomenon may also attract some extra cost in form of 'real interest rate' or 'waiting decay'. This is in line with Marjit (2007). Real interest rate is denoted by r (per diem) which has to be borne by producers as each worker needs to be paid v^D as their daily wage. Labor will not work at any wage rate less than v^D since it is his 'outside option'. On the other side 'waiting decay' is a mere

reflection of consumers' preference, *per se*. Consumers want to get the product early. They value the product less if delivered a day later. Producers see this behavior as one where some amount of product is lost that requires to be replenished by adding some more labor or labor cost. This is denoted by δ (say). Hence the zero profit condition for X becomes

$$P_X = v^D(1+\delta)(1+r) + v^D \quad \text{(where } r, \delta > 0) \qquad (9)^{10}$$

Comparing (8) and (9) 'night-shift mode' would be preferred over 'idle night organization mode' iff

$$(2+\theta)v^D < \{v^D(1+\delta)(1+r) + v^D\}$$
$$\text{Or, } \theta < \{\delta + (1+\delta)r\} \qquad (10)$$

If (10) holds true, the economy opts for 'night-shift mode'. If for some reason, however, real interest rate per diem (r) or δ fall significantly, producers may switch to 'idle night organization mode' of production.

A closer inspection of (8) and (9) reveals that for a closed and small economy framework wage rates for skilled workers would be different under two different modes of organizations described above.

For 'night-shift mode' $\quad v_{NS}^D = \frac{P_X}{2+\theta}$ $\qquad (11)$

For 'idle night organization mode' $\quad v_{IN}^D = \frac{P_X}{2+\delta+r+\delta r}$ $\qquad (12)$

$v_{NS}^D \Rightarrow$ skilled wage rate when night shift is used; $v_{IN}^D \Rightarrow$ skilled wage rate when night shift is not used.

Under condition (10), $v_{NS}^D > v_{IN}^D$ as P_X is given from small country assumption.

We now proceed to determine the equilibrium values under communications autarky (see Figure-1). In Figure-1 the two vertical axes measure the wage rate for skilled labor and the horizontal axis measures the total endowment of skilled labor, S.

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[10] However, there is another way of looking at the same issue. If we exactly follow Marjit (2007), the concern of time preference, denoted by , should affect the return to skilled wage on both days. In fact time preference acts as discount factor for commodity price P_X. Equation (9) would be modified as $P_X = v^D(1+\delta)(1+r) + v^D(1+\delta)$. Then 'night-shift' would be preferred over 'idle night organization mode' iff $(2+\theta)v^D < \{v^D(1+\delta)(1+r) + v^D(1+\delta)\}$ or, $\theta < \{2\delta + (1+\delta)r\}$. Under this situation $v_{IN}^D = \frac{P_X}{(1+\delta)(2+r)}$. Notice that, even if one uses this argument our results will not change significantly.

