Response to Referee's comments (2)

First of all I would like to thank you for your valuable comments and suggestions on this note. I have tried to address most of the points you raised in the report. Relevant changes are also made in the revised draft. The detailed responses are listed below.

1. From the introduction I am not sure what the paper adds to the literature. Are there any different conclusions to the existing literature? Why the focus on services and distance in particular? What are the lessons we learn from reading the paper?

R#1. In the introduction (pp 5) of the revised draft I have explicitly talked about how this note is different from the existing papers, and how this short note adds some value to the literature on Time Zone and Trade.

By this time it is, perhaps, clear that total volume of trade has two components: physical trade and virtual trade. Physical trade falls with distance. But my focus in this note is on the relationship between virtual trade and distance. The idea of virtual trade is essentially trade in services or trade in labor tasks that can be exported and imported back via internet. This part is relatively less explored. So in this note I strive to add some value to the existing literature which is yet to be highly researched. In doing so I attempt to relate physical distance influencing (non-) overlapping time zones between two trading partners with virtual trade. Notice that this kind of trade becomes a central issue of research only after information technology revolution. So a reduction in the cost of communication is the primary driving force for virtual trade. Hence I start with a negligible cost of communication.

The world being circular, time zones are essentially the reflection of aerial distance. Therefore, in a finer sense distance between two places are exhibited by the difference in time zones or calendar dates. And, hence, in the hindsight of time zone and trade literature there is physical distance that triggers virtual trade positively which is quite contradictory with the standard 'distance and goods' trade' arguments. Taking clue from this baseline wisdom I move forward to check how distance can impact on volume of production and trade. Then I briefly attempt to look at if such kind of trade caused by difference in time zone which in turn led by distance may induce any change in capital accumulation or output growth.

2. I find dubbing the trade in services as 'virtual trade' unfortunate. Trade is still happening, but happens to be in labor services.

R#2. I agree that trade in all types of services is not virtual, but most of the service trade is virtual if we ignore the physical presence of the service provider. So I used

the term "virtual". I started from this point and it has been mentioned in the second paragraph of the introduction (pp 3). Again the issue of labor tasks or services are briefly mentioned in the introduction (**also see R#1**).

3. The model seems deterministic. From the model's set-up it seems obvious that output and trade will increase; the time saving is modeled as a change in the in the final price. Therefore, a country with a higher final price - i.e. a country not exploiting the time zone differences - has a lower output.

R#3. Yes, this is the main channels through which the model works.

4. In the model it is not clear which goods are traded or whether trade is balanced (I assume so). Is the final good traded for an intermediate stage, or are both intermediate stages traded? This should be clarified.

R#4. You assumption of balanced trade is absolutely true. Following your concern I have attempted to provide with the explanation for pattern of trade (pp 8-9).

Using the thought process one can easily understand that not only the final good production (possibility of trade as supply becomes greater than demand) increases, along with it a double (at most) amount of m compared to S is also traded. A careful investigation of the arguments I made here makes it clear that the trade is taking place for both the intermediate inputs and final output (assuming that trade is balanced). Because, a part of S (after the first stage) is exported first. Then it is imported back after the final stage is done. Similar kind of pattern of trade can be experienced for both the trading partners as countries are free to allocate resources between intermediate input and final output production. Here it is worth mentioning that we have implicitly assumed identical factor endowment and technology of production in order to rule out Heckscher-Ohlin and Ricardian comparative advantage principles. For both the countries the final output is in fact "timely" delivered in identical calendar date though there would be difference in the time of delivery due to time zone difference. This implies a surge or abrupt increase in trade volume. It is interesting to note that this hike in trade volume is only because of virtual trade which is made possible through internet communication revolution.

5. The effect of distance on the consumer's valuation is rather ad hoc and not clear to me. With respect to the latter point consider, for example, the problem of coordination costs. The further away the foreign affiliate is, the less time is available to coordinate the work, which increases the risk of something going wrong. One might therefore think that there is an inverse u-shaped effect of distance on the consumer's valuation. The author should provide a strong rational for the distance assumption.

R#5. I am sorry that I am not in complete agreement with this comment as coordination cost in Time Zone literature is essentially communication cost through internet, which is now-a-days available at a nominal cost and independent of distance, per se. So there is no point of less availability of time to coordinate with the affiliate located at a distant place. We assume that there is nothing like monitoring cost. This may bring another dimension to the literature. However, your concern is valid in form of (un)timely delivery if time-zones are overlapping or countries are located relatively closely. Nevertheless in light of your worry I have restructured the entire sub-section III including the footnotes (pp 8-10).

