Digital Mobility of Financial Capital Across Different Time Zones, Factor Prices and Sectoral Composition

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Abstract

In this paper I make an effort to formalize the possibility of transfer of financial capital across time zones to exploit the benefit of day night mismatch between two countries. The major pre-condition for such transaction is the completion of production, buying and selling of the product in twelve hours day-time of any calendar date. And the process of monetary transaction must be done through digital platform. In this backdrop I argue that exploration of such possibility reduces the effective cost of capital in the sector which is potentially time-zone difference exploitative. Subsequently we find other factor price effects and sectoral composition changes in a very conventional Heckscher-Ohlin nugget kind of structure. Though the results are not very surprising, but the mechanism. Without any traditional channels like trade, FDI, technology transfer, endowment changes I generate price effect due to digital mode of payment and twelve hours of activity.

JEL classification: F12, F 16, F 21

Keywords: Time Zone Differences; Service Trade; Financial Capital, Outsourcing

1. Introduction

The process of unbundling of production and consumption started long ago. During early days of our civilization, we had a system of completely bundled economic activities such as production of goods and services and the consumption of these very goods and services. In this sense the economy was then purely localized- your consumption set is defined by what you produce. Soon people realized that such localized arrangement is not capable of bringing in efficiency in production. Such efficiency can be ensured only if the choice of production of various goods is done following comparative cost advantage and the division of labour. However, the main obstacle was huge transportation cost. But with time and with theinventionof better transportation facilityor technological progress in transportation, people gradually started thinking of not producing everything theyneed, instead procure some needed goods fromothers. That was the starting point of 'unbundling'. Then we moved to another phase ofunbundling covering fragmentation of production of any commodity. Currently we are in the phase of another round of unbundling whichis beyond fragmentation of goods production oroutsourcing in goods production. In this phaseof unbundling, we do trade in service and ideas e.g., BPO, ITES, consultancy etc. However,in all these rounds of unbundling the maindriving forces remained same - reduction inthe cost of production, accessing the final outputquickly and that too from the efficient source.It has been observed in therecentpast that trade in ideas is gradually taking the front seat pushing traditional goods trade back.Such tradein ideas encompass medical consultancy, proof-reading, codes for software etc. Interestinglycartographical distance between trading partners hasinteresting implications for cost of moving goodsand ideas [Mandal, (2015); Baldwin, (2016)]. With revolution ininformation communication technology, the cost of movingideas is driven down to almost zero, whereas formoving goods the cost rises with distance. In thisline ofargument, we canexplore further to examinethe issue of location of countries across overlapping and non-overlapping time zones. Such dimension is nicely captured in Kikuchi (2011, 2013), Marjit, Mandal andNakanishi (2020) (hereafter, MMN) and Marjit, Das and Mandal (2023) (hereafter MDM).

In this paper, we extend our analysis beyondthe concerns raised in the existing literature that includes Mandal and Prasad (2021), Anderson (2014), Anderson and Van Wincoop (2003), Aviat and Coeurdacier (2007), Baldwin (2017), Baldwin and Venables (2013), Brei and von Peter (2018), Christen (2017), Dettmer (2014), Egger and Larch (2013), Fink et al. (2005), Head et al. (2009), Kikuchi (2011), Kikuchi et al. (2013), Lin and Sim(2012), Mandal (2015),Marjit, Das and Mandal (2023), Marjit, Mandal and Nakanishi (2020), Martin and Rey (2004), Matsuoka and Fukushima (2010), Nakanishi and Long (2015, 2020),Raguideau-Hannotin (2023), Stein and Daude (2007).

Taking clue from Chapter 12 of MMN (2020)we check how capital mobility across time zones(TZs) can change the interest rate and other factorprices. However, before that we try to motivate on how and why it is reasonable to exploit the time zone difference in respect of capital mobility which in nature is mobile.And subsequently the possible effects onwage disparity, sectoral composition, informality in the economy are also examined. We will come back to this issue in a later section.

The entire paper is arranged as follows: Section 2 tries to set the platform along with the background environment for the basic model which would be placed in Section 3. Section 4 attempts to develop a variant of the model with a new competitive sector in both the cases our attempt remains to figure out the consequences of financial capital flow across TZs. The last section concludes the paper and also indicates at the possible complications of such mobility of financial capital along with solution techniques.

2. Driving Environment

Traditional economic arguments entail that the price of any factor of production is primarily determined by the marginal productivity theory. Such theory provides satisfactory applicationof marginalistic principle which even helps solving for factor prices in imperfectly competitive markets. And then depending on the degree of mark-up or imperfection related exploitation, we assign various levels of factor prices in different factor markets. This defines demand side of the story. It is also true that the nature of supply of factor has some usual connotations. But one

important thing that we usually miss in such analysis is the amount of time the factor is used for production. While calculating factor prices we, in the hindsight, assume that there is no difference between the factor usage time and factor retention time. To be a bit more explicit, retention time includes both usage time and idle time. So, the factor price is ideally the returns to factor for its retention time. Now whether the retention time is identically equal with usage time that depends on the producers who use such factor.

For example, labor is used for twelve hours in a calendar date because labor is assumed to work only during day-time. After the day-time the labor is free, the producer cannot force him to retain and to work. So, for labor, usage time and retention time are identical, though labor price, w , is the return to labor according to its usage time only[1].