Given the fixed endowment of unskilled labor, one can draw a downward-sloping marginal productivity schedule for skilled labor used in Y, from the left-hand origin and that in the knowledge-intensive X sector from the right-hand origin. Let us take the traditional good Y as the numeraire with its price equal to unity and start with exogenously given price P_X. Then the day-shift wage rate for skilled labor is determined from (8). Given this day-shift wage rate for skilled labor, we can determine the
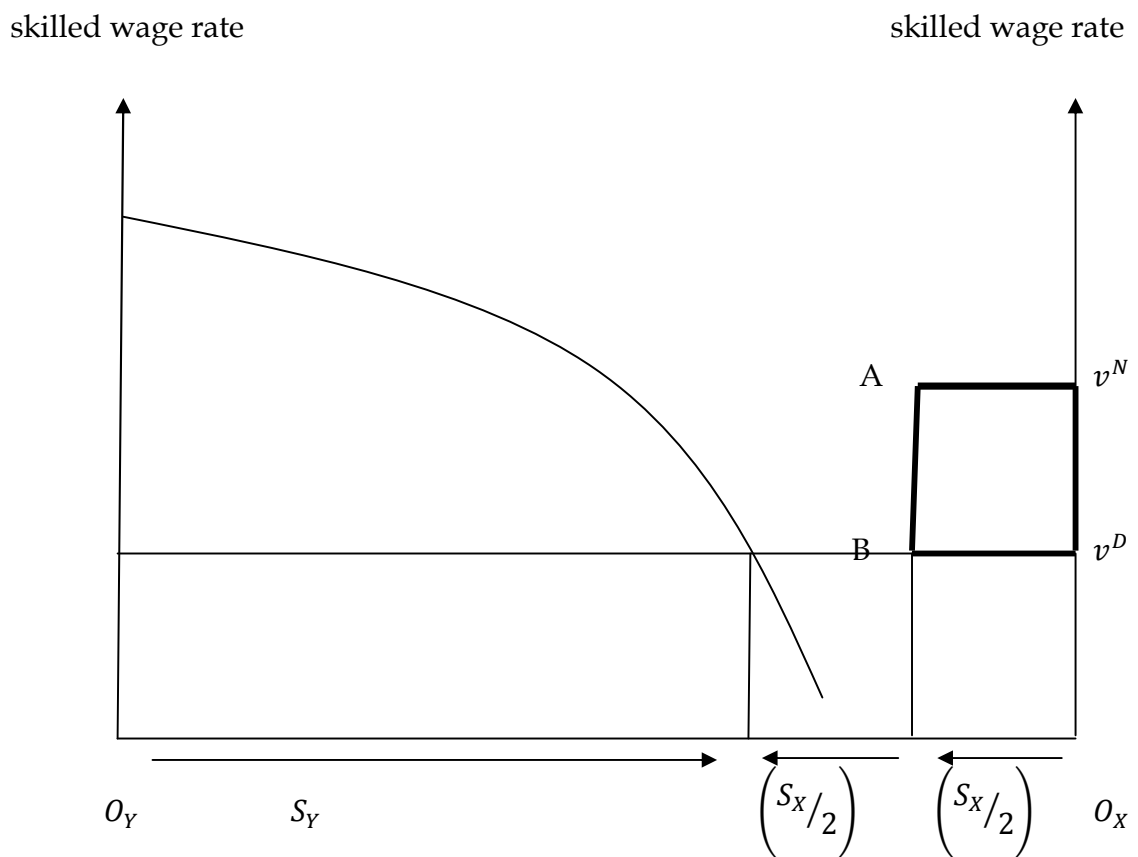

Figure-1: Communication Autarky

employment levels S_X and S_Y in the two sectors: $S_X/2$ is employed as day-shift skilled worker while the rest $S_X/2$ is employed as night-shift skilled worker. Shaded rectangle

indicates the total additional payments for the night-shift workers, $\theta v^D S_X^N$ (the area named as $ABv^D v^N$).

3. Trade and Technological Advancement

In the structure developed in the last section when country is opened up for trade another possibility comes into play: vertical production sharing with other country. Here we consider only those countries who are not in the same time-zone with the country concerned[11]. More specifically we are interested about those countries where time-zones are exactly opposite. This allows for some kind of gain through both removing night-shift dissatisfaction of work and cost of idle night organization mode. This, however, comes with some costs. Realistically we assume that vertical product sharing requires some trading or communication cost at the rate τ. The present study focuses only on communication cost[12]. Let it be of ice-berg variety[13].

In our scenario, via communications networks, product-in-process at the end of one country's daytime will be sent to the other country and day-shift skilled labor will be applied. There are three possible cases[14]: (*a*) Home specializes in the first stage while Foreign specializes in the second stage, (*b*) Foreign specializes in the first stage while Home specializes in the second stage, and (*c*) in each country, half of the workers in the *X* sector work in the first stage, while the rest half work in the second stage. Although trade patterns are different in each case, factor market implications are qualitatively

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[11] Presence of slightly different time-zones is an important prospect in this connection. In order to focus on that, we need to move gradually from overlapping to non-overlapping time-zones. Then the functions would reflect some sort of continuity. This is, of course, an interesting dimension of the analysis. We are, however, intentionally abstaining ourselves from such concerns. If time zones are not substantially separated such trade may not take place.

[12] Physical cost of trade due to distance is one of the major hindrances to trade in goods. This acts as an important impediment to trade in services too. For details see Head et al (2009).

[13] An interesting reference in this connection is Marjit and Mandal (2012).

