Virtual trade between different time zones, educational capital and corrupt informal sector

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Abstract

With the help of a stylized economy resembling the features of a developing country endowed with huge supply of unskilled labor, informality, informality related corruption and limited supply of educational capital we examine how virtual trade with a country located in a geographically different time zone affects the factor prices and subsequently output of different sectors. We show that skilled labors and educational capital owners are the beneficiaries of virtual trade. The service sector expands and the formal and informal good producing sectors contract along with the number of people engaged in corruption related intermediation. Following this, we also check the effect of a fall in the extent of cost of corruption. Results show an increase in unskilled wage and outflow of educational capital thus hurting the skill intensive sector. We proceed further to club the effects of both virtual trade and fall in cost of corruption and explore the consequences. Interestingly, both skilled and unskilled labors benefit. The effect on output and intermediators, however, is ambiguous.

Keywords: Time Zones; Virtual Trade; Service; Educational Capital; Informality; Corruption; Extortion.

JEL Classification: F16, F2, D73, E26, O17, L86

1. Introduction

Most of the activities of today's globalized world are connected via internet. Be it merchandise trade or service trade it has been playing a significant role. And in case of service trade the role of Information and Communication Technology (ICT) is predominant. Services that were considered to be non-tradable a few decades ago are now being traded breaking the limitation for the provider and the consumer to be present at the same place. Examples of such services can be financial services, insurance services, legal advices, accounting, advertising, management consulting, company's front desk works, services related to communication, computer, software programming etc. According to the World Bank value of ICT service exports in the world as in 2016 was about 1.4 trillion US dollars; percentage of communications, computer, information, and other services was 45.9% and that of insurance and financial services was 11.7% of the total service exports in the world. In this paper, we term the trading of information through internet or availing commercial or business service from professionals using ICT as virtual trade. Besides, availability of ICT has also allowed producers of services to outsource[1](insource) service creation activities to (from) that part of the world that can produce it in an efficient and economical manner. In this case of creation of services using communication technology, time zone difference between the partner countries can be most beneficial for the producers. For instance, suppose a software programming firm in USA opens a branch in India. Since both the countries are located in different time zones the regular working time of the two locations do not coincide. This difference in working hours turns out to be very useful. When working hours end in USA the semi-finished task is transferred through the internet to India where the working hours have just started. Indian engineers start working on them and send it back when their working hours end. In this fashion, the task can continue for 24 hours and the work gets

[1]The terms outsourcing, fragmenting and offshoring though have technically different meanings, in this paper we use it synonymously indicating the separation of a production process to affiliates in different locations on the globe.

completed earlier compared to the time required when production takes place only in one location or in a single time zone.

There is no doubt that technology is changing every day and so are consumers' choices. It may happen that when a particular product is conceived it is in high demand but if its production is delayed, the rapid technological progress may make the consumers' demand to shift to a more advanced product causing severe loss to the producers. Therefore, time plays a very important role in production these days and virtual trade across different time zones allows production to get accomplished quickly. Some theoretical papers that discuss the role of time zones in production and trade are Marjit (2007), Kikuchi and Iwasa (2010), Kikuchi and Marjit (2011), Mandal (2015), Mandal et al. (2018b), Marjit and Mandal (2017), Kikuchi (2006).[2] Other notable papers that add insights to the role of time zones on service trade and the consequent effect on the involved economies and economic agents are Matsuoka and Fukushima (2010), Kikuchi and Marjit (2010), Kikuchi and Long (2011), Kikuchi et al. (2013), Nakanishi and Long (2015), Head et al. (2009), Dettmer (2014), etc.