Now let's move to the case of use of capital across day and night which is not so easy and hence turns out to be interesting. We assume only working capital or financial capital which is directly used for production of goods and services. We also assume that such activity requires only 12 hours or day-time of a calendar date. Physical capital is not considered here because even if the production is over in 12 hours, we cannot withdraw the physical capital from the production process and use it for something else. However, this does not indicate that we completely ignore the presence of physical capital as factors of production in our analysis. We will surely have those factors but nature of capital there is distinctly different from that of the working capital or financial capital.Such dimension of capital would be more explicit in the later part of this article. One more thing I want to mention in this context that I would be using working capital and financial capital interchangeably as both are capable of corroborating any argument of mobility of capital across TZs. Therefore, in a sense, physical capital is stuck, and such stickiness of capital for the remaining 12 hours (night-time) of the calendar date must be taken into account by the owner of the

[1]In our case, even if there is any difference between usage time and retention time, it does not matter. In fact, we are not much bothered because of the following reasons:Our focus is not the labor price, though some consequences on labor price must be there; labor cannot be transferred very quickly across TZs.

physical capital while determining its price. So, for physical capital, price of capital is the return to usage time (day-time) plus idle time (night-time). On the other side of the story, the characterof working capital is markedly different from physical capital. Working capital or financial capital is free since the production is over in 12 hours (day-time) and the produce is sold in the market.[2] Then it is up to the producer what he wants to do with such working capital. He can use it for production purpose or can keep it idle or re-use it again for production until the next morning as he wouldrepay the lender/owner only next day morning. To put our arguments in a more reader friendly manner, let's assume that the producer borrows financial capital, K, from a bank at a given interest rate, r, per calendar date. Bank is not interested to know what the producer is doing with it during the calendar date. Bank just wants the interest rate, r, next day morning. Also notice that the bank remains closed for 12 hours during the night time. Hence, r, interest rate is charged for 24 hours of a single calendar date where 24 hours is calculated as a continuous one. So, the producer has to repay r as the interest rate.[3]A very brief mathematical exposition of this argument and hypothetical possibilities are provided in Appendix-I.

Now, for some sectors which use financial capital, the producer uses Kduring 12 hours of day-time, production gets over in the evening, it is sold in the market, and hence $K$is back to the producer. But the producer cannot repay the money, because the bank is closed by that time.So, even if$K$ is not used further during the 12 hours night time, the cost of capital would be exactly r. In such case K is retained for 24 hours of the calendar date, out of which 12 hours of day-time is the usage time and the remaining 12 hours of night-time is idle time.

Alternatively, if the same K is used during night-time and can fetch some return, then either the return to K to the producers would be greater than r, guaranteeing supernormal profit for the borrower of the K.Or, in a competitive set up,

[2] Stock market trading where the seller gets some money only at the end of the day could be a classic example of use of such financial capital.

[3]May be similar type of transaction is taking place now, but we are not directly involved into it. Since our transaction demand for money is very low during night/sleep time, bank can digitally use our money to do some business in other countries which are located in non-overlapping time zones.

where the borrower needs only r, required to pay the bank, the cost of using capital during day-time must be less than r. The same for night-time would also be less than r. In an ideal situation it should be $\frac{r}{2}$for day-time and $\frac{r}{2}$for night-time. And also remember that the borrower gets back K with r interest rate next day morning, and he visits the lender bank and repays the full amount. This is possible when financial capital can be transferred digitally, at a zero-transfer cost across non-overlapping time zones.[4] In such situation, the effective supply of capital is just being doubled. So, we are in a position to explore the consequences of removal of idle time from the process of production and usage of factors.[5]

Mathematically, $r = f(K, T_K^R)$

$f'_K < 0$

Where, K = Supply of financial capital

T_K^R= Time, K is retained

$T_K^R = T_K^U + T_K^I$

T_K^R is constant = Continuous 24 hours; T_K^U = Time capital is used for work; T_K^I = Time capital remains idle.

Thus,

$r = f[K, (T_K^U + T_K^I)]$

$f'_{T_K^U} < 0 \quad and f'_{T_K^I} > 0$in the sense that $(\frac{r}{T_K^U})$ falls and $\left(\frac{r}{T_K^U}\right)$ rises, respectively.

T_K^U and T_K^I are inversely related and T_K^R is constant.

When $T_K^U = T_K^I = 12\ hours$ and the rate of interest paid for the whole day is r, this r is essentially paid for $T_K^U = 12\ hours$. Hence per hour interest rate is $\frac{r}{12}$. The cost of using K for 12 hours is $\frac{r}{12} \cdot 12 = r$. When T_K^I increases and $T_K^I > 12\ hours$, r is paid for T_K^U which is less than 12 hours (say Ω; Ω< 12). Per hour interest rate is $\frac{r}{\Omega} > \frac{r}{12}\ as\ \Omega <$

[4] For more analysis on non-overlapping time zones and transfer related issues one can refer to Marjit, Mandal, Nakanishi (2020), Kikuchi (2013) and the references there.

[5] So, such transfer of working capital has the potential to simultaneously generate both Stolper-Samuelson and Rybczynski effects in a conventional competitive trade model.

12. Therefore, the cost of using K for 12 hours would be $\frac{r}{\Omega} \cdot 12 > r$. On the contrary when T_K^I decreases, T_K^U rises and becomes greater than 12 hours (say Γ> 12). Hence, per hour interest rate is $\frac{r}{\Gamma} < \frac{r}{12}\ as\ \Gamma > 12$, and thus the cost of using K for 12 hours is $\frac{r}{\Gamma} \cdot 12 < r$. At the extreme Γtakes a value of 24 hours, leading to the cost of using K for 12 hours as $\frac{r}{24} \cdot 12 = \frac{r}{2}$.

Therefore, as T_K^U rises the effective cost of using capital for 12 hours falls. In our case it is denoted by *r*. We would unfold the consequences of a fall in *r* in more details later.

3. Benchmark Model and Results

In the backdrop of cross-country mobility of financial capital to exploit the difference rendered by day-night mismatch between two countries, we attempt to develop a theoretical framework in order to decipher the consequence of such capital mobility. We start our analysis with a small open economy where both product and factor markets are competitive. Production of relevant goods and services follows standard constant returns to scale, and marginal productivity assumption. We largely follow Jones (1965,1971) for methodological basis. However, we mix both Heckscher-Ohlin-Samuelson (HOS) and Specific Factors (SF) models to develop a hybrid structure which is popularly known as H-O nugget.

