Eurasian Journal of Economics and Finance, 5(3), 2017, 1-16
DOI: 10.15604/ejef.2017.05.03.001

EURASIAN JOURNAL OF ECONOMICS AND FINANCE

www.eurasianpublications.com

TIME ZONE DIFFERENCE, COMPARATIVE ADVANTAGE AND TRADE: A REVIEW OF LITERATURE[1]

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Abstract

With the growing development in communication technology and increased fragmentation of production process, services that were once considered non-tradable can now be traded across different nations. In this respect, trading countries located in different time zones of the world with non-overlapping working hours are able to develop a comparative advantage together for the supply of these services. Disintegrating the production of a service across different time zones can allow the production to be completed efficiently and make the product available in the market meeting consumer demand in a timely fashion. In this paper, we have reviewed some of important research that has been conducted in the area of time zone differences and trade. This type of trade further affects the factor market and production patterns of the involved countries and has also been significant for their growth and welfare.

Keywords: Comparative Advantage, Time Zone, Service, Trade

1. Introduction

Standard theories of international trade primarily try to explain the sources of trade between two countries, the patterns of trade and finally whether the trading countries gain from trade. The leading trade theories that explain trade relations are the Ricardian theory of comparative advantage, the Heckscher-Ohlin-Samuelson (HOS) model of factor endowment theory and Krugman's prediction of trade owing to increasing returns to scale. The first two theories are based on premises of competitive environments while the last one incorporates a "love for variety" utility function to introduce imperfect competition in trade theory. According to the Ricardian

[1] This paper is a part of M. Phil dissertation of the first author at the Department of Economics and Politics at Visva Bharati University, Santiniketan. Usual disclaimers apply.

model, the country which can produce a commodity using lesser amount of factors than other countries will develop an advantage in the production of that commodity compared to other countries. As a result, this country will be able to export the commodity profitably while importing other commodities which are relatively costly to produce. The HOS model explains trade on the basis of factor endowment within a country where a country ends up exporting that commodity which it produces using the abundant factor intensively. In both these approaches, trade takes place between distinctly different countries while Krugman proposes that trade can also take place between two identical countries with similar taste, technology and endowment. Krugman's theory of trade hinges upon the presence of increasing returns to scale in production. In the presence of economies of scale, there is a tendency for a country to increase its production of a commodity by engaging in trade and hence expanding the market for the produced commodity.

In recent decades, however, a new factor has emerged as a contributor to trade between two countries- the difference in time zones (TZ) (Marjit, 2007). When two countries are located in different time zones their working hours might partially overlap or not overlap at all, the extreme case being where end of a typical workday in one country might coincide with the start of working hours in another. If such differences in timing can be utilized, then these two countries can contribute to a production process (mainly production of services) which can now operate on a round-the-clock basis. This obviously requires a well-developed communication network connecting the two countries so that their respective affiliates can communicate production issues effectively. It further demands favorable conditions to allow for efficient fragmentation of the production process. This strand of literature has gotten impetus with the widespread outsourcing phenomenon in the services industry and concurrent revolution of communications technology resulting in drastic reduction in communication costs.

Section 2 first discusses the importance of communication networks in trade as described in Kikuchi (2011). It argues how a country stands to gain from its interconnections with other countries by exploiting the technological advancements in communication networks. Interconnected communication network is shown to increase the connectivity of service firms and improve the terms of trade. It also affects the pattern of comparative advantage and the choice of location of firms thus reversing the home market effect. Next, this section discusses the conditions under which a firm decides to fragment its production and outsource to different countries. Finally it examines the importance of time in production and trade of goods and services.

Section 3 reviews research that has been done in line with the idea of TZ differences and trade. This was first spelt out in Marjit (2007) where the possibility of trade between countries in different time zones was modeled in a Ricardian framework and such trade was found to be gainful. The author asserts that importing intermediaries from countries located in non-overlapping time zones can prove to be more gainful than producing the entire product in the domestic country itself. Kikuchi (2006), considering a three-country model, also shows how utilization of time zones can help countries uncover key comparative advantages. Kikuchi and Iwasa (2008) depict how a change in location of firms can allow them to take advantage of time zone difference whereas Kikuchi and Marjit (2010) relate trade between two countries with non-overlapping time zones as periodic intra-industry trade. The effect of trade between countries located in different time zones on the factor market and factor prices of the trading countries have been examined in Matsuoka and Fukushima (2009), Kikuchi and Marjit (2010), Kikuchi and Long (2011), Mandal *et al.* (2013), Kikuchi *et al.* (2013), Nakanishi and Long (2015) etc. Further, Kikuchi and Marjit (2011), Mandal (2015) and Marjit and Mandal (2016) have analyzed the effect of time-zone-difference induced trade on the countries' growth rates.

The consequence of time zone difference on the interaction between trading countries is also discussed in section 3. According to Stein and Daude (2007), time zone differences have a negative effect on bilateral FDI stocks because of the need of real time communication between headquarters and their foreign affiliates. However, the authors find that this negative impact is much smaller in case of bilateral trade. Christen (2012) compares the effects of time zone difference on service trade and delivery of services through foreign affiliates. As services require proximity between the producer and the consumer; with time zone difference the transaction cost of doing business abroad increases because both time and space of the buyers and the suppliers differ. Therefore, affiliate sales are preferred over trade in services. Hence in contrast to Stein

and Daude (2007), Christen (2012) finds a positive relation between time zone difference and foreign affiliate sales. Finally, Section 4 concludes the paper.

2. Communication Network and Fragmentation of Production

Trade between countries located in different time zones is mostly virtual. This type of trade becomes possible only through the availability of a well-functioning communication network. Such network allows fragmenting the development of a service to countries located in non-overlapping time zones. The possibility of fragmentation of a production process helps to divide the process into multiple steps so that each step can be undertaken in the country which allows it to be produced in the most efficient manner. Additionally, fragmented production and utilization of time zones together allow a production process to operate for twenty four hours as end of one country's working hours marks the beginning of the other country's workday. The following sub-sections explain the role of communication, fragmentation of production and time in the sphere of production and trade.

