Time Zone Differences, Communication Cost and Service Trade

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Abstract

The paper explains how service trade has been facilitated because of the availability and development of Information and Communication Technology (ICT). With this, the paper points out to the budding theory of time zone (TZ) differences and trade where time zone difference between two countries evokes service trade given the availability of ICT. A general equilibrium framework is taken to explain the effect of trade across non overlapping time zones on factor prices and output. Results show a rise in wage of skilled labour and a fall in rent. The result is conditional on the assumptions of factor intensity. In case of output, the sector exploiting the time zone difference is seen to expand while the other contracts. This outcome, however is independent of the assumption of factor intensity.

JEL Classification: F1, F11

Keywords: Time Zones, Outsourcing, Services, Trade

1. Introduction

Development in information and communication technology has allowed to share information to any part of the world. Be it an individual or multinational firms everyone is utilizing the communication network to their benefit. With the development in communication technology there are also changes in the day to day life. People are increasingly relying on electronic tools and internet to accomplish their needs. Availability of ICT has expanded the market for both producers and consumers. Now consumers are not restricted to avail any good or service from their local area. Rather they can get connected to a large range of goods or service providers residing in different parts of the globe and order their requirement all through the communication network. Producers on the other hand can now contact professionals like architects, software engineers, lawyer, doctors, business consultants etc. residing at different locations for their assistance in developing or planning a particular project be it manufacturing of a good or development of a service or provision of a service. Professionals can share information or trade the demanded service through the internet. Therefore, as Christen (2017) mentions that the requirement of being at the same space and time has been reduced because of the developing technology that aims for seamless exchange of knowledge. Now a variety of services that were considered to be non-tradable a few decades ago are being traded across the world. We now encounter service provisions being outsourced to different parts of the world to professionals who can provide it most efficiently. Outsourcing or offshoring comprises of Informaton Technology Outsourcing(ITO) which consists of IT consulting, software development and management, network management etc.; Bussiness Process Outsourcing (BPO) which consists of Finance & Accounting, Marketing & Sales, Supply Chain Management, Training, Call Centers, Document Management etc.; Knowledge Process Outsourcing (KPO)- this contains services like Business consulting, legal services etc.; and many industry specific activities (Fernandez-Stark et al., 2011) Outsourcing of service provision activities is mainly done from developed to developing countries like India, Vietnam, Brazil, Ukraine, Philippines etc. with the aim of providing the service in an efficient and economical way. There are many factors that are taken into account while deciding the location to outsource the service. Major among them are- factor cost, skills of the labors, transport/communication network, availability of resources etc. One more factor that can be taken into account while deciding where to outsource is the difference in time zones between the engaged countries.

Time zones have significant impact on goods and services trade. The impact on goods trade is mainly negative because then time zones get associated with distance between the countries and transaction and transportation cost is significantly higher. However in case of services the negative effect owing to huge distance does not arise as it is being traded electronically. Though there may be some interaction problem due to difference in time zones termed as the synchronization effect by Head et al. (2009) but the same difference also helps to continue a task for 24 hours without any halt. For example services like customer care, data management etc. that need to be provided all the time are divided to teams located in different time zones. When the working hour of one team is finished the task is delegated to the other team located in a different time zone. Therefore the task continues there whereas the first group enjoys their leisure time. Another example can be of software development process. After completing a certain portion of the process during the regular working hours the semi-finished work is traded to another country located in different time zone where working hours have just started. At the end of the day the intermediate service is again traded to another country for completion. In this way the development process undertakes continuously without making anyone do overtime or night shifts. This process of working continuously round the clock is termed as continuity effect by Head et al. (2009). In order to examine the effect of time zones on goods and service trade, Head et al. (2009) have used the Eurostat data for 65 countries over the period 1992-2006 and have found a positive effect for both goods and service trade suggesting that continuity effect dominates the synchronization effect. Tomasik (2013) has given empirical evidence on the presence of both synchronization effect and continuity effect. The results showed a dominating synchronization effect for goods trade while for service trade continuity effect was seen to dominate. Dettmer (2014) also gives empirical evidence of continuity effect while estimating the impact of time zone on business and commercial service trade and merchandise trade. Analyzing data from 27 OECD countries with their respective 226 partner countries for the time period ranging from 1999 to 2006, it is shown that there is a positive effect of time zone on services, especially for business service trade, suggesting a stronger continuity effect. The current research also focuses on the advantage that is yield from the continuity effect. The continuity effect becomes more fruitful when time matters in case of production and trade of a good or a service. Time in fact plays a very important role in trade and production in this era where technology is developing swiftly and so are the