[14] According to the indeterminacy of trade patterns with time zone differences, see Marjit (2007).

same (i.e., the employment level of the day-shift skilled labor in the X sector will be the same among three cases). Thus, we concentrate on the first case (a).

Taking clue from (10) vertical product sharing or vertical trade (virtual in nature) would be chosen if

$$(2 + \tau) < (2 + \theta) \qquad (13)^{[15, 16]}$$

And the skilled wage rate would be

$$v_{NT}^D = \frac{P_X}{2+\tau} \qquad (14)$$

$v_{NT}^D \Rightarrow$ skilled wage rate when network technology comes with cost at the rate τ.

To focus in the central point of the paper we consider that $v_{NT}^D \leq v_{NS}^D$. This will help us to concentrate on the effects of technological advancement.

3.1   Implications for Factor Returns

Assume that technological advancement in communication network takes place. This advancement reduces the trade cost τ as well as labor cost to produce the knowledge-intensive good: now any country does not have to utilize night-shift workers. In this case, since technology is identical among countries, production technology exhibits as if the same day-shift wage rate $\tilde{v}^D$ will be applied two-times along with reduced trade cost. Say the reduced trade cost is τ_1 such that $\tau_1 < \tau$. The unit cost with communication network can be written as (where C_{NT} represents cost with communication network advancement)

$$C_{NT} = (2 + \tau_1)\tilde{v}^D \qquad (15)$$

In this case the equilibrium wage rate for day-shift skilled workers $\tilde{v}^D$ is determined from the condition that $P_X = C_{NT}$. Hence

$$\tilde{v}^D = \frac{P_X}{(2+\tau_1)} \qquad (16)$$

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[15] In a sense, the country buying the half-.finished product needs to indebt itself and hence have to pay back more than the equivalent of v^D, if we consider a positive interest rate. In this circumstance, we may think of generalizing this model to encompass a broader notion such as half years, or seasons, where the idea of a positive interest rate would be more befitting. We thank the referee for pointing out this.

[16] Assume $(2 + \theta) < \{(1 + \delta)(1 + r) + 1\}$ such that we start from "night-shift mode'.

If $\tau_1 < \theta$ then $\tilde{v}^D > v^D$. It is further apparent from (11) and (16), for a negligible or sufficiently small τ_1 (if cost of communication falls significantly) $\tilde{v}_{NS}^D$ is likely to be higher than v_{NS}^D. But there will be no night-shift work in service sector.

The impact of technological advancement is represented in Figure-2, which compares the communications autarky equilibrium (point M) and the one with communications networks (point N). The impact can be interpreted as if the disutility from night-shift labor supply, θ, vanishes whereas the reduced communication cost comes in[17]. When $\tau_1 < \theta$, this raises the day shift skilled wage and increases the resources devoted to the X sector: the new equilibrium is depicted as point N in Figure-2. At the same time, the wage of unskilled labor is reduced as skilled labor is pulled out of the Y sector as a consequence of the 'time zone difference' effects of communications networks. The present model predicts an increase in wages of day-shift skilled labor, a decrease in unskilled wages and an increase in the skill premium as a result of this particular form of technological advancement[18]. It is important to note that the sources of these changes can be divided into: (1) switching from the night-shift work toward the day-shift work within the X sector, and (2) inter-sectoral labor reallocation due to utilization of time zone differences. The second point needs further comments. Since the night-shift work bears significant additional costs for workers, it is costly to produce good X under communications autarky. Utilization of time zone differences, however, removes these additional costs and it becomes more comfortable to work in sector X.[19] This induces more skilled worker to choose to work at that sector.

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[17] According to the impact of utilization of time zone differences, Zaheer (2000) emphasizes the productivity gains from the entrainment or synchronization of individual circadian rhythms, the social rhythms, and work rhythms.

[18] Harris (1998) emphasizes this kind of impact of the introduction of communications networks on labor markets.