2.1. Role of Communication Network

Communication networks primarily link different users and allow them to promptly share information with each other. Recent developments in telecommunications network such as teleconferences, emails etc. have made services more tradable both within a country and between countries. In this connection Kikuchi (2011) explores the role of communication in trade and how it makes trade gainful.

First, Kikuchi (2011) explains how presence of a country-specific communication network can help a country to gain a comparative advantage in the production of a good and aid in its export. To show this, the author considers an economy producing two types of goods – one is homogenous which is supplied competitively and the other type consists of differentiated goods that are supplied by monopolistically competitive firms. The former type does not require any communication network for its production and is termed as the non-network good while a functioning communication network is essential for the latter type, also called the network good. The construction of such a communication network entails a large fixed cost which must be borne by the firms using that network. However, an increase in the number of network users will lower the share of such cost that falls on each user. Given this condition if two countries, one large and the other small (in terms of labor force) open their goods market, the larger country taking advantage of its relatively greater number of network users, specializes in the production of network goods. Under incomplete specialization by the large country, both countries will gain due to an increase in the number of varieties of goods produced. With complete specialization, the terms of trade for the large country improves and thus the large country gains while the small country may or may not gain depending on the relative strengths of the *variety effect* and the *terms of trade effect*.

Next, Kikuchi (2011) demonstrates how interconnectivity of country-specific communication networks among countries affects the nature of trading equilibrium. Say, there are *M* identical small countries that open their goods market and out of which *m* countries' country-specific networks are interconnected. In this situation, the connected countries will experience an increase in supply of the good that requires a communication network. Also, with an increase in connectivity the average cost of network falls which in turn enhances exports. This then implies that the connected countries will naturally specialize in the network goods. However, depending on the relation between consumers' expenditure share for the network good and the number of connected countries, two distinct cases may emerge as trading equilibrium. When the expenditure share is less than or equal to the proportion of connected countries, both types of goods will be produced by all countries. In this case, every country will gain regardless of its interconnectivity. If the expenditure share is more than the proportion of connected countries, the connected countries will completely specialize in the network goods and thus gain from increased connectivity, and improvement in the terms of trade. On the other hand, the unconnected

countries might lose from trade since the income of non- network good remains fixed (and if the autarkic price is less than the trading price).

The interconnection of country-specific networks also affects the decision with regards to where a firm will be located. Suppose there are two countries – North and South; North being abundant in skilled labor and South being unskilled labor-abundant. Skilled labor is required to produce a design that is used in the production of a variety of differentiated network goods such that North can develop new products more efficiently. On the other hand, unskilled labor is required to produce a homogenous good. Income of skilled labor is equal to the payment of the design. When the networks are unconnected, skilled labor income differential between the two countries is substantial with Northern income being higher than that of the South and thus the North housing most of the firms. In this case, the North becomes a net exporter of the network products. On the contrary, when the networks are connected, the total cost of network provision for each country falls as now both North and South share a common network. The interconnectivity in this case also favors Southern skilled labor. Since North has a higher number of skilled workers, most of the network provision cost is paid by North while the Southern country has to pay less. Because of this, it may so happen that the income of Southern skilled labor becomes higher than the Northern skilled worker. As a result, some of the products that were developed in the North now will be produced in the South thus altering a firm's location. This might lead to the North exporting both design and homogenous goods while the South becomes a net exporter of the differentiated products.

2.2. Fragmentation of Production

Fragmentation of production has become a gainful venture these days and it has dramatically changed the organization of production of goods and services across the world. From the conception of a product to its end use, the production process is divided into several steps which are then distributed over the globe to different places where each step can be executed most efficiently. Some of the factors that affect the decision to fragment a production process are technological progress, decreasing transport cost, communication cost and information cost, decrease in economic barriers to trade etc. (Amador and Cabral, 2012). Fragmentation of production to foreign countries is commonly explained on the basis of lower labor cost. Long *et al.* (2005) suggest that along with lower factor cost, for a production process to be offshored to a foreign country, the affiliate country should be developed enough to be able to undertake the assigned activities and communicate with the headquarters effectively[2]. They consider a Ricardian model and examine how fragmentation increases with opening up of trade. Their paper begins with production of a good that follows a Leontief structure requiring *k* components, where production of these components requires specialized services. The authors suggest that the number of such specialized services depends on the level of development of a country with developed economies having higher number of specialized services. They extend their work to a two-country framework: where one is a developed country and the other a developing one. When there is free trade in only goods and components but services are not traded, then the advanced economies will tend to produce components that are more service-intensive and outsource the manufacturing of components that are less service-intensive to developing countries. On the other hand, when there is free trade in services and zero transport cost, the price of aggregate services will be the same in both countries and since factor cost is lower in the developing country, it will export all the components. However, with the presence of positive transport cost, the extent of outsourcing may be diminished.

Harms *et al.* (2012) also analyze the offshoring decisions of firms. They assume offshoring cost to vary non-monotonically along the production chain. The final production stage is always accomplished at the home country since the finished good is to be sold in the home market. Depending on the magnitudes of offshoring and transportation costs, a firm chooses whether to undertake the entire production process at home (*domestic production*) or in the

[2] Tast (2014) and Kayani (2017) are interesting works that examine the relation and causality between an economy's growth and investment inflows.

foreign country (*production abroad*) or offshore only those stages of production to the foreign country for which the offshoring cost is low (*fragmented production*). In the *production abroad* regime, transport costs are to be incurred only once but in case of *fragmented production* regime, transportation costs are incurred multiple times since the good will be shipped back and forth between the two countries. If transportation cost is high, a firm will choose to produce in the foreign country (assuming foreign country has sufficiently less factor cost) and in case of low transportation costs *fragmented production* is chosen. Conversely, if offshoring costs are high then the *production abroad* regime is not chosen. In this situation *fragmented production* is chosen only when the transport cost is very low. With declining transport cost, offshoring increases as initially the production organization shifts from *domestic production* to *production abroad* regime and then with further decline in transport cost *fragmented production* prevails.