Our system of equations uses following notations with corresponding interpretation.S = (total supply of) skilled labor; K= (total supply of) financial or working capital; L= (total supply of) unskilled labor;N= (total supply of) land;$X, Y,\ Z$= Output of various sectors; a_{ij} =amount of i^{th} factor used in production of one unit of j^{th} commodity ($i = S, K, L, N$ and $j = X, Y, Z$); w_s= wage of skilled labor; w= wage of unskilled labor; $\bar{w}$= unionized wage; r= rent; P_j= price of j^{th} commodity; θ_{ij}= distributive share of i^{th} factor in j^{th} commodity; λ_{ij} = employment share of i^{th} factor in j^{th} commodity;L= (total supply of) unskilled labor;σ = elasticity of substitution.

In the basic model we have three factors producing three goods X, Y and Z. X is a typical skill-intensive sector[6]. Y defines a traditional agricultural sector which uses land *(N)* as specific factor of production. In fact, we can, for brevity assume that Y may cover both agriculture and manufacturing such that it uses *N* as specific factor[7]. And finally, sector Z introduces informality in our structure. Informality is captured not by unorganised labor usage, as has been done in the traditional literature [Marjit and Kar (2011)]. I try to touch upon the essence of informal credit market which changes an interest rate higher than *r*. Informal mark-up μ is assumed to be exogenously given. Therefore, the effective price of financial capital becomes $r(1+\mu)$. In our analysis, it does matter whether such informal capital is provided by the local money lenders or an intermediator between local banks and informal producers. Both these agents earn some money over the prevailing market interest rate which remains fixed throughout the basic model. So, in brief *X* uses skilled labor*(S)* and financial capital *(K)*; Y uses unskilled labor*(L), K* and land *(N)*; and Z uses *L* and *K*.

Assuming competitive market for both the products and factors, and full employment for all the inputs, the general equilibrium specification of our model takes the following form:

$$a_{SY} \cdot w_S + a_{KX} \cdot r = P_X \quad (1)$$

$$a_{LY} \cdot w + a_{KY} \cdot r + a_{NY} \cdot R = P_Y \quad (2)$$

$$a_{LZ} \cdot w + a_{KZ} \cdot r(1+\mu) = P_Z \quad (3)$$

Readers are requested to carefully note that same K is earning different return in different sectors. X and Y yield *r*, whereas Z yield $r(1+\mu)$. However, *K* is perfectly mobile across X, Y and Z as far as '*r*' is concerned.[8] It has no implication for μ. One

[6] Note that we don't consider the possibility of offshoring of intermediate services across TZs and appropriate the time preference approach of the consumers. For such arguments ne can check MMN(2020).

[7]N can encompass both physical capital and land. Also note that in the next section we develop a variant of the basic model where agriculture and manufacturing are considered separately.

[8]The producer himself can borrow money in the morning at *r* interest rate; use it throughout the day; then use it to lend someone residing in non-overlapping TZ. In that case the cost of capital used in X should not be *r* at which the borrower borrowed money from banks or any financial institutions.

more thing we must emphasis that in X and Y, *K* does not have the option to move during night which is possible in Z. So, for X and Y there is no difference between usage time and retention time. But the case of Z is different. Hence for Z, equation (3) becomes:

$$a_{LZ} \cdot w + a_{KZ} \cdot (1+\mu)\, f[\bar{K}, (T_{KZ}^{U} + T_{KZ}^{I})] = P_Z \qquad (3A)$$

Further assume that, supply of financial capital is fixed at $\bar{K}$; and a_{KY} is also fixed.Also remember that $T_{KZ}^{U} + T_{KZ}^{I} = 24$; thus an increase in T_{KZ}^{U} signifies a decrease in T_{KZ}^{U}. Following the argument, we developed before $r' = \frac{\delta r}{\delta T_{KZ}^{U}} < 0$. Such functional form of financial capital in the sector with potential to exploit TZ difference can easily be incorporated in the main model. However, to fetch the main results of our model we can just consider the fall in *r* as an exogenous shock, and can carry on with equation (3) instead of (3A).

Full employment conditions are

a_{KY} is assumed as fixed.

$$a_{SX}X = \bar{S} \qquad (4)$$

$$a_{KY}Y + a_{KX}X + a_{KZ}Z = \bar{K} \qquad (5)$$

$$a_{LY}Y + a_{LZ}Z = \bar{L} \qquad (6)$$

$$a_{NY}Y = \bar{N} \qquad (7)$$

We follow standard 'hat' algebra following Jones (1965, 1971) in order to derive relevant results.

From (1)

$$\widehat{w_S} = (-)\hat{r}\,\frac{\theta_{KX}}{\theta_{SX}} > 0 \qquad (8)$$

Knowing that he can earn some money from his friend staying in non-overlapping TZ, he calculates the remaining amount required to pay the lender. Therefore, the unit cost of capital in X must be less than what was when the capital remained idle during night. But since the market is competitive and the concerned country is small, price of the commodity or service remains unchanged. In what follows other factors benefit due to a fall in *r*.