Along with a well-developed ICT, another important requirement for such trade is that the labors of the partner country must be skilled enough to work on the outsourced semi-finished task. For skill formation, educational capital is a must. So, the current essay deals with the inflow and outflow of educational capital, brought about by virtual trade or some other parametric changes, in an economy where both formal and informal sectors exist. Presence of formal and informal sectors in an economy is a well-known fact and is true for almost every economy. According to ILO (2018) the non agricultural informal employment in developing and emerging economies together accounts for 59.5% of the total employment and for the developed countries it is about 17.1%. Globally the level of informal employment is 50.5% of the total non-agricultural employment. Including agriculture, the figure rises to

[2] A brief review of all the theoretical works done on the idea of time zones and trade can be found in Prasad et al. (2017)

61.2 % of the total employment. Following conventional arguments (Marjit and Kar, 2011), in our paper we reason the cause of informality to be the incapability of the formal sector to absorb the huge labor supply available within the economy. Precisely, by informal units we refer to those who were not lucky enough to secure a job in the formal sector and have to survive by doing income generating productive activities which do not necessarily follow government prescribed rules and regulation, for example, they escape tax, they are not registered, their employment is not formally contracted, etc. Disobedience towards the rules makes them devoid of enjoying social and legal protection, wage regulations and property rights. We differentiate between formal and informal sector by difference in the wage of unskilled labor. In the formal sector, there is job security and presence of labor unions who can bargain for a standard wage rate and demand the implementation of minimum wage laws. The informal workers, however, do not have this opportunity; they have to compete in the market and get the competitive wage. The informal units' operations are highly labor intensive and requires little amount of capital.

One more aspect of mostly developing economies is the presence of extortion related corruption. Extortion activities may exist in both formal and informal sectors. Extortion here refers to forceful or involuntary payment of money to a group of people in order to avoid damage that could be caused by them (Konrad and Skaperdas, 1998; Battisti et al., 2015) or to lubricate official processes (Mishra and Ray, 2010; Choi and Thum, 2005) or to get protection against violation of government regulations (Mandal et al., 2018a). Papers like Piculescu and Hibbs (2005), Choi and Thum (2005), Johnson et al. (1999) and Friedman et al. (2000) claim that corruption in the formal sector give rise to informal activities. We have slightly different viewpoint, in our model, informality gives rise to corruption and it is present only in informal sectors. Again, the extortion activity in our paper is in some way related to what Bhagwati (1982) christened as Directly Unproductive Profit (DUP) seeking units who

are not actively involved in the production but tries to gain profit taking advantage of the informal nature of productive units. The informal units fall prey to this type of corruption as they do not fully abide by government prescribed laws and thus cannot avail legal protection. They pay the extortionist in order to get saved from punishment because of their extralegal nature. In case of legal troubles, the people engaged in extortion claim to negotiate with the officials and save the informal segment from being penalized. Therefore, presence of informal sector gives rise to a corrupt segment in the economy that does not take part in productive activities but helps the informal sector to subsist by doing intermediation activities.

On the other hand, presence of educational capital also connects formal and informal productive segments as it helps the workers in the informal segment to get skilled and secure a job in the formal sector, thus moving to a legally and socially acceptable segment free from extortionists' harassments[3]. The current research encompasses all the above mentioned issues and tries to observe the effect on factor prices and output when a) the service sector opts for virtual trade across different time zones; b) the extent of extortion fee falls; and c) when both 'a)' and 'b)' occurs together. The paper is related to Mandal et al. (2018a), Mandal et al. (2018b) and Mandal and Roy (2018) but incorporation of the ideas of virtual trade owing to time zone difference, inflow/outflow of educational capital, and corrupt informal sector together makes this paper different from the existing lot.

Remaining paper is arranged as follows. Section 2 describes the basic structure of the model. There are formal and informal sectors with the informal sector being subject to extortion. There are four factors: skilled labor, unskilled labor, physical capital and educational capital. Unskilled labor who could not secure a job in the formal segment has two options, to get involved either in productive informal activities or in directly unproductive

[3] We assume there is no corruption in the formal sectors as in case of such encounters the formal units can rightfully claim protection against the extortionists.

extortion activities. Skill formation is one way to reduce the size of informal and corrupt units. Section 3 elucidates how virtual trade instigates inflow of educational capital favoring skill formation. Consequently, there are changes in the factor markets, factor prices and output. Another option where the corrupt activities can be discouraged is the fall in the fee that is to be paid to the intermediators. Section 4 describes the resultant condition of the economy in response to a fall in the fee that the informal units pay to the extortionist. Results reveal an expansion of the informal sector while the effect on intermediators is conditional. However, skill formation is discouraged under such change. Section 5 tries to combine both the effect of virtual trade across different time zones and a fall in extortionists' fees. Both skilled and unskilled labors gain under such change. Size of different sectors depends on inflow or outflow of educational capital, which again depends on the magnitude of the two counteracting changes. Section 6 concludes the paper.