Choi and Choi (2013) also contemplate lower factor price especially lower labor cost can encourage fragmentation of production to different countries. In doing so, they also acknowledge the issue of uncertainty of wage rates prevailing in the developing countries. They assume developed countries to have lower capital cost and developing countries to have lower wages in order to examine whether a firm in the developed country chooses in-house production or outsourcing and further if it chooses to outsource whether it outsources to an independent firm in the developing country or establishes its own FDI firm. The optimal decision entails outsourcing to an FDI firm in the developing country as the firm can effectively use capital of its own country and cheaper labor of the developing country.

2.3. Time Affecting Trade

Time is important in every aspect and plays a critical role in both production and trade of a good. Delays in production and delivery of a good may reduce its value. Hummels (2001) points out how air route is chosen instead of sea route for delivering goods in United States, even when air shipping costs are higher. This is because when goods are traded via sea route, it takes more time and this in turn imposes significant costs such as the cost of holding inventory and depreciation cost. These costs become even larger if the consumers change their product choices with time. Deardorff (2003) explains the importance of time in the sphere of production and trade. He asserts that with development in communication and technology, a product can be produced earlier. However, in case of delayed delivery or production, inventory holding may or may not be useful for fulfilling product demand on time. Since consumer preferences can change rapidly with time such inventory holding may not serve its purpose if it cannot keep up with the choice requirement of the consumer. In this case, a producer not only incurs the cost of holding inventories but additionally suffers a loss equivalent to the value of the good as the producer has no choice other than selling the outdated product as scrap. Thus, it is necessary for production to be just in time. Deardorff (2003) affirms that speed of production can however be increased by utilizing more physical or human capital, thus implying that products with higher rates of depreciation will be produced by capital intensive techniques. Therefore, in case of trade, time sensitive products will be exported by the countries who can afford capital intensive production.

3. Time Zones and Trade

Proper utilization of time definitely helps to serve the consumer better. But extracting the advantage rendered by differences in time zones and a dept utilization of time are not analogous although they share some commonalities. Time zone difference paves the way of utilizing work-time (day, per se) for production in a more judicious way and ensures early delivery of the product. However, this phenomenon is independently incapable of yielding significant changes in production and consumption unless it is backed by low cost of communication/transportation.

Suppose production of a service requires two days for completion and the production can only be executed during the day time. The idiosyncratic nature of the production process creates a natural delay in both production and delivery of the service that reduces its value significantly. As a result, the realized price of the service is lower than the price that the producer could have fetched if the service was produced and delivered earlier. In order to ensure that the producer is

able to procure the *full value* of his service, an efficient strategy here could be fragmenting the production process to another country which is located in a different time zone such that one country's day overlaps with the other country's night. Thus, one country starts the production process and finishes half of the production of the service at the end of its work day which is then communicated or mailed to the other country where the day has just begun. The semi-finished job is then completed in the other country and mailed back to the former one. Thus, the former country's night time is also utilized by the use of communication network, which allows for efficient fragmentation of the production process to a country located in a different time zone. Thus, the service is ready in only one day and available to consumers in due time allowing the producer to realize the *full value* of the service. In the following sub-sections we review different aspects of time zone related research that has been accomplished in the literature.

3.1. Time Zone Difference as a Source of Trade and Comparative Advantage

This idea has been first modeled in Marjit (2007) in terms of a simple Ricardian model with two countries (A and B) and the rest of the world (ROW). Country A and some parts of ROW are located in one time zone while Country B and the remaining parts of ROW are located in another time zone. The locations of these groups of countries are such that there is no overlap in the working hours of one group with the other. Both countries A and B produce two goods X and Y. Good Y can be produced within one working day whereas good X requires two working days. One unit of X can be produced by one unit of labor while β units of labor are required to produce one unit of Y. All markets are perfectly competitive. As the production of X requires two working days, X is available for sale on the third day (assuming markets remain closed at night). Because of this delay in reaching the market, the price of X is multiplied by a discount factor δ ($0<\delta<1$), such that the more the delay less will be the value of δ and therefore the effective price of X. This captures the idea that consumers value the product more if it is available earlier.

Because of the delay in production of X, price of Y is assumed to be higher than the price of X and consequently both countries opt for the production of Marjit (2007) assumes that if X could be produced in one working day then both countries would choose to produce X. This can in fact be achieved if both countries utilize the difference of their geographic locations and hence their non-overlapping working hours. They can outsource the second stage of production at the end of day after completing the first during their regular working hours. The second stage will be completed in the other country during the night time of the home country and then the final product can be sent back to the home country so that good X can be available in the market the very next day of the home country. This eliminates the delay factor from the price of the good and then both countries will choose to produce X. With vertical trade, wage of X workers also becomes greater than that of Y. This suggests that there are gains from trade across different time zones (given the shipment cost of goods-in-process is negligible).

In the model, if production of X is divided into a number of stages, then the number of stages up to which a country will produce will depend upon its labor endowment. The model also proposes that if country B does not have the technology to produce X then A should transfer the technology costlessly to B. Otherwise, both countries will specialize in the production of Y and get lower value than if both countries were capable of producing X. Thus even if country A charges zero price for the technology transfer to B, it will still produce X gainfully. Marjit (2007) also considers shipment cost in this model and explains why vertical trade would be beneficial if the benefit from exploiting the time difference exceeds cost of shipment involved in the vertical trade. The outcome of the model thus far where each country specializes in some fragmented production of X is valid if A and B are small compared to ROW and good Y is produced elsewhere. Now, if A and B are the only two countries in the world then Y must be produced by at least one of them. Zero production of Y will raise its relative price and attract workers towards Y sector. Hence both countries will produce different stages of X and also some Y.