From (3)

$$\widehat{w} = (-)\hat{r}\frac{(1+\mu)\theta_{KZ}}{\theta_{LZ}} > 0 \quad (9)$$

From (2)

$$\hat{R} = (-)\widehat{w}\frac{\theta_{LY}}{\theta_{NY}} - \hat{r}\frac{\theta_{KY}}{\theta_{NY}}$$

$$\hat{R} = (+)\hat{r}\frac{[(1+\mu)\theta_{KZ}\theta_{LY} - \theta_{KY}\theta_{LZ}]}{\theta_{LZ}\theta_{NY}} \quad (10)$$

If Z is *L*-intensive andY is *K*-intensive

$$[(1+\mu)\theta_{KZ}\theta_{LY} - \theta_{KY}\theta_{LZ}] < 0 \Rightarrow \hat{R} > 0$$

Wage inequality between skilled and unskilled workers is defined as follows:

$$(\widehat{w_S} - \widehat{w}) = \left(-\hat{r}\frac{\theta_{KX}}{\theta_{SX}} + \hat{r}\frac{(1+\mu)\theta_{KZ}}{\theta_{LZ}}\right)$$

$$= \hat{r}\left(\frac{(1+\mu)\theta_{KZ}}{\theta_{LZ}} - \frac{\theta_{KX}}{\theta_{SX}}\right)$$

$$= \hat{r}\left[\frac{(1+\mu)\theta_{KZ}\theta_{SX} - \theta_{KX}\theta_{LZ}}{\theta_{LZ}\theta_{SX}}\right] \quad (11)$$

Usually, X uses more *S* than K and Z is K intensive compared to X. In such case $(\widehat{w_S} - \widehat{w}) < 0$.

Wage inequality may increase even if X is not S-intensive and Z is not *K*-intensive. In that case the following inequality should hold:

$$[(1+\mu)\theta_{KZ}\theta_{SX} - \theta_{KX}\theta_{LZ}] > 0 \quad (11A)$$

$$\theta_{KZ}\theta_{SX} > \frac{\theta_{KX}\theta_{LZ}}{(1+\mu)} \Rightarrow \frac{\theta_{KZ}\theta_{SX}}{\theta_{KX}\theta_{LZ}} > \frac{1}{1+\mu} \Rightarrow \frac{\theta_{KX}\theta_{LZ}}{\theta_{KZ}\theta_{SX}} < (1+\mu)$$

$$\Rightarrow (1+\mu) > \frac{\theta_{KX}\theta_{LZ}}{\theta_{KZ}\theta_{SX}} \quad (11B)$$

Thus, we have our first Proposition.

Proposition I: *Following capital mobility across TZs wage inequality decreases if X is S-intensive and Z is K-intensive.*

The apparent intuition one gets is that the factor intensity assumption between X and Z automatically guarantees satisfaction of equation (11). Factor -intensity comparison ensures $(\theta_{KZ}\theta_{SX} - \theta_{LZ}\theta_{KX}) > 0$. We also know that $\mu > 0$. And hence $(1+\mu) > 0$. Therefore, $[(1+\mu)\theta_{KZ}\theta_{SX} - \theta_{LZ}\theta_{KX}] > 0$ which is very apparent. And equation (11B) is also automatically satisfied under equation (11A). However, satisfaction of $(1+\mu) > \frac{\theta_{KX}\theta_{LZ}}{\theta_{KZ}\theta_{SX}}$ does not necessarily require the factor intensity assumption mentioned before. Hence, we conclude that wage inequality may decline even without assuming that X is *S*-intensive and Z is *K*-intensive. A careful investigation of equation (11B) also asserts that it is individually based on factor-intensity comparison between X and Z. From the above comparison we know,

$$\theta_{KZ}\theta_{SX} > \theta_{KX}\theta_{LZ} \Rightarrow \frac{\theta_{KX}\theta_{LZ}}{\theta_{KZ}\theta_{SX}} < 1$$

On the other hand, $(1+\mu) > 1$. Thus $(1+\mu)$ must be greater than $\frac{\theta_{KX}\theta_{LZ}}{\theta_{KZ}\theta_{SX}}$. Also remember that the economic interpretation of the implications of factor intensity assumption between X and Z are very usual and are in line with Jones (1971), Mandal &Marjit (2010) etc.

Now let us move to output effect of financial capital mobility across TZs.From the concept of elasticity of substitution in Y, assuming thata_{KY} is fixed (for example tractor, machine, sprayer, irrigation pump etc.)

$$\widehat{a_{TY}} = (+)\sigma_Y(\hat{w} - \hat{R})\theta_{LY} = \sigma_Y\left[-\hat{r}\frac{(1+\mu)\theta_{KZ}}{\theta_{LZ}} - \hat{r}\frac{(1+\mu)\theta_{KZ}\theta_{LY} - \theta_{KY}\theta_{LZ}}{\theta_{LZ}\theta_{NY}}\right]$$

$$= (-)\sigma_Y\left[\frac{(1+\mu)\theta_{KZ}\theta_{NY} + (1+\mu)\theta_{KZ}\theta_{LY} - \theta_{KY}\theta_{LZ}}{\theta_{LZ}\theta_{NY}}\right]\hat{r}$$

$$= (-)\sigma_Y\hat{r}\left[\frac{(1+\mu)\theta_{KZ}(\theta_{NY} + \theta_{LY}) - \theta_{KY}\theta_{LZ}}{\theta_{LZ}\theta_{NY}}\right]$$

Borrowing from condition (10)

$[(1+\mu)\theta_{KZ}(\theta_{NY} + \theta_{LY}) - \theta_{KY}\theta_{LZ}]$ may be less than zero. Hence, $\widehat{a_{NY}}$ <0

From (7)

$$\hat{Y} = (-)\widehat{a_{NY}}$$

$$\hat{Y} = (+)\sigma_Y \left[\frac{(1+\mu)\theta_{KZ}(1-\theta_{KY})-\theta_{KY}\theta_{LZ}}{\theta_{LZ}\theta_{NY}}\right]\hat{r} > 0 \qquad (12)$$

$\hat{Y} > 0$ when Z is *L*-intensive and Y is *K*-intensive (between Y and Z). Note that Y and Z share same *L* and *K* though Y uses a specific factor, N. Hence, output effect of Y and Z must be interconnected.