[19] Nevertheless, we should not forget that communication also requires certain amount of cost, whatever small it may be. For brevity we can assume it to be zero.
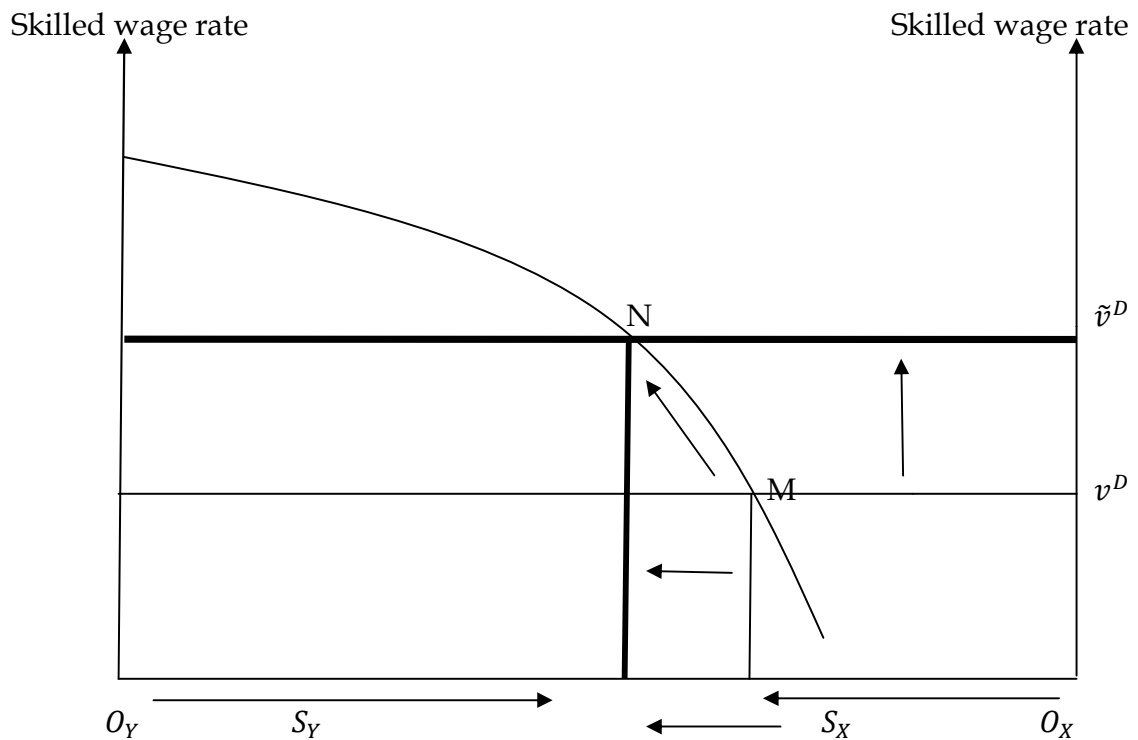
Skilled wage rate   Skilled wage rate

Figure-2: Technological Advancement

It must also be emphasized that the utilization of time zone differences can be interpreted as a creation of "virtually connected good *X* sector between countries," where "24-hour knowledge factories" operate[20]. These changes result in an increase in relative demands (and therefore supplies) for day-shift skilled labor around the globe.

Proposition 1: *Due to a technological advance in communications networks, there is an increase in wages to day-shift skilled labor, while a decrease in unskilled wages for both countries.*

Let us briefly compare the present results with Harris's (1998). Based on increasing-returns-to-scale technology, Harris has shown that the introduction of communications networks raises the wage premium for skilled labor. Sources of these changes are the realization of aggregate returns to scale via Smithian division of labor.

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[20] Gupta and Seshasai (2004, 2007).

Contrary to that, the present results derived from constant-returns-to-scale technology: increased productivity simply arises from utilization of time zone differences (i.e., avoidance of the night-shift work)[21].

Next, let us consider trade gains. The effect on national income of each country is unambiguously positive provided that skilled wage increases. The national income is equal to factor income given by $(wL + vS)$. The increase in returns to skilled labor are more than offset by the losses to unskilled labor. If trade with time zone differences raises skilled wages, it will undoubtedly raise aggregate real income and productivity.