Kikuchi (2006) is another important contribution in this regard where a three-country model is used to show how utilization of time zone differences can affect the structure of comparative advantage. Say, there are three countries: Country 1, Country 2 and Country 3 with no overlap in working hours. When one country's work day ends, another country's work day

begins, and so on. Each country produces two tradable consumption goods X and Y and one intermediate business service good, good Z. Good Z has *n* differentiated varieties where each unit of variety requires production in two stages, each stage utilizing one unit of labor, such that the second stage of each variety can be outsourced. Good X is produced using only differentiated business services as inputs. In this backdrop when there is no outsourcing, the total cost of producing good Z involves a fixed cost of production along with the labor cost. When the second stage is outsourced to another country, the total cost of the firm also includes a communication network fee along with the fixed cost and labor cost. When outsourcing takes place, production can be achieved earlier and the working hours required for production of one unit of service are reduced due to specialization; as a result, good Z can be prepared with less than two units of labors. This implies that if the advantage of time difference is taken into account, then there is a reduction in marginal production costs. Now if the cost of communication is offset by the benefit of having lower marginal production costs, then the total cost in autarkic situation will be higher than in 'outsourcing situation'. In this case, it will be profitable to outsource than to maintain a communication autarky (i.e. no outsourcing). In the outsourcing case, in the connected countries (countries whose networks are connected), X sector can purchase services from all service firms located in the connected countries and thus the number of available business services increases. Also, due to efficient utilization of time differences, each service firm within the connected countries can supply its services at a lower cost. Further, with increased division of labor due to outsourcing, the average cost of producing good X becomes lower and as a result, export of good X is enhanced. As a result, the network provides opportunities for entry into the service sector in connected countries and the size of the connected countries' business service sector will eventually expand. The point is that there will be a cumulative process in which the increased connectivity via network will enhance exports, and exports will enhance further specialization in the business service sector. Thus, connected countries that utilize the time difference will acquire a comparative advantage in good X. It is further shown that if the expenditure share of good X is sufficiently small, then each country in the world will gain from trade.

3.2. Location of the Firm

Trade between countries situated in different time zones also affects the location decision of firms. This has been shown by Kikuchi and Iwasa (2008) by taking two countries (Home and Foreign) located in non-overlapping time zones which differ in their size in terms of labor endowment. In contrast to Marjit (2007), Kikuchi and Iwasa (2008) examine the role of time zones in monopolistically competitive markets with increasing returns technology. In Kikuchi and Iwasa (2008), there are two sectors: a monopolistically competitive sector producing a large variety of differentiated services and a perfectly competitive sector producing a homogeneous good. It is assumed that production of each service requires one workday and the service can therefore be sold after one workday. Similar to Marjit (2007), there is a cost of delay associated with the delivery of the service. The delaying cost is interpreted as the shipment cost, required for the delivery of differentiated services, having the 'iceberg' effect. This means, for every t (t>1) units shipped, only one unit arrives. Therefore, the price the Home consumers have to pay is tp, where p is the producer's price.

If communication networks are utilized, a country is assumed to import differentiated services more quickly. In this case for every t' (t>t'>1) units shipped one unit arrives. This implies importing the service becomes less expensive than purchasing domestically. Observing the number of firms before and after outsourcing, Kikuchi and Iwasa (2008) argue that if the Foreign country is small, then the number of varieties produced there will increase i.e. firms will be located in the Foreign country to utilize the time zone difference. Due to an increase in the number of service producing firms in the Foreign country, demand for each service will decline. But, on the other hand, if the degree of product differentiation is high enough, then the firms can raise the price of services thus suppressing the negative effect caused by a decrease in demand.

3.3. Shift Working and Trade

Conventionally production process takes place only during daytime and at night time the process remains idle. Now if we suppose production process continues for twenty four hours with workers working in shifts then also the good that required two days to be produced would be ready for sale the very next day. But usually, workers are not willing to work at night as long as they are not paid a higher wage than the daytime workers. This increases the cost of production and eventually outsourcing the night time production process to another country with non-overlapping time zone could be beneficial. However, trading costs can hinder this opportunity. This issue has been aptly analyzed by Matsuoka and Fukushima (2009), who examine the conditions for a firm to outsource its production process. Matsuoka and Fukushima (2009) introduce the concept of shift working disutility and allow the workers (consumers) to choose between day and night shifts. Shift working disutility raises the cost of night production. It is assumed that there are two identical countries (Home and Foreign) located in different time zones such that when it is daytime at Home, it is night time at the Foreign country. There is one competitive sector in each country producing a non-traded final good using intermediate differentiated goods that can be produced in either of the two countries. Each consumer is endowed with *L* units of time that is spent on labor and leisure. Consumers' utility depends on consumption of the final good, the leisure time and on the time when they work. The disutility of work during daytime is lower when compared to that of the night time. Consumers prefer to work in the shift that gives them higher utility. In order to compensate for the night shift disutility, the wage offered for working during the night shift is higher than the dayshift wage. In such a set up under free trade, a firm producing the intermediate good can sell its variety both at Home and in the Foreign country. If the firm of the intermediate goods sector produces both stages domestically, then total quantity produced by it will be identical to the autarky situation, assuming zero long run profits due to free entry and exit. However, if the firm outsources the second stage (night shift) of production to the Foreign country; the countries being in different time zones, the day shift workers of the Foreign country are utilized with daytime wages being paid to them. On one hand, this reduces labor cost by removing the night shift disutility while on the other hand it entails a fixed cost associated with using the communication network that allows both countries to trade the intermediates. Therefore, a firm will decide to outsource only when the night shift disutility is more than the communication cost.