Elasticity of substitution in X

$$\sigma_X = (-)\frac{\widehat{a_{SX}} - \widehat{a_{KX}}}{\widehat{w_S} - \hat{r}}$$

Or,$\widehat{a_{SX}} = \widehat{a_{KX}} - \sigma_X(\widehat{w_S} - \hat{r})$ and $\widehat{a_{KX}} = \widehat{a_{SX}} + \sigma_X(\widehat{w_S} - \hat{r})$

Therefore, $\widehat{a_{KX}} = \sigma_X(\widehat{w_S} - \hat{r})\theta_{SX}$ and

$$\widehat{a_{SX}} = (-)\sigma_X(\widehat{w_S} - \hat{r})\theta_{KX}$$

Differentiating the full employment condition for *S* one gets:$\hat{X} = (-)\widehat{a_{SX}}$

$$= (+\_)\sigma_X\theta_{KX}(\widehat{w_S} - \hat{r})$$

$$= (+)\sigma_X\theta_{KX}\left(-\hat{r}\frac{\theta_{KX}}{\theta_{SX}} - \hat{r}\right)$$

$$= (-)\sigma_X\theta_{KX}\left(\frac{\theta_{KX} + \theta_{SX}}{\theta_{SX}}\right)\hat{r}$$

$$\hat{X} = (-)\sigma_X\frac{\theta_{KX}}{\theta_{SX}}\hat{r} \qquad (13)$$

$\therefore \hat{X} > 0$ unambiguously as $\hat{r} < 0$.

And from (6)

$$\lambda_{LY}\hat{Y} + \lambda_{LZ}\hat{Z} = 0$$

$$\hat{Z} = (-)\frac{\lambda_{LY}}{\lambda_{LZ}}\sigma_Y \left[\frac{(1+\mu)\theta_{KZ}(1-\theta_{KY})-\theta_{KY}\theta_{LZ}}{\theta_{LZ}\theta_{NY}}\right]\hat{r} < 0 \qquad (14)$$

Because $\hat{r} < 0$ and$[(1+\mu)\theta_{KZ}(1-\theta_{KY}) - \theta_{KY}\theta_{LZ}] < 0 \Rightarrow$Zcontracts.[9]

[9]One can also recheck the negative output effect from equation (5)

$\lambda_{LX}\hat{X} + \lambda_{KY}\hat{Y} + \lambda_{KZ}\hat{Z} = 0 \Rightarrow$

Hence, we have our next proposition:

Proposition II: *Due to mobility of financial capital across TZs informality declines, software industry expands.*

Explanation: We have already established that skilled wage rises due to capital mobility in the informal sector. Such increase in W_S guarantees expansion of X as *S* is used as specific factor in X. Expansion of X requires mobile factor *K*. Since total supply of *K* is fixed, increased demand for *K* must be supplied from either Y or Z. Again, we also know that *R* rises. Thus, expansion of Y is also ensured because of specificity of *N* in Y. Also, be aware of the fact that expansion of Y has to be supported by increased employment of *L* in Y. Such *L* must be released from Z. Hence, Z must shrink.

Note this part carefully while writing the draft of the paper.

4. Variant of the Basic Model

In this section we introduce manufacturing sector, Z, in the basic model. Financial capital is used only in I,informal sector. When money is used to lend in the informal sector, only μ falls.[10]

$$w_S a_{SX} + r a_{KX} = P_X \tag{15}$$

$$w a_{LY} + r a_{KY} + R a_{NY} = P_Y \tag{16}$$

$$\bar{w} a_{LZ} + r a_{KZ} = P_Z \tag{17}$$

$$w a_{LI} + r(1+\mu) a_{KI} = P_I \tag{18}$$

Quantity system gives following equations.

$$a_{SX} X = \bar{S} \tag{19}$$

$\hat{Z} = \frac{1}{\lambda_{KZ}}\left(-\lambda_{LX}\hat{X} - \lambda_{KY}\hat{Y}\right) \Rightarrow \hat{Z} = \frac{1}{\lambda_{KZ}}\left[(+)\lambda_{KX}\frac{\theta_{KX}}{\theta_{SX}}\sigma_X\hat{r} - \lambda_{KY}\sigma_Y\left(\frac{(1+\mu)\theta_{KZ}(1-\theta_{KY})-\theta_{KY}\theta_{LZ}}{\theta_{LZ}\theta_{NY}}\right)\hat{r}\right]$

$\hat{Z} = \frac{\hat{r}}{\lambda_{KZ}}\left[\frac{\theta_{KX}}{\theta_{SX}}\lambda_{KX}\sigma_X - \lambda_{KY}\sigma_Y\left(\frac{(1+\mu)\theta_{KZ}(1-\theta_{KY})-\theta_{KY}\theta_{LZ}}{\theta_{LZ}\theta_{NY}}\right)\right] < 0$

[10] Such argument can also be applied in the basic model as the mark-up μ was present only in the informal sector. We have not carried out that exercise, and have left it for readers. In this section we have added one more sector to the basic model and introduced unionized labor market.

$$a_{NY}Y = \bar{N} \quad (20)$$

$$a_{LY}Y + a_{LZ}Z + a_{LI}I = \bar{L} \quad (21)$$

$$a_{KX}X + a_{KY}Y + a_{KZ}Z + a_{KI}I = \bar{K} \quad (22)$$

Notice that our eightunknown variables are solved(w_S, w, r, R, X, Y, Z and I) from eightequations (15, 16, 17, 18, 19, 20, 21, 22). It is also important to note that informalityin this version of the model is captured by thepresence of union in Z and by the absence of labor union in I and Y.So, in terms of *L* both Y (agricultural) and I comesunderthe informal purview. At the same time non-unionized feature of unskilled labour alsoguarantees full employment of L. However,there isanother distinguishing feature ofthe informal sector I. It is the use of *K* with a mark-up in I. This particular character distinguishes I from all other sector, even from another sector Y that uses non-unionized labor.Also find an interesting nature of the structure of the extended version of the model. Equations (17) and(18) constitutes H-O sub-section of themodel whereas(15) and (16) constitutes SFM part of the model. Thus, this variant of the basic model is an amalgamation of H-O and SFM trade structures.