2. The Model

We consider a small open economy facing competitive goods and factor markets. The goods' market open in every 24 hours. 12 hours of daytime is dedicated to work and the nighttime is the leisure time (see Marjit, 2007 for further details). There are four factors of production – skilled labor (S), unskilled labor (L), physical capital (K) and educational capital (E), with the economy being abundant in L.[4] There are two formal sectors X and Y. X is a service whereas Y is a physical good. The production of service requires S and K. Y is produced using L and K. E is required to upgrade L into S. X is S intensive and Y is K intensive. Some portion of L cannot be absorbed in the formal sectors so they earn a living producing informally. We term

[4] The symbols that has been used in this paper are: S= total endowment of skilled labor; S_i= initial endowment of skilled labor; S'= newly trained skilled labor; K= physical capital; L= total endowment of unskilled labor; X= service output; Y= formal sector good production; Z= informal sector; N= extortionists or the corrupt sector; L_N= L engaged in N; L_S= L that upgrades to S;L_P= L engaged in productive sector Y & Z; E= educational capital;w_S= wage of skilled labor; $\overline{w}$= unionized wage: w=wage of unskilled labor ; R= rent of educational capital ; r= rent for K; P_X= price of X; P_Y= price of Y; P_Z= price of Z; δ = the discount factor; α = extortionists' share in price of Z; a_{ij} = amount of factor i used in production of one unit of j (i=S, K, E, L; j=X, Y, S, Z); θ_{ij} = distributive share of i in j; λ_{ij} = employment share of i in j.

this sector as the informal sector (Z) which is unskilled labor intensive. With the rise of informal productive activities, there arise some corrupt people who are also engaged in the informal sector. However, they are unproductive. We term these people as extortionist (N).

Production of X is divided into two sequential stages; each stage takes one working day and one unit of skilled labor and capital. Therefore, the production takes two working days and requires two units of skilled labor and capital that cannot be substituted with each other. The service becomes available to the consumers the third day. The price that the service provider receives is δP_X. δ is the term which discounts the price when there is delay in delivering the good. Since a consumer has to wait for two days to receive the product, δ reflects the waiting cost, i.e. the cost of making the consumers wait for the product, which the producers bear by discounting their price. Its value ranges from 0 to $1 (0 < \delta \leq 1)$. When production is delayed, δ is less than one and when the consumers receive the product on time its value becomes 1 (Mandal, 2015). This implies that as the time to deliver the service declines, δ rises gradually and ultimately attains the value 1. When δ is 1 the effective price becomes P_X, the actual value of the product. This is in line with Marjit (2007). The cost-price equation for X is given as:

$$a_{SX} w_S + a_{KX} r = \delta P_X$$
$$\Rightarrow 2w_S + 2r = \delta P_X \quad (1)$$

Per unit of Y is produced using a_{LY} amount of unskilled labor (L) and a_{KY} units of physical capital (K). The blend of inputs is chosen to minimize cost given the prevailing factor prices. The production takes only one working day. Y is a formal sector so following Marjit and Kar (2011), wage of unskilled labor is set by a bargaining process between the employers and labor unions. The employers have to abide by the minimum wage laws and therefore, the

wage is fixed at a level higher than what would be in the competitive condition. We denote the unionized wage as $\overline{w}$. The equilibrium condition for Y is:

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

where r denotes the rent given to K and P_Y is the price of Y. Y has limited number of vacancies so it cannot absorb all the available L. However, unskilled labor has to survive by doing some income generating activities. As they could not be the part of formal segment of the economy they rush to the informal segment, Z. As mentioned in the previous section, workers of this sector are not protected by labor unions so wages are determined under competitive conditions. Production of one unit of Z requires a_{LZ} units of L and a_{KZ} units of K. The profit maximizing condition is:

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

The economy also consists of some L that do not take part in the productive informal activities rather make profit by taking advantage of the extra-legal nature of Z. These are directly unproductive units in terms of Bhagwati (1982). Because of illegal nature, the informal units are not certain about their survival and are likely to get evicted or caught in some legal issues. Therefore, Z has to rely on some form of intermediation activities what we call here the corrupt sector N. For this purpose Z pays a part of its income to N. The case can also be that these are the people who will report about the illegal activities of the informal units if they are not paid. Therefore, the payments that N gets are actually through extortion. The term α in equation (3) is the proportion of price of Z that needs to be paid to the extortionists. As competitive conditions are assumed, total payment done by Z must be equal

to the total cost of intermediation. If the amount of unskilled labor engaged in N is expressed as L_N; the cost-value equation is given as:

$$wL_N = \alpha P_Z Z \tag{4}$$

where the RHS is the total payment done by Z for intermediation.

We must note here that $w < \overline{w} < w_S$. Therefore, L would be willing to get trained and get qualified as S in order to get a higher remuneration. This requires E, and the economy has some supply of educational capital (E). Per unit cost of E is R. a_{ES} is assumed to be the fixed amount of E required to upgrade L to S. Thus, if an unskilled labor (L) wants to get skilled it has to incur the cost of educational capital ($a_{ES}R$) by themselves. Also, as L decides to get trained it has to forgo the wage that it was earning. So the cost of getting transformed to S includes the opportunity cost of training in addition to the cost of E. It will be viable for L to get trained only if the cost is less or at least equal to the compensation that they will get after training i.e. w_S. Following competitive condition, we have the equilibrium condition for S as:

$$a_{ES}R + w = w_S \tag{5}$$

It follows from the above equation that L engaged in Y will not opt for training as $\overline{w} > w$ and the cost–price equality thus expressed will not hold.

Therefore, we have three categories of L: L engaged in productive sectors Y and Z (L_P), L engaged in directly unproductive activities of N (L_N) and L who opt for training (L_S); i.e.

$$L = L_P + L_N + L_S \tag{6}$$

We assume all the factors are fully employed within different sectors of the economy. The full employment condition of skilled labor, physical capital, unskilled labor and educational capital is respectively as follows:

$$2X = S_I + S^{'} = S \tag{7}$$

$$2X + a_{KY}Y + a_{KZ}Z = K \tag{8}$$

$$a_{LY}Y + a_{LZ}Z + L_N = L_P + L_N \tag{9}$$

$$a_{ES}S' = E \tag{10}$$

In equation (7), S is the total supply of skilled labor, S_I is the initial endowment of skilled labor and S' represents the newly trained L which is equal to L_S i.e.

$$L_S = S' \tag{11}$$

With this, the structure of the model is complete. We have nine variables – w_S,w, R, r, X, Y, Z, L_N and S'. r is obtained using (2). Putting the value of r in (1) and (3), we respectively get the values of w_S and w. With the values thus obtained, R can be calculated using (5). With solved factor prices, all technological coefficients are determined through constant returns to scale assumption. Now, given the supply of E, S' is determined using (10). The value of S' is used in (7) to calculate the value of X. Using the obtained X and substituting the value of L_N with the help of equation (4), Y and Z can be solved from (8) and (9). Therefore, the model is solvable.

3. Effect of Utilization of Time Zone Difference

Suppose considering the sound development of ICT producers of X decide to fragment the production process between two countries with each country producing one stage. As production cannot be continued during the nighttime, the producers decide to outsource one of the stages of production to a country located in a different time zone whose working hours starts at the end of Home country's 12-hour workday. Thus by choosing outsourcing locations belonging to different time zones, the nighttime is also utilized. Let us consider that the two countries are identical except that their time zones are opposite. With this, the service production takes two working days as before but those two working days are now accommodated within 24 hours. As a result, the desired service is available one day earlier and the producers get the full value for their service. This means δ becomes equal to 1 in equation (1). As RHS of equation (1) has changed, to maintain the