Proposition 2: *If shipment cost of goods-in-process is negligible, there are always gains from trade across different time zones.*

Proof: Consider any one of the countries. They are small so P_X, r etc are frozen. But trade must be balanced: $P\,D_X + D_Y = P\,X(S_X,\ \tau > \theta) + Y(\bar{S} - S_X, L)$ where P represents the relative price of X and D stands for demand for goods. τ is the initial communication cost. Now we wish to look at the change in welfare due to a fall in τ. Change in welfare is denoted by $\left(P\,\dfrac{dD_X}{d\tau} + \dfrac{dD_Y}{d\tau}\right)$. Hence

$$P\,\frac{dD_X}{d\tau} + \frac{dD_Y}{d\tau} = P\,\frac{dX}{d\tau} + \frac{dY}{d\tau} = \left(P\,\frac{\delta X}{\delta S_X} + \frac{\delta Y}{\delta S_X}\right)\frac{\delta S_X}{\delta \tau} + P\,\frac{\delta X}{\delta \tau}$$

$\left(P\,\dfrac{\delta X}{\delta S_X} + \dfrac{\delta Y}{\delta S_X}\right)$ =0 due to envelope condition. Thus welfare change is precisely shown by $P\,\dfrac{\delta X}{\delta \tau}$ which essentially implies a discrete change from $\dfrac{S_0}{2+\theta}$ to $\dfrac{S_1}{2+\tau_1}$. S_0 and S_1 signify skilled-labor employment in X without and with communication network, respectively. It is explicit from previous analysis that $S_1 > S_0$ and $\tau_1 < \theta$. Hence $P\,\dfrac{\delta X}{\delta \tau} > 0$ and welfare increases unambiguously due to a decrease in communication cost.

According to trade patterns, in particular case (*a*), at the end of Home's day-shift working hours, all goods-in-process (i.e., stage 1 products) is exported to Foreign. Similarly, at the end of Foreign's day-shift working hours, all goods-in-process is

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[21] See Marjit (2007) on this point.

exported to Home[22]. Thus, due to communications breakthroughs, *intra-industry trade with time zone differences* occurs across countries. These kinds of trade with time zone differences can be interpreted as new versions of *periodic intra-industry trade* or *virtual intra-industry trade.*[23] Traditionally, trade in perishable agricultural products, electricity and similar goods have been based on predictable, periodic fluctuation 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.* The present study emphasizes that, due to communications revolutions similar kinds of trade based on time zone differences can also be emerged.

4. Two Sided Wage Inequality

Note that in our model in each country the wage ratio of skilled to unskilled workers increases, an outcome that has eluded the standard Heckscher-Ohlin-Samuelson model. Typical trade pattern allows only for asymmetric change as the South exports more labor-intensive goods. Trade may actually reduce wage inequality in the South which it has not. Interesting work on two-sided wage inequality both in the North and the South includes Feenstra and Hanson (1996), Davis (1998), Marjit and Acharyya(2006) and Marjit and Kar (2009). However, that trade across time zones as a natural catalyst in the process has never been explored. It is possible that the time zone advantage may not be restricted only to the skilled people. Therefore, it may not be always the case that such trade helps only skilled labor. But it is very likely that communication costs are likely to be much lower in virtual environment, and it is also well recognized that only educated workforce can utilize this technology more efficiently. Business process outsourcing necessarily involves skills of some category.

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[22] If one considers the value of traded goods and/or services the explanation would be slightly modified as one exports half-finished good and imports finished good. Nevertheless, the main message of this paper would remain essentially same.

[23] Grubel and Lloyd (1975).

Hence the assumption of the model is quite close to reality. It will be definitely interesting to empirically test this phenomenon.

5. Concluding Remarks

This study highlights the role of business-services trade benefiting from time zone differentials and its impact on national factor markets. It is shown that an acceleration in intermediate business-services trade involving production in two time zones can have a huge impact on factor markets: switching from the night-shift work towards the day-shift work and an increased wage premium for skilled labor. Even more noteworthy is the finding that, via increased specialization, aggregate real income will be increased by trade with time zone differences. Although these results are derived under the specific assumptions that markets are perfectly competitive and the dissatisfaction from night-shift work is exogenously given. A much richer model can be framed by introducing asymmetric countries regarding population size, marginal productivities, differing values of discount factor, gradual movement from overlapping to non-overlapping time-zones etc. A more realistic model should include all such issues and it appears that a more general setting would also yield similar results.

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