To evaluate the welfare effect, the price index of autarky equilibrium is compared with the free trade situation, first with domestic production and then with the outsourcing case. The authors demonstrate that trade liberalization with domestic production equilibrium is welfare enhancing when compared to the autarky situation as foreign varieties become available to the home producers thus lowering the price index. The price index in the outsourcing situation is found to be lower further. This is because with the increase in number of varieties, outsourcing increases the firm's productivity by lowering marginal costs and also eliminates the night shift disutility. With the decrease in price index, real wage increases and so does the labor supply. It is further proposed that declining cost of outsourcing always promotes welfare improvement.

3.4. Periodic Intra-Industry Trade

In another interesting paper based on time zone difference and trade, Kikuchi and Marjit (2010) point out how service trade across different time zones could be gainful when nighttime demand in one time zone is fulfilled by using daytime supply in another time zone. Through this kind of trade, international wage rate differences can be utilized along with the daytime-nighttime wage differential. The authors interpret this kind of trade as new versions of *periodic intra-industry trade.* A brief review of the model as formulated by the authors is as follows. There are two identical countries located in different time zones such that their work hours do not overlap with each other. There are two competing categories of services: daytime services (provided by hiring dayshift labor) and night time services (provided by hiring night shift workers). There is a variety of services produced under each category by monopolistically competitive firms. Each consumer is assumed to purchase services from only one category and their utility increases with increase in the number of varieties. Dixit-Stiglitz form is used to express the quantity index of each individual consumer.

The entrepreneur of each firm has to decide whether to provide daytime service or nighttime service. Nighttime wage rate is assumed to be higher than daytime wage rate resulting in nighttime services being more expensive than daytime services. The share of consumers, at equilibrium, purchasing daytime services is found to be negatively related to the nightshift wage premium. As nighttime services are more expensive, consumers prefer to purchase daytime services, which further shrinks the market for nighttime services.

Now, given the time difference between these two countries, if communication networks are utilized, the nighttime service can be imported from the foreign country which is less expensive than the domestic nighttime service. After trade, it is found that half of the consumers buy daytime service and half purchases the nighttime service, resulting in balanced trade between the two countries.

With trade liberalization, now the daytime service at home can be purchased from home daytime service providers and foreign nighttime service providers. As the night shift wage is higher in both countries, daytime service providers have a cost advantage. So, the home country will be a net exporter of services during daytime and the foreign country will be a net exporter of services during home's nighttime. Thus, a periodic intra industry trade occurs between the two countries mainly driven by the time zone difference and improvement in technology.

3.5. Effect on Factor Markets and Production

When the importation of day-time labor services at the local night-time becomes possible, this will result in changes in the relative supplies and demands for shift working labor services, and hence factor prices (Kikuchi and Long, 2011). Taking two countries located in non-overlapping time zones, two goods (one involves shift working and the other does not) and two factors (labor and capital), Kikuchi and Long (2011) demonstrate the impact of periodic intra-industry trade in labor services on the nature of shift working, factor prices and on the pattern of comparative advantage. There are two goods X and Y where the production of X involves working in shifts. Two pools of labor exist - one that works in dayshift and the other during night shift. Unlike Kikuchi and Marjit (2010), there is another factor of production, capital which is used in production of both goods X and Y. When capital is hired, rent is paid for the whole day (24 hours) irrespective of whether it is used only for day shift jobs or for both day and night shifts. Consequently, this gives incentive to firms of sector X to operate in both shifts. The authors assume night shift wage to be higher than the dayshift wage although it is not prohibitively high. A zero ex-post elasticity of substitution between capital and labor services is also assumed, implying that firms have to maintain the same capital to labor service ratio in both day shift and night shift operations.

Now with the help of communication network if there is trade in labor services, as explained in Kikuchi and Marjit (2010), periodic intra-industry trade will occur. As the foreign dayshift workers supply labor as home's night shift labor, but are paid domestic daytime wages, production cost of good X falls. Both dayshift and night shift labor (foreign daytime labor) demand rises. This would also raise the demand for capital. Hence, the supply of good X will rise. If labor and capital are fully employed, a rise in the supply of good X results in the supply of labor and capital for good Y to fall. Thus production of Y falls. Compared to rest of the world, these two countries, due to connected labor markets develop a comparative advantage in the production of good X.

Nevertheless, the way that factor prices are affected will depend on the factor intensity of good X and good Y. If good X is more capital intensive than good Y, then as Y sector releases labor and capital, X sector will absorb more of capital and less of labor. A relative increase in the demand for capital will lead to higher rental rates for capital and lower wage rates for labor. Thus, Kikuchi and Marjit (2011) propose that there will be a decrease in wages and an increase in rental in both countries, given the good through which trade in labor services occurs is capital intensive.

Mandal *et al.* (2013) illustrate how the reduction in communication costs along with the presence of time zone differences affects factor prices and inflow of educational capital when labor is sector specific and capital is mobile across sectors. This study considers two small open economies (Home and Foreign) and the rest of the world. The focus is on the economy which is outsourcing or insourcing service. The economy is assumed to be endowed with skilled labor (S),

unskilled labor (L) and two types of capital K and E. K is used for production while educational capital E is used to train unskilled labor. All the factors are mobile across sectors but cannot move internationally except E. Three goods are produced: X, Y and Z. The production of X is achieved using skilled labor, S, and requires two consecutive 12 working hours. Thus, one unit of X is ready for sale on the third day. To make the product available a day earlier, half of the work can be outsourced to a country located in a non-overlapping time zone. For doing this, communication network cost (ρ) is to be incurred. Y is capital intensive and produced using S and K. Z is labor intensive and produced using L and K. Using E, L can be upgraded to S and hence greater supply of E indicates more L can be upgraded to S.