I have mentioned earlier that difference in time zones depends on physical distance, d, i.e.

$$\delta = \delta(d); \hspace{8cm} (7)$$

$\delta \geq 1$ and $\delta' < 0$. $\delta = 1$ when countries are located in non-overlapping time zones (maximum aerial distance) and $\delta > 1$ for overlapping time zones. When overlapping time stretch increases (aerial distance falls) δ goes up and conversely. Nevertheless δ remains greater than unity as long as there is any overlapping time in calendar date. The argument is built on the assumption that the globe is circular and the distance between places are measured aerially. And I further consider that the distance between two places can be covered along the diameter of the globe (circle)[1]. I also assume that in order to exploit the benefit of time zone difference it has to be exactly non-overlapping. Note that δ takes any value greater than unity when virtual trade occurs between countries located in two overlapping time zones i.e., δ takes the value $\bar{\delta}>1$ for all such countries. When $\delta = \bar{\delta} = 1$, virtual trade is most beneficial in that the loss injected by untimely delivery of the final output is completely vanished.

Using the thought process one can easily understand that not only the final good production (possibility of trade as supply becomes greater than demand) increases, along with it a double (at most) amount of m compared to S is also traded. A careful investigation of the arguments I made here makes it clear that the trade is taking place for both the intermediate inputs and final output (assuming that trade is balanced). Because, a part of S (after the first stage) is exported first. Then it is imported back after the final stage is done. Similar kind of pattern of trade can be experienced for both the trading partners as countries are free to allocate resources between intermediate input and final output production. Here it is worth mentioning that we have implicitly assumed identical factor endowment and technology of production in order to rule out Heckscher-Ohlin and Ricardian comparative advantage principles. For both the countries the final output is in fact "timely" delivered in

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[1] If we consider the story of covering the linear distance or travelling through the circumference of the circle the relationship between distance and trade in labor task or services or virtual trade will exhibit an inverted U-shape. Volume of virtual trade will increase (when δ is continuous) with distance first indicating an increase in non-overlapping stretch of time (day or night) and hence δ approaches unity. Thereafter, δ again goes up inflicting a negative effect on virtual trade. I thank an anonymous referee for clarifying this issue.

identical calendar date though there would be difference in the time of delivery due to time zone difference.[2] This implies a surge or abrupt increase in trade volume. It is interesting to note that this hike in trade volume is only because of virtual trade which is made possible through internet communication revolution.[3]

Now let us modify equation (7) and make it continuous and plug it into the profit maximizing level of output.

$$\delta = \delta(d) \qquad\qquad (8)$$

Note that $\delta'(d) < 0$. Therefore,

$$S_t = K(P_S)^{\frac{1-\alpha}{\alpha}} \left(\frac{1-\alpha}{2}\right)^{\frac{1-\alpha}{\alpha}} \left(\delta(d)\right)^{\frac{\alpha-1}{\alpha}} \qquad\qquad (9)$$

Equation (9) yields that as distance rises δ gradually falls (but it still takes a value greater than unity) and S goes up. S reaches the maximum when d corresponds to exactly non-overlapping time zones associated with maximum distance along the diameter of the globe.

The welfare implication for virtual trade is very easy to understand. For a small country framework, without changing the terms of trade the volume of trade has gone up implying an unambiguous increase in welfare. Even if the countries are large and trade in final goods/services is not allowed, the volume of trade effect will raise the welfare. Along with it domestic production of consumable S goes up. Therefore an increase in welfare is unambiguous.

Proposition II: With distance both volume of trade and welfare increases as $\delta'(d) < 0$ and $\delta > 1$. ∎

6. How is the labour endowment distributed across the world? Is the conclusion robust to variations in the distribution of the endowments?

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[2] I thank an anonymous referee for asking me to clarify this point.

[3] This is done in Kikuchi (2009) but in a different structure. Kikuchi (2009) used a three country framework to analyze how internet connection translates the time zone difference into comparative advantage. So the unconnected country fails to exploit the time zone related natural difference. Therefore internet connectivity leads to trade creation. In this paper though I indirectly hint at trade creation proposition, I do not consider a three country model that can easily be extended for. Further I attempted to go slightly beyond the time zone argument by bringing in the issue of distance to the forefront. Here internet connectivity is a necessary condition, but to extract benefit fully from internet connection the countries need to be located at a distance. To be more precise the distance consistent with non-overlapping time zone is most advantageous.

R#6. Please see R#4 where I have explained why I have implicitly assumed identical factor endowment (also see pp 8-9).

7. In section IV the author states that the section's focus is "on impact of distance on growth." However, this is no correct. The focus is on capital accumulation, rather than economic growth, which is conventionally defined as a continuous growth of output.

R#7. I have just hinted at the physical capital accumulation which is primarily triggered by distance related time zone differences. I agree with your hesitation. Accordingly, I have modified the title of the sub-section IV (pp 10) and also done some required changes wherever necessary.

References

Kikuchi, T., (2009), "Time Zones as a Source of Comparative Advantage", *Review of International Economics*, 17(5), 961-968.