preference of consumers. Hummels and Schaur (2013) points out some evidences where in order to make transportation quicker and avoid loss from changing market condition, air route was chosen which was more costly than sea route. The dynamic technology has increased the expectations of humans and also made them impatient to delays which were acceptable earlier (Deardorff, 2001). So, timely production and delivery has become more important than it was before and if the continuity effect is present it will help the production to get accomplish earlier. Theoretical studies also focus on the advantage of working round the clock. Notable papers on the idea of time zones and service trade are Kikuchi (2006), Marjit (2007), Matsuoka and Fukushima (2010), Kikuchi and Marjit (2010), Kikuchi and Iwasa (2008), Kikuchi and Long (2011) etc. Marjit (2007) proposes time zones as a new factor that can induce trade between two countries. Even if technology and endowment of the trading countries are same, the difference in time zones can lead to a beneficial venture. Using a Ricardian framework it is shown that if two countries located in different time zones vertically integrate the production process, they can attain comparative advantage in the production of the concerned service as compared to the rest of the world. This results from earlier production through continuous work process. Marjit (2007) even suggests that if one of the countries do not have the required technology for production, costless transfer of the same will still be beneficial as the two countries get the advantage of being in different time zones. Kikuchi (2006) uses a three country monopolistic competition model to explain the phenomenon of trade between different time zones. Since separating production between different countries will lead to specialization in a particular task by each country, there will be an increase in productivity. This increase in productivity of workers is explained as a source of benefit of using the time zone difference in addition to the continuous work process. Kikuchi and Iwasa (2010) also focus on the positive effect of earlier delivery due to continuous work process while analyzing the effect of trade between different time zones on locations of the firm. They take two countries differing in size in terms of labour endowment and show that firms will be located in the smaller country in order to utilize the time difference. Matsuoka and Fukushima (2010) compares the phenomenon of outsourcing to different time zones with production in two shifts – day and night- undertaken domestically. In case of outsourcing a part of production process the firm

has to incur a communication cost. On the other hand, opting for night shifts also raises the production cost. The rise in cost is because of a disutility that workers face due to night shifts. In order to compensate for the disutility, night shift workers are paid a higher wage which raises the cost. Therefore, it is proposed that a firm will decide to outsource only when the night shift disutility is more than the communication cost. They point out that in addition to the rise in productivity, the producers can also utilize the day–night wage difference while outsourcing to a different time zone. In this case night shift work is done by the dayshift workers of the other country who are paid dayshift wages. According to Kikuchi and Marjit (2010) the difference in day and night shift wage induces a *periodic intra-industry trade* where a country becomes an importer of services during the night and an exporter of the same during the day. Mandal (2015) using a Cobb Douglas production function shows timely production, as a result of trading between time zones, increases the volume of output. With trade not only production of the good increases but there is also a rise in volume of trade since along with the final product, intermediate inputs are also traded between the trading partners. Papers like Marjit and Mandal (2017) and Kikuchi and Marjit (2011) shows the possibility of growth because of lower time for production. Thus fragmenting production between different time zones allows production to continue for 24 hours without any halt which in turn leads to earlier completion of tasks, rise in productivity, reduction in production costs, rise in output and growth. It is to be noted here that for exploiting the full benefit of time zone difference the time zones of the trading countries must be non-overlapping, i.e. when day starts in one country, night starts in the other, or in case of more than two countries the working hours should not coincide. For example if four hours of a day overlaps the maximum time that can be used out of 24 hours is 20 hours. Therefore to utilize every hour of the 24 hours the daytime of one country or its working hours should not coincide with the other. Our research focuses on the advantage of a reduced time for production process and aims to show the effect on factor prices and output of the economy. Papers like Kikuchi et al. (2013), Mandal et al. (2018) and Kikuchi and Long (2011) also focus on the effect trading intermediaries on the factor prices and composition of production but the idea has not been framed in a standard Heckscher-Ohlin framework as depicted by Jones (1965).

The subsequent section describes the model and explains the results. The model mainly follows the ideas of Marjit (2007), Mandal (2015) and Matsuoka and Fukushima (2010). This is followed by the conclusion. Mathematical calculations and explanations are delegated to the appendices.