Whenmoneyis lent in I, and that isallowed to be sent abroad to acountry situated in NOTZ, μmust fall.When μ falls, nothing would happen to *r* whichis apparent from (17) where wage is fixed at$\bar{w}$. Given this *r*, w_S is solved from (15). Hence*w* is calculated from (18), and using these *w*and*r*we solve for R from (16). From quantity systemwe get X from (19) and Y from (20). Then (21)and (22) gives Z and I. Carefully remember that whatever happens to μ, *r* does not change.

From (17)

$$\hat{\bar{w}}\theta_{LZ} + \hat{r}\theta_{KZ} = \widehat{P_Z} = 0 \Rightarrow \hat{r} = \frac{0}{\theta_{KZ}} = 0$$

From (15)

$$\widehat{w_S}\theta_{SX} + \hat{r}\theta_{KX} = \widehat{P_X} = 0 \Rightarrow \widehat{w_S} = \frac{0}{\theta_{SX}} = 0$$

From (18)

$$\hat{w}\theta_{LI} + \hat{r}\theta_{KI} + \hat{r}\mu\theta_{KI} + \hat{\mu}\mu\theta_{KI} = \widehat{P_I} = 0$$

$$or, \qquad \hat{w}\theta_{LI} + 0 + 0 = (-)\hat{\mu}\mu\theta_{KI}$$

$$\hat{w} = (-)\mu\frac{\theta_{KI}}{\theta_{LI}}\hat{\mu} > 0 \; if \hat{\mu} < 0 \qquad (23)$$

$$\hat{w}\theta_{LY} + \hat{r}\theta_{KY} + \hat{R}\theta_{NY} = \widehat{P_Y} = 0$$

$$\Rightarrow \hat{w}\theta_{LY} + \hat{R}\theta_{NY} = 0$$

$$\Rightarrow \hat{R} = (-)\hat{w} \cdot \frac{\theta_{LY}}{\theta_{NY}}$$

$$= (+)\mu \cdot \frac{\theta_{KI}}{\theta_{LI}} \cdot \frac{\theta_{LY}}{\theta_{NY}} \cdot \hat{\mu} < 0 (24)$$

Thus, $(\widehat{w_S} - \hat{w}) = 0 + \mu \cdot \frac{\theta_{KI}}{\theta_{LI}} \cdot \hat{\mu}$

$$= \mu \cdot \frac{\theta_{KI}}{\theta_{LI}} \cdot \hat{\mu} < 0$$

Proposition III: *Due to financial capital mobility across TZ wage disparity must improve, and the result is unconditional.*

Explanation: Change in μ is appropriated by unskilled labor. Whereas skilled labor's return remains unchanged as its complementary factor, *K,* gets same price as before. Such non-changing price of *K* is guaranteed by unionized labor wage in Z. Hence, the effect on wage inequality is apparent.

Now let us very briefly check the output effects:

$\hat{Y} = (-)\widehat{a_{NY}}$

$$\widehat{a_{TY}} = \sigma_Y(\hat{w} - \hat{R})\theta_{LY} = \sigma_Y\left(-\frac{\theta_{KI}}{\theta_{LI}} - \frac{\theta_{KI}}{\theta_{LI}}\frac{\theta_{LY}}{\theta_{NY}}\right)\mu\hat{\mu} = (-)\sigma_Y\left(\frac{\theta_{NY} + \theta_{LY}}{\theta_{NY}}\right)\frac{\theta_{KI}}{\theta_{LI}}\mu\hat{\mu}$$

$$= (-)\sigma_Y\frac{\theta_{KI}}{\theta_{LI}}\frac{1}{\theta_{NY}}\mu\hat{\mu} \qquad (25)$$

$$\hat{Y} = (+)\sigma_Y\frac{\theta_{KI}}{\theta_{LI}}\frac{1}{\theta_{NY}}\mu\hat{\mu} < 0 \qquad (26)$$

Similarly,

$$\hat{X} = (-)\widehat{a_{SX}}(+)\sigma_X(\widehat{w_S} - \hat{r})\theta_{KX}$$

$$\hat{X} = (+)\sigma_X(0-0)\theta_{KX} = \sigma_X \,.\, 0 \,.\, \theta_{KX} = 0 \tag{27}$$

From (21) and (22)

$$\lambda_{LY}\hat{Y} + \lambda_{LZ}\hat{Z} + \lambda_{LI}\hat{I} = 0$$

$$\lambda_{LZ}\hat{Z} + \lambda_{LI}\hat{I} = (-)\sigma_Y \frac{\theta_{KI}}{\theta_{LI}}\frac{\lambda_{LY}}{\theta_{NY}}\mu\hat{\mu} \tag{28}$$

$$\lambda_{KX}\hat{X} + \lambda_{KY}\hat{Y} + \lambda_{KZ}\hat{Z} + \lambda_{KI}\hat{I} = 0$$

$$0 + \sigma_Y \frac{\theta_{KI}}{\theta_{LI}}\frac{\lambda_{KY}}{\theta_{NY}}\mu\hat{\mu} + \lambda_{KZ}\hat{Z} + \lambda_{KI}\hat{I} = 0$$

$$\lambda_{KZ}\hat{Z} + \lambda_{KI}\hat{I} = (-)\sigma_Y \frac{\theta_{KI}}{\theta_{LI}}\frac{\lambda_{KY}}{\theta_{NY}}\mu\hat{\mu} \tag{29}$$

Using Crammer's rule,

$$\begin{pmatrix} \lambda_{LZ} & \lambda_{LI} \\ \lambda_{KZ} & \lambda_{KI} \end{pmatrix}\begin{pmatrix} \hat{Z} \\ \hat{I} \end{pmatrix} = \begin{pmatrix} -\sigma_Y \frac{\theta_{KI}}{\theta_{LI}}\frac{\lambda_{LY}}{\theta_{NY}}\mu\hat{\mu} \\ -\sigma_Y \frac{\theta_{KI}}{\theta_{LI}}\frac{\lambda_{KY}}{\theta_{NY}}\mu\hat{\mu} \end{pmatrix}$$

$$\hat{Z} = \frac{1}{|\lambda|}\left(-\sigma_Y \frac{\theta_{KI}}{\theta_{LI}}\frac{\lambda_{LY}}{\theta_{NY}}\lambda_{KI}\mu\hat{\mu} + \sigma_Y \frac{\theta_{KI}}{\theta_{LI}}\frac{\lambda_{KY}}{\theta_{NY}}\lambda_{LI}\mu\hat{\mu}\right)$$

$$\hat{Z} = (-)\sigma_Y \frac{\theta_{KI}}{\theta_{LI}}\frac{\mu}{\theta_{NY}}\hat{\mu}\left(\frac{\lambda_{LY}\lambda_{KI} - \lambda_{KY}\lambda_{LI}}{|\lambda|}\right) \tag{30}$$

$$|\lambda| = (\lambda_{LZ}\lambda_{KI} - \lambda_{KZ}\lambda_{LI})$$

$|\lambda| < 0$ if Z is *K* intensive

Manufacturing, Z, should be *K* intensive than I.And agricultural sector Y, should be *L* intensive than I. So, Y is most *L* intensive. Hence$(\lambda_{LY}\lambda_{KI} - \lambda_{KY}\lambda_{LI}) > 0$

Thus, $\hat{Z} < 0$ if $|\lambda| < 0$ (Z is *K*-intensive), $(\lambda_{LY}\lambda_{KI} - \lambda_{KY}\lambda_{LI}) > 0$ and $\hat{\mu} < 0$.

$$\hat{I} = (-)\frac{\sigma_Y}{|\lambda|}\frac{\theta_{KI}}{\theta_{LI}}\frac{\mu}{\theta_{NY}}\hat{\mu}(\lambda_{LZ}\lambda_{KY} - \lambda_{LY}\lambda_{KZ}) \tag{31}$$

Since Z is *K*-intensive and Y is most *L*-intensive,$(\lambda_{LZ}\lambda_{KY} - \lambda_{LY}\lambda_{KZ}) < 0$, $|\lambda| < 0$, $\hat{\mu} < 0$

$\Rightarrow \hat{I} > 0$.

Proposition IV: *Manufacturing sector, Z contracts and informal sector, I expands owing to a fall in r .* ■

If I, the informal sector, is most *K*-intensive likewe assume in the basic model and Z, the manufacturing sector, *L*-intensive compared to I, $|\lambda| > 0$. Then I must contract like what we had in the basic model.

5.Conclusion

The dimension of mobility of financial capital across non-overlapping time zones following day-night mismatch between countries is not explored in the literature hitherto. I examined such phenomenon and argued that capital price must fall if we can use financial capital for the entire 24 hours of any calendar date. This is possible for those goods and services which are produced and sold in 12 hours and transaction is completely in digital mode. In such a backdrop I explored the consequences of such capital mobility in standard H-O nugget trade structure. I checked what happens to wage inequality and sectoral composition of the economy. I also checked what happens to the extent of informal activity in the economy.

Here digitalization of the entire system is creatingemployment as a separate layer between banks and the informal units for that banks are unable toreach every corner of the society, and relativelypoor people also suffer from the issue ofpaucity of collateral. Intermediaries aresuccessfully bridging such gap and acting asguarantor for the money borrowed and lent. Such intermediariesuse their personal network,social capital, and reputation to borrow moneyfrom banks, or banks may easily employ somepeople to do this intermediation to access theseunits who are not directly connected with the traditional banking mechanism. So, in asense, partially, 'incomplete' and 'inefficient' financial systemwhich fails to include 'All' is capableof creating employment in financial marketif the transaction system is nicely backed bydigital payment platform.

Before I end, I must warn about one pre-requisite for such transaction. In spite of its not-illegal nature, this sort of transfer of money across TZs is taking place at a personal level where contract incompleteness plays an important role. The more is the incompleteness; chances of defection are higher which surely thwarts the process of transfer. So, one should also think of designing a mechanism to protect the principal from the fraudulent act of the agent.

Bibliography

Anderson, E. (2014). Time differences, communication and trade: Longitude matters II. *Review of World Economics, 150* (2), 337-369.

Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American economic review*, *93*(1), 170-192.

Aviat, A., &Coeurdacier, N. (2007). The geography of trade in goods and asset holdings. *Journal of International Economics*, *71*(1), 22-51.

Baldwin, R. (2017). *The great convergence: Information technology and the new globalization*. Harvard University Press.

Baldwin, R., & Venables, A. J. (2013). Spiders and snakes: Offshoring and agglomeration in the global economy. *Journal of International Economics*, *90*(2), 245-254.

Brei, M., & von Peter, G. (2018). The distance effect in banking and trade. *Journal of International Money and Finance*, *81*, 116-137.

Christen, E. (2017). Time zones matter: The impact of distance and time zones on services trade. *The World Economy*, *40*(3), 612-631.

Dettmer, B. (2014). International service transactions: Is time a trade barrier in a connected world? *International Economic Journal, 28* (2).

Egger, P. H., & Larch, M. (2013). Time zone differences as trade barriers. *Economics Letters*, *119*(2), 172-175.

Fink, C., Mattoo, A., & Neagu, I. C. (2005). Assessing the impact of communication costs on international trade. *Journal of International Economics, 67* (2), 428-445.

Head, K., Mayer, T., & Ries, J. (2009). How remote is the offshoring threat? *European Economic Review, 53* (4), 429-444.

Jones, R. W. (1965). The structure of simple general equilibrium models. *Journal of political Economy*, *73*(6), 557-572.

Jones, R. W. (1971). Distortions in factor markets and the general equilibrium model of production. *Journal of Political Economy*, *79*(3), 437-459.