Assuming perfectly competitive markets, if there is a decline in communication cost, then wage of skilled labor (W_S) will increase as product price is unchanged and the complementary factor absorbs some of the gain. As S is also required in the production of Y, with increase in W_S, rent (r) will fall. A fall in r will increase the wage of unskilled labor (W) used in the production of Z. However, the wage inequality between skilled and unskilled workers will rise due to fall in ρ, as the share of communication cost must not be higher than productive skilled wage share in the production of X, and, Y and Z being capital intensive and labor intensive respectively. Since Z is L-intensive, an increase in W will lead Z sector to economize on its usage of L implying an expansion of the Z sector. As Z and Y both use the same K, the expansion of Z will lead to a contraction of Y. With this, some S will be released which will be absorbed in X. Thus, there is a complementary relation between sector X and sector Z. Again, per unit cost of E is also seen to increase with a fall in ρ and the widening wage gap between skilled and unskilled labor. With a positive change in the per unit cost of E, there will be additional flow of E and unskilled workers will be trained to become skilled and get employed in X or Y sector. This will lead to a contraction of Z. While the newly trained skilled worker can be employed both in X and Y but as shrinkage of Z also releases K which can only be absorbed in Y, therefore Y must expand. It is also shown that under certain conditions i.e. if the economy does not start with an abundance of skilled workers, X will also expand. Thus, due to time zone difference (here ρ was taken as a proxy of time zone) and induced inflow of E, the economy ends up as a skilled based one. Time zone difference creates complementarity between X and Z and inflow of E creates complementarity between X and Y.

Kikuchi *et al.* (2013) also elucidate the impact of trade across different time zones on factor markets, relative wage distribution and allocation of labor between day shift and night shift work. The impact of technological improvement on factor markets is also examined. The model considers two small identical economies Home and Foreign with non-overlapping time zones and the rest of the world (ROW). One day (24 hours) is divided into two periods i.e. day-shift working hours and night-shift working hours, each of which are 12 hours long. There are two goods X and Y produced in competitive setups. Y uses both skilled and unskilled labor and one unit of Y is produced in one day-shift working hours. On the other hand, sector X uses only skilled labor and one unit of X is produced in two shifts- day and night. As night shift work involves some disutility, night wage rates are higher than the day shift wage rates. The dayshift wage rates of skilled labor in both sectors X and Y are equal as mobility of skilled workers across sectors is assumed. X sector also has the option of producing the good using two day-shift working hours. In this case, half of the production is executed in one day and the other half the next day, with night time work shift remaining idle. Along the lines of Marjit (2007), this attaches an extra cost to the product in the form of 'decay cost' which implies that consumers prefer to have the product earlier. Given this type of extra cost, a producer will choose to produce solely in day shifts only if night shift dissatisfaction is comparatively high.

When utilization of technology evokes trade between Home and Foreign, the night shift option becomes redundant, as X can now be produced using only day shift workers. This reduces the labor cost of production but introduces a communication cost, which is assumed to be of an iceberg type. To focus on the impact of technological advancement, it is assumed that cost of production under vertical integration of production is less than the production cost under communication autarky. Now Kikuchi *et al.* (2013) show that with advancement in technology, the communication cost falls which makes production of X more beneficial with the integration of Home and Foreign market. The wage of skilled workers is also shown to be higher with trade

while there is a decrease in unskilled wages for both countries. Finally, the authors establish that if shipment cost of goods-in-process is negligible, there are always gains from trade across different time zones.

Contrary to the assumption of identical trading countries, as evidenced in the studies discussed above, Nakanishi and Long (2015) also analyze the effect of trade on factor prices when Home and Foreign differ in their sizes. A model is constructed with two goods, X and Y, and two small economies, Home and Foreign, located in diametrically different time zones. Each country is endowed with capital, labor and land. Land and capital are immobile across countries. Each country produces two goods, a knowledge intensive good X using labor and capital and a traditional good Y using labor and land. It is assumed that shift working is possible only for good X while Y can only be produced during day time.

Without trade in labor services, the night shift wage is higher than the day time wage to attract labor to work at night. The volume of night shift workers in each country is less than half of the country's total labor endowment and day shift production is higher than the night shift production. Taking advantage of time zone difference firms of sector X, for their night shift work, can import labor services supplied by day shift workers in the other country at a wage rate lower than the night shift wage rate. Assuming both countries have identical factor endowments, a technological advancement in communication networks that enable trade in labor services will cause the wage rates of both day time and night time labor to converge to a common value. Therefore, there will be an increase in day time wage rate and a decrease in the night time wage rate. As wages of daytime labor goes up, its demand in sector Y also falls leading to a decline in land rent. However, there will be an increase in capital rental rate in sector X if the marginal product of capital is concave in labor. Taking advantage of the decrease in night time wage rate X producers will expand the night shift production. On the other hand, due to increase in daytime wage rate, Y producers reduce employment and output. The labor trading countries will have a comparative advantage in the shift working commodity relative to the other countries who does not engage in labor service trade.