2. The Model and Results

Let us focus on two identical countries in the world located in non-overlapping time zones, one in east and the other in the western part of the world. Both of them are small open economies having competitive markets. Each country has two sectors one producing good and one producing service. Since the countries are small, price of both the good and service are determined in the rest of the world. Skilled labour and capital are used as inputs in both the sectors. Skilled labour is used intensively in the production of service while capital is the intensive factor for good production. Both the factors are fully employed within the two sectors. We assume one working day consists of 12 hours and there is no work during the night time. Even markets are closed during the night and opens after every 24 hours. The goods sector takes one working day to produce one unit whereas the service sector needs two working days to produce one unit of service. The production of service, therefore can be divided in two stages each requiring one working day. Further each stage requires one unit of skilled labour and one unit of capital which cannot be substituted or in other words we assume that the technology that allows the substitution of S (K) for K(S) is not yet developed. Therefore two stages will require two units of skilled labour and two units of capital. We assume the cost of trading the service to the consumers to be negligible. Since competitive situation is assumed the price of one unit of service (P_X) will be equal to the unit cost of production. However the price that the producers receive is not the full value of the service but an amount lower than the price. This is because, consumers of the economy are assumed to be sensitive to delays- a tacit assumption in this time of fast changing technology where a product in high demand today can become obsolete after few days leading to a fall in the satisfaction of owning the particular good. Given that it takes two working days to prepare the service, the consumers can own it after 48 hours. As the consumers have to wait for two days to receive the service the price is discounted by a discount factor δ. The value of the discount factor ranges between 0 and 1. When there is delay in

production the value of δ is less than 1 and as the time of the service to reach the consumers fall, δ gradually rises to 1.

The cost price equality of X is given by:

$$2w_S + 2r = \delta P_X$$

Where $w_S$is the wage and r is the rent. The input cost of service production equals the discounted price where δ is less than one. In other words we can say that price of X is distributed among the factors and a part of it goes as a compensation for delay.

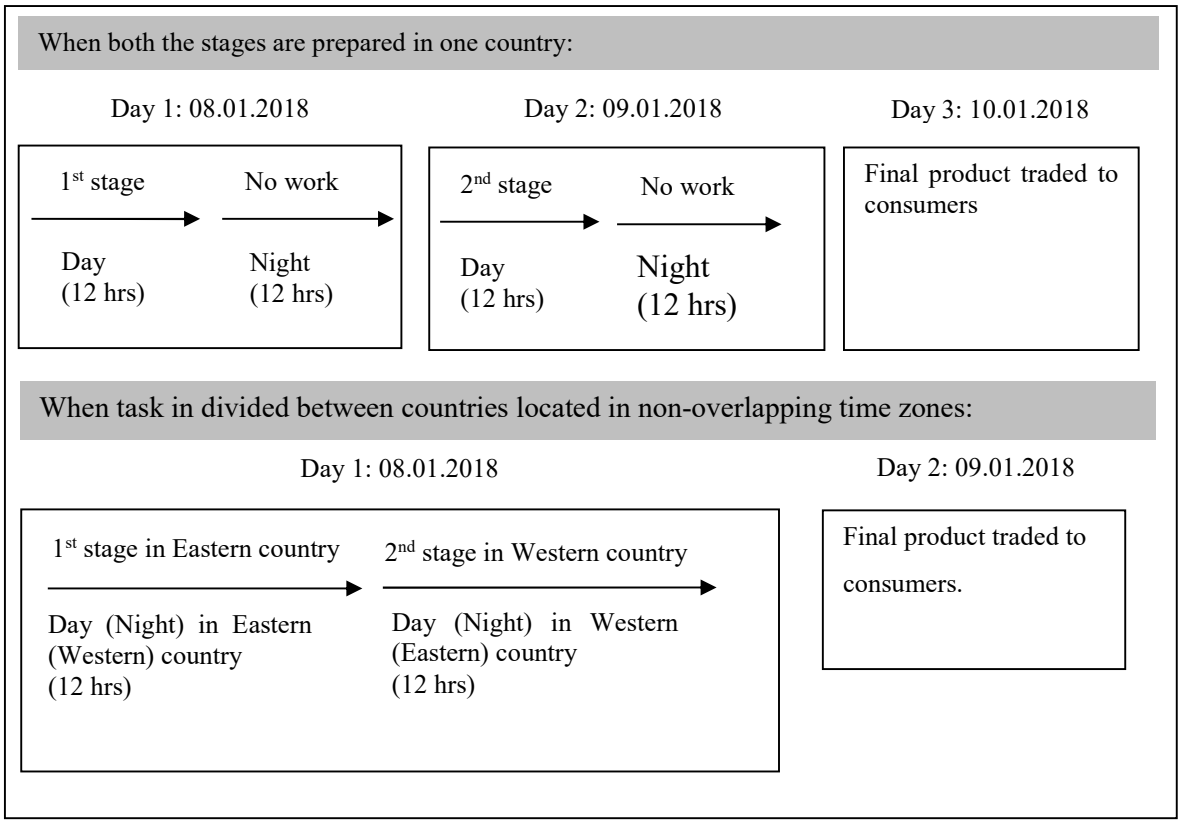
On the other hand the equilibrium condition of Y is given as:

$$a_{SY}w_S + a_{KY}r = P_Y$$

Where a_{SY} and a_{KY} are respectively the amount of skilled labour and capital used for the production of one unit of Y. Unlike in X, in case of Y the inputs can be substituted at a constant rate. The amount of inputs thus chosen for production of one unit of Y is to make the cost of production minimum given the factor prices.

Now producers of service must be willing to acquire a higher value for their output. This can be achieved if they are able to reduce the time taken to complete the preparation of service. Since it takes two working days within which 12 hours of night time, equivalent to one working day, is wasted; the producers in both the countries will want to utilize the night time also. There are two options either to organize work even in the night or the two countries can take advantage of their non over lapping time zone and share the production process. For organizing night shift production, available factors should be halved to two groups one working in day shift and one working in the night shift. Since the night shift workers are sacrificing their leisure time they need to be paid higher than the day shift in order to compensate for their disutility. The workers who consider that their disutility of night shift is compensated chooses to work at night while others work in day. However it cannot be said that the number of workers who choose to work in day will be equal to the number of workers who chose to work in night and since there exist full employment additional labour cannot be employed to equate factors of both the shift. For the current model it is necessary that there is one to one correspondence with the first stage and second stage workers. The other option is to share the production process with the other country.

Since the two countries are identical the amount of factors is also same. In this case as the working hours of the two countries are non-overlapping because of opposite time zones, the first stage is completed in the eastern country and at the end of the day the intermediate service is traded to the western country where the day of the same calendar date has just begun. The second stage undertakes in the regular working hours of the western country while workers in the eastern country rest in their regular resting time. The phenomenon illustrating both the cases of domestic production and fragmented production is as follows:



As we can see from the above figure, since the two countries are in non-overlapping time zones where their working hours do not overlap; when daylight fades in one country the day of the same calendar date starts in the other. So both the stages are done in the same date but we get two working days within one day. The service becomes available to the consumers in 24 hours which earlier took 48 hours. Therefore, Producing the service in two countries located in opposite time zones helps for earlier production and the consumers receive it one day earlier. The discount factor that was attached with the price of the service now rises to 1 and the producers

now realize the full value of the service.[1] The rise in value of service thus received by the producers encourages them to raise their output. Raising the output level requires more labour and capital, therefore, there is an increase in demand of factors in the economy and factor prices rises. Since there is no change in price of good Y, the rise in factor prices will make the existing level of output unviable for Y producers. Sector Y reduces the level of output. With this skilled labour and capital are released in the economy which gets absorbed in sector X. Thus now sector X can raise its production. It is to be noted here that since good Y was capital intensive, more of capital than labour are released in the economy. X being S intensive the available S is employed but some K remains unemployed. This leads to excess supply of K in the economy lowering its rent.[2] With this, one of the factor becomes dearer and one of them is cheaper than the initial condition. Y producers can employ more of K in order to substitute the work done by S with K and therefore use less of S. The substitution is assumed to be at a constant rate. The unemployed K therefore gets employed back in Y. The economy returns back to full employment situation. There is also a slight rise in output of Y because of fall in rent and substitution among factors but still it will be far below than the initial level.