Kikuchi, T. (2011).*Time zones, communications networks and international trade.* Routledge Studies in the Modern World Economy.

Kikuchi, T., Marjit, S., & Mandal, B. (2013). Trade with time zone differences: Factor market implications. *Review of Development Economics*, *17*(4), 699-711.

Lin, F., & Sim, N. C. (2012). Death of distance and the distance puzzle. *Economics Letters*, *116*(2), 225-228.

Mandal, B. (2015). Distance, production, virtual trade and growth: A note. *Economics*, *9*(1), 20150001.

Mandal, B., & Prasad, A. S. (2021). A simple model of time zone differences, virtual trade and informality. *Indian Growth and Development Review*, *14*(1), 81-96.

Mandal, B., &Marjit, S. (2010). Corruption and wage inequality?. *International Review of Economics & Finance*, *19*(1), 166-172.

Marjit, S., Das, G. G., & Mandal, B. (2023). *Virtual trade in a changing world: Comparative advantage, growth and inequality*. Cambridge University Press.

Marjit, S., & Kar, S. (2011). *The outsiders: Economic reform and informal labour in a developing economy*. Oxford University Press.

Marjit, S., Mandal, B., & Nakanishi, N. (2020). *Virtual Trade and Comparative Advantage*. Springer Singapore.

Martin, P., & Rey, H. (2004). Financial super-markets: size matters for asset trade. *Journal of international Economics*, *64*(2), 335-361.

Matsuoka, Y., & Fukushima, M. (2010). Time zones, shift working and international outsourcing. *International Review of Economics and Finance, 19* (4), 769-778.

Nakanishi, N., & Long, N. V. (2015). The distributional and allocative impacts of virtual labor mobility across time zones through communication networks. *Review of International Economics, 23* (3), 638-662.

Nakanishi, N., & Long, N. V. (2020). A new impetus for endogenous growth: R&D offshoring via virtual labor mobility. *Review of International Economics*.

Raguideau-Hannotin, L. (2023). The case of financial and banking integration of Central, Eastern and South Eastern European countries: A gravity model approach. *International Economics*, *174*, 91-111.

Stein, E., &Daude, C. (2007). Longitude matters: Time zones and the location of foreign direct investment. *Journal of International Economics*, *71*(1), 96-112.

Appendices

Appendix-I

I borrow*k*amount of money from Bank early morning at a certain interest rate per day. Per day means 24 hours in a day (consider any calendar date). I borrow such money to do some business. No matter if I use this money or not, I must pay r interest rate for one day (24 hours). Unfortunately, this money can be used only for 12 hours during daytime (ideally). But after 12 hours money cannot be returned to the bank as banks are closed in the evening and during night. So, though r amount is meant for 24 hours of use, the seed money is basically used for only 12 hrs. Thus, the money remains 'wasted' during 12 hours of night. I lend this money to the local business men / traders/ intermediators who don't have access to banks due to lack of collateral. – Therefore, bank finances local traders through me. I use my social capital or local network as 'guarantee' on local traders' behalf. They borrow money from me, buy local vegetables, fish (fish vendor), rural non-farm outputs (Tokri made of bamboo, plates etc.) then sale during the day-time and give my money back in the evening with interest rate τ for 12 hours.

Digital transaction or digital payment is very important in this context, because without such online payment platform for buying and selling (like Paytm, GPay, Unified Payment Interface) local businessmen cannot return money to my (lender's) account in the evening as normal banking activities are usually closed by then.

Then I can send the same money k to my friend in a non-overlapping TZ. He can do similar thing and earn τ as interest payment for 12 hours.And he can return my money before the next calendar date starts. Without that money I can't repay my bank. Across country transfer of fund is done through NEFT or any digital method.

So, Case-I

Without transfer $\pi_I = k(1+\tau) - k(1+r) = k(\tau - r) > 0; \qquad \tau > r$

Case-II

When K is transferred to non-overlapping TZ and interest rate is Ψ, total earning as profit is,

$$\pi_{II} = k(1+\Psi) + k(1+\Psi) - k(1+r) = k(1+\Psi+\Psi-r)$$

Without transfer of k, k capital fetches $k(\tau - r)$ profit. Per unit capital earns

$\frac{k(\tau-r)}{k} = (\tau - r)$profit. Notice that this is the cost of capital *r.*

If without transfer and with transfer profits are same,

$k(1+2\Psi-r) = k(\tau-r) \Rightarrow k+2k\Psi = k\tau - kr \Rightarrow k+2k\Psi = k\tau \Rightarrow 2k\Psi = k\tau - k \Rightarrow \Psi = \frac{k(\tau-1)}{2k} \Rightarrow \Psi = \frac{\tau-1}{2}$

So, the rate of interest in case of transfer possibility to a country located in non-overlapping TZ should be less than τ as $\left(\frac{\tau-1}{2}\right) < \tau \Rightarrow \Psi = \frac{\tau-1}{2} < \tau$

Alternatively, if interest remains same in both 'without transfer' and 'with transfer' case at τ , then in 'with transfer' case less capital would be enough to fetch equal amount of profit that is earned in 'without transfer' case. Say the required amount of capital is A. Thus, equal profit under these two competing situations yields following equation from which we have to determine the value of A.

$A(1+\tau+\tau-r) = k(\tau-r) \Rightarrow A = \frac{k(\tau-r)}{(1+\tau)+(\tau-r)} = \frac{k}{\frac{(1+\tau)}{(\tau-r)}+1} < k$

Under Case-II:

If profit is kept same as equal to $k(\tau - r)$

i) Either charge low interest rate; now $\Psi = \frac{\tau-1}{2}<\tau$.However, whether Ψ is less or greater than τ that is not relevant here, that is not important either; the important point is that $\Psi < r$.

OR, ii) Borrow less capital. The quantity of capital required to fetch identical profit in these two conditions is $\frac{k(\tau-r)}{(1+\tau)+(\tau-r)} < k$.