Next, the authors consider the case of these two countries being of different sizes but having the same factor endowment ratio. If Home is considerably larger than Foreign, then its demand for night shift labor cannot be completely fulfilled by the foreign day shift labor supply; so some of the residents of the home country will have to work at night. Therefore, the night shift wage of Home will still be more than the day shift wage rate. As Foreign's day time labor is supplied to Home as night shift labor services, day shift wage of Foreign must equal the night shift wage of Home. Similarly, as Home supplies its day time labor services to Foreign as their night shift service, night shift wage rate in foreign declines to be equal to the day shift wage rate of Home. Consequently, the day shift wage of Foreign becomes more than its night shift wage. No foreign resident will work at night and hence Foreign will completely specialize in day-shift work. On the other hand, Home residents will provide services both in day-shift and night-shift. Comparing the autarkic situation with the trading situation, we find that in Foreign, as trade in services occur, the day time wage rises and the night time wage rate falls. Hence in Foreign, the Y sector which can produce only in daytime, reduces its production (due to rise in wage rate) eventually leading to lower land rents. In Home (the larger country) with liberalization of trade in labor services, the night time wage rate goes down (but is still higher than the night time wage of foreign and daytime wage of Home). However, the daytime wage rate in Home may or may not increase. Changes in land rent in Home depend on the changes in the daytime wage rate. If there is an increase in the daytime wage rate, then land rent will decrease.

The capital rental rate in both countries increases due to trade in labor services under the condition that the marginal product of capital is concave in labor. In fact, the capital rental rates in both countries are equalized. When Home's night time production is offshored to Foreign, it can be taken as the export of Home's capital to Foreign's daytime market. Then, both Home's capital and foreign capital will receive the same rental rate in the Foreign's daytime market. Therefore, the night-time rental rate in Home will be equal to the day-time rental rate in Foreign. Similarly, day-time rental rate in Home and night-time rental in Foreign are also equalized.

3.6. Growth

Kikuchi and Marjit (2011) propose a two-country AK model of intermediate services trade that captures the role of time zone difference in economic growth. Similar to Kikuchi and Iwasa (2008), there are two countries, Home and Foreign, located in different time zones with non-overlapping working hours. There are two sectors-final good sector and intermediate business service sector. Domestically business service production requires one working day and the product is ready for sale after one working day; the delivery of domestic business services involves significant cost in terms of delay. If, by utilizing the communication networks and non-overlapping working hours, the business services are imported from Foreign, it is available quicker and thus the cost of delivery is lower. In order to capture the positive time cost for delivery of intermediates, 'iceberg' effect of delivery cost is considered. Unlike Kikuchi and Iwasa (2008), intermediate business services are also produced under perfect competition. The final good is produced using capital, home intermediate business services and foreign intermediate business services. It is assumed that intermediate business services can be traded but not the final goods. Because of iceberg effect of delivery cost, if one unit of foreign intermediates is to be sold in the home market t' (>1) units should be shipped. Thus, the price of the foreign intermediate service will be t' times higher than the original price. If there is technological improvement in the communication network, then the service can be transported sooner. Then the quantity to be shipped for one unit sale of foreign intermediate in the home market will be t'_1, where $t'_1 < t'$. Thus, a technological advancement will lead to a reduction in the delivery cost.

Now, Kikuchi and Marjit (2011) consider a time saving technological advance in one of the countries, and demonstrate that with a reduction in delivery cost for one country, there is an increase in marginal productivity of capital in both countries at the same rate. For example, if the technological development occurred at Home, this results in faster capital stock growth in the Home country. Since home producers can now import foreign intermediates more quickly, the demand for foreign intermediates (services) increases. This causes a rise in the relative price of the foreign intermediates in the world market. These terms of trade effect lead to a faster growth rate of capital stock in the foreign country with an attempt to stabilize world growth. Therefore, with terms of trade improvement, the country without technological improvement can also experience an increase in economic growth.

Mandal (2015) examines the relationship between distance, production and trade between different time zones and shows its effect on welfare and economic growth. Following Kikuchi and Marjit (2010), a Cobb-Douglas production function for service output (S) is taken. Output is produced with capital and an intermediate input, the latter in turn being produced by labor. Similar to Marjit (2007), production of output requires two consecutive stages or workdays. Because of this, the service output cannot be delivered in a timely manner which reduces consumers' valuation of the good. This time preference is denoted by δ as in Marjit (2007) but here δ is assumed to be greater than 1. Due to delay in delivery, the effective price of the product becomes P_S/δ where P_S is the original price of the product. When time zone difference is utilized, one of the stages can be produced in the other country when it is nighttime in the former country. Thus the output is available in due time and δ vanishes from the equilibrium production equation. As $\delta > 1$ and has a negative relation with the volume of S it becomes evident that production rises with utilization of time zone difference.

Next, Mandal (2015) relates the time preference δ with distance between time zones. Distance is generally considered to restrict trade between countries but this may be entirely true especially in the case of tangible goods. It is shown here that in case of virtual trade, distance can actually be beneficial on the contrary. If the distance between trading countries is so large that the trading partners fall on two diametrically different time zones that are non-overlapping then distance favors trade. To establish this, δ is assumed to be negatively related with distance. The more the distance between the two trading countries, less overlapping are the time zones of the countries concerned (here it is assumed that the globe is circular and distance between two places can be measured aerially and can be covered along the diameter of the globe). Therefore, $\delta > 1$ for countries located in overlapping time zones while $\delta = 1$ for non-overlapping time zones. When $\delta = 1$, price of the product is P_S. Thus, when distance between two countries is the largest,

virtual trade is most beneficial as δ becomes 1 and full price of the output is realized. This increases both production and profits.

It is also established that with virtual trade not only production of the good in question increases but also the volume of traded goods/services increases since along with S, intermediate inputs are also traded between the trading partners (after the first stage the partial output is exported and the final output is imported back following the final stage). This increases welfare of both the trading countries. Even if trade in final goods/services is not allowed, the volume of trade effect due to trade in intermediate inputs will raise welfare of the countries concerned. Higher volume of intermediate inputs will lead to higher domestic production of S resulting in welfare gains. It is further shown that increase in distance enhances capital accumulation leading to higher growth rates.