Therefore when the service sector opts to produce its product utilizing the time zone difference, there is a rise in economy wide wage and a fall in rent. This effect also depends on the factor intensity condition. If X was K intensive and Y was S intensive. Y would have released more of S and X would have used up more K leading to a rise in rent and fall in wage. However the factor intensity condition is not significant for the expansion/contraction of outputs. The output of that sector rises whose returns for the producers has risen and the sector with unchanged price shrinks.

3. Conclusion

The development in ICT has opened up new avenues of trade in case of services. The preparation and provision of services are now vertically or horizontally fragmented between different part of the world and the intermediate and final services are traded with the help of communication

[1] Since we have assumed time zones of the two countries to be such that daytime of one does not coincide with the daytime of the other, all of 24 hours can be utilized to work without wasting any time. Therefore the discount factor attains the value one. If some hours of daytime would have colluded with each other, 24hours of countinuous work could not be achieved as one of the teams will have to stay idle during the overlapping hours. This will not allow δ to attain the highest value, 1. This idea follows from Marjit (2007) and Mandal (2015).

[2] The outcome is similar to the Stolper Samuelson theorem.

network. Thus development of ICT has made outsourcing of service activities a common trend. In this respect, the paper is an attempt to highlight the effect of time zone difference as a beneficial factor that needs to be considered while deciding the location to outsource. Even if cost, technology, efficacy of performing a task is same, just the difference in time zones can prove to be beneficial for trading a service. To show this we construct a model having the Heckscher-Ohlin type of framework where earlier production is valued more. We find that fragmenting production to a country located in non-overlapping time zone leads to an expansion of the service sector. On the other hand the sector sharing the same factors with the service sector is seen to contract. Also the factor that is used intensively in the production of the service gains while the other factor loses.

Appendices

This section elucidates the mathematical calculations and derivations regarding how splitting production between different time zones affects the factor prices and output of the economy. The resultant effect on factor prices is shown in *Appendix A* while *Appendix B* is assigned to illustrate the change in output level. For convenience, all the symbols used in the paper are summarized as follows: X= service; Y= tangible good; S= skilled labour; K= capital; w_S= wage; r=rent; δ=discount factor; P_X= price of X; P_Y= price of Y; a_{ij}= amount of factor i required for production of one unit of j $(i = S, K; j = X, Y)$; θ_{ij}=share of i in price of j; λ_{ij}= employment share of factor i in sector j.

The basic structure of the model is summarized in the following equations

$$2w_S + 2r = \delta P_X \tag{1}$$

$$a_{SY} w_S + a_{KY} r = P_Y \tag{2}$$

$$2X + a_{SY} Y = S \tag{3}$$

$$2X + a_{KY} = K \tag{4}$$

Equation (1) and (2) shows the competitive market equilibrium condition where cost of producing one unit is equal to the price. (3) and (4) gives the skilled labour and capital constraint respectively. There are four unknowns w_S, r, X and Y and four equations hence the model is solvable.

Appendix A

Differentiating both sides of (1) we get,

$$2dw_S + 2dr = P_X d\delta$$

Dividing throughout by P_X and expressing relative change by '^',

$$\frac{dw_S}{w_S}\frac{2w_S}{P_X} + \frac{dr}{r}\frac{2r}{P_X} = \frac{d\delta}{\delta}\frac{\delta P_X}{P_X}$$

$$\hat{w}_S\theta_{SX} + \hat{r}\theta_{KX} = \hat{\delta}\delta \tag{5}$$

Similarly from (2)

$$\hat{w}_S\theta_{SY} + \hat{r}\theta_{KY} = 0 \tag{6}$$

Here θ_{ij} $(i = S, K; j = X, Y)$ refers to the share of i in price of j. The symbols follows from Jones (1965, 1970). Equations (5) suggests that change in δ will be absorbed by changes in w_S and r. Since both the sectors use the same factors, the equilibrium condition of sector Y also gets affected. Using (5) and (6) we can solve for the values for the relative change in skilled wage (w_S) and rent (r). The results are as follows:

$$\hat{w}_S = \hat{\delta}\delta\left(\frac{\theta_{KY}}{|\theta|}\right) > 0 \tag{7}$$

$$\hat{r} = (-)\hat{\delta}\delta\left(\frac{\theta_{SY}}{|\theta|}\right) < 0 \tag{8}$$

The denominator$|\theta| = \theta_{SX}\theta_{KY} - \theta_{SY}\theta_{KX}$. Since X is S intensive and Y is K intensive $\theta_{SX} > \theta_{SY}$ and $\theta_{KY} > \theta_{KX}$. Therefore $|\theta| > 0$ and a positive $\hat{\delta}$ makes $\hat{w}_S > 0$ and $\hat{r} < 0$. This implies, an increase in the discount factor due to utilization of time zone difference results in a rise in skilled wage and a fall in rent when the sector utilizing the time zone difference is skilled labour intensive. The results are similar to what we get from the Stolper-Samuelson theorem but here

the resultant effect is not because of the rise in price but because of rise in δ. We also find that the relative change in w_S is more than that in r-

$$\hat{w}_S - \hat{r} = \hat{\delta}\delta\left(\frac{\theta_{KY}}{|\theta|}\right) - (-)\hat{\delta}\delta\left(\frac{\theta_{SY}}{|\theta|}\right)$$

$$\text{or,} \qquad \hat{w}_S - \hat{r} = \frac{\hat{\delta}\delta}{|\theta|}(\theta_{KY} + \theta_{SY})$$

$$\text{or,} \qquad \hat{w}_S - \hat{r} = \frac{\hat{\delta}\delta}{|\theta|} > 0$$

Appendix B

Since the factor prices has changed, the cost minimizing blend of inputs can now be changed. However given our assumptions, the input coefficients of X cannot be changed but it is possible for Y to substitute K with Skilled labour at a constant rate. The rate at which substitution can take place is given by the elasticity of substitution:

$$\sigma_Y = \frac{\hat{a}_{SY} - \hat{a}_{KY}}{\hat{r} - \hat{w}_S}$$

To find the relative change in the input coefficients we manipulate the formula of elasticity of substitution as:

$$\hat{a}_{SY} = \hat{a}_{KY} - (\hat{w}_S - \hat{r})\sigma_Y \qquad (9)$$

Together with this we make use of the envelop condition

$$\hat{a}_{SY}\theta_{SY} + \hat{a}_{KY}\theta_{KY} = 0$$

$$\Rightarrow \hat{a}_{KY} = -\hat{a}_{SY}\frac{\theta_{SY}}{\theta_{KY}}$$

Substituting the value of $\hat{a}_{KY}$ in (9) and putting the value of $(\hat{w}_S - \hat{r})$ we've

$$\hat{a}_{SY} = (-)\hat{\delta}\delta\frac{\theta_{KY}}{|\theta|}\sigma_Y < 0 \qquad (10)$$

Similarly we get,

$$\hat{a}_{KY} = \hat{\delta}\delta\frac{\theta_{SY}}{|\theta|}\sigma_Y > 0 \qquad (11)$$

Thus, there is a rise in the amount of K required per unit of Y and a fall in that of S.

Now, to check the relative change in output we take total differential of (3) and (4) and express them in relative change form

$$\lambda_{SX}\hat{X} + \lambda_{SY}\hat{Y} + \lambda_{SY}\hat{a}_{SY} = 0$$

$$\lambda_{KX}\hat{X} + \lambda_{KY}\hat{Y} + \lambda_{KY}\hat{a}_{KY} = 0$$

Using (10) and (11),

$$\lambda_{SX}\hat{X} + \lambda_{SY}\hat{Y} = \lambda_{SY}\hat{\delta}\delta\frac{\theta_{KY}}{|\theta|}\sigma_Y$$

$$\lambda_{KX}\hat{X} + \lambda_{KY}\hat{Y} = (-)\lambda_{KY}\hat{\delta}\delta\frac{\theta_{SY}}{|\theta|}\sigma_Y$$

Using Cramer's rule,

$$\hat{X} = \frac{\delta\hat{\delta}}{|\lambda||\theta|}\lambda_{KY}\lambda_{SY}\sigma_Y > 0$$

$$\hat{Y} = (-)\frac{\delta\hat{\delta}}{|\lambda||\theta|}(\theta_{SY}\lambda_{SX}\lambda_{KY} + \theta_{KY}\lambda_{KX}\lambda_{SY})\sigma_Y < 0$$

Where, $|\lambda| = \lambda_{SX}\lambda_{KY} - \lambda_{KX}\lambda_{SY}$

Thus, utilization of time zone difference for production of a service raises service output whereas indicates a contractionary effect on the other sector. This effect is independent of the factor intensity assumption as both $|\lambda|$ and $|\theta|$ have the same sign.

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