Marjit and Mandal (2016) also exhibit how virtual trade has a positive impact on growth of two trading countries. Similar to Marjit (2007), Marjit and Mandal (2016) consider a situation when one unit of the product requires two inputs each of which further needs twelve hours to be produced. Thus if a typical workday consists of twelve hours during the day time and night time production is ruled out (due to prohibitively higher cost), one unit of the product will be produced in two days. But, if one of the inputs can be produced in another country during their daytime when it is night in the former country, then the product will be available only in one day. Since the product is available one workday or twelve hours earlier, one interpretation of this is that output per unit of time has increased implying higher growth rate. Another interpretation that the authors provide is –if production continues during a country's night time, then workers have to sacrifice their normal resting hours and firms have to compensate them with a premium. Alternatively, when there is another partner country across a non-overlapping time zone, both the countries can sleep well and workers will not have to be paid extra. Therefore, cost of input falls leading to higher incentives to invest. This also results in a higher growth rate. The authors acknowledge that the virtual trade in intermediates incurs some cost and the gains from trade will only be realized if this cost is less than the delay or carryover cost involved in the autarky situation.

3.7. Time Zones and FDI

Time zones have also been found to play an important role in determining the locations of FDI. According to Stein and Daude (2007), time zone difference imposes an important transaction cost related to the need for frequent interaction in real time between the countries, an issue that has been overlooked by the empirical literature associated with the gravity model of bilateral trade. The authors believe that although recent advances in communication technologies have replaced the need for face-to-face interaction but still real time interaction involves serious costs when countries are located in non-overlapping time zones since people would naturally prefer to sleep during the night. An alternative way to make real time interaction possible is to travel. In that case, east-west transaction costs are expected to be higher than north-south transaction costs as travelers may be affected by jet lag and require time to adjust to the time difference. Thus for information-intensive activities that require considerable real time interaction transaction costs due to time zone difference should be substantial. This study empirically corroborates that time zone differences between source and host countries have a negative and significant impact on bilateral FDI. However, the impact of time zone on bilateral trade is found to be smaller than in the case of FDI as real time interaction is expected to be not as demanding in case of trade transactions as in the case of FDI. Finally, the authors investigate the evolution of the time zone effect over time recognizing the improvement in technologies such as internet or video conferencing over the years which pose to be a close substitute of real time interaction. The study finds that the effect of time zone difference is increasing over time. The authors postulate that technological advancement may actually reinforce the time zone effect because parties exposed to such technologies and located in very different time zones are now expected to work beyond regular business hours whenever real time interaction of doing business is deemed important.

Christen (2012) examines the role of distance and time zone difference as a measure of transaction cost for the delivery of services. Because service provision requires proximity and interaction between the buyer and the supplier, distance and time zone difference increase the

coordination cost between service suppliers and consumers. Christen (2012) finds that both distance and time zone difference positively drive U.S. outward affiliate sales. In order to precisely capture the transactions costs associated with distance and time zone difference, three different model specifications are used. The first specification decomposes distance into a longitudinal and latitudinal component and looks at its impact on outward affiliate sales. The empirical results show a highly significant positive effect of both longitudinal and latitudinal distance on affiliate sales. An increase in any one of the two distance measures by 100 kilometers is found to increase foreign affiliate sales by 2%. In the second specification, countries are grouped with respect to different ranges of time zone difference. Compared to the reference group with no time zone difference, it is found that time zone difference of 1 or 2 hours has no significant impact on affiliate sales. However, time zone difference of more than 5 hours significantly raises the need for an affiliate but again there is no impact of the time zone group of 8 to 9 hours on affiliate sales. The author suggests that there are some ranges in which time zone differences play a more important role than in others. Specifically three thresholds, 5 to 6 hours, 9 to 10.5 hours and 11 to 12 hours, are observed to significantly raise the cost of doing business abroad enhancing the level of affiliate activity in these areas. The third specification takes into account the possibility of non-linear effects of time zones by using dummy variables for every time zone difference in the data set. Again, the results show a positive impact of time zone difference on affiliate sales as countries are located further away from the United States to the tune of 5 hours and 9 hours or more in terms of time differences. These results suggest that countries within these ranges of time difference suffer from higher transaction costs due to less or no overlap in working hours and hence due to longer distance thus raising the need for provision of services through foreign affiliates. The author also reports that results are more robust for information intensive service sectors such as professional, scientific and technical services.

4. Conclusion

Trade between countries has traditionally been explained in terms of difference in taste, technology and endowment. New trade theory suggests that a critical factor in determining international trade patterns rests on the presence of increasing returns to scale that occurs in key industries. Following the widespread development in communication technology; however, there comes another factor that can allow two countries to involve in a trade relationship: the difference in time zones of the trading countries. When the location of two countries is such that one country's day is equivalent to the other country's night, given an efficient communication network, the production process can be effectively fragmented between these two countries. In such a scenario, one country works on a product during daytime and communicates the semi-finished product at the end of the day to the other country where the day has just begun. Therefore, there is efficient utilization of time as the production operation can occur seamlessly for twenty four hours. As a result, each of these countries specializes in a particular stage of the production process. Production can be completed at a lower cost (given negligible communication cost) and hence the countries acquire a comparative advantage in the production of the concerned product (service) compared to the rest of the world. Even under circumstances when night shift work is possible, substituting home night shift work with other countries' day time labor services can still make the overall production process more cost effective since night time wage rates are usually higher than daytime wages. In fact, locations of firms can also be altered to take advantage of time zone differences. This type of trade impacts the prices and compositions of the factors used in the production of both tradable and non-tradable goods. Such activity also has a positive impact on welfare and growth of the trading countries. Then a natural conclusion that follows is that the more the distance between two countries less overlapping will be their time zones and hence more benefit can be extracted. Although some studies have expressed a concern that for FDI, time zone difference creates a hindrance in terms of lack of real time interaction between buyers and sellers, some other research in this area however finds that this lack of interaction in fact positively affects foreign affiliate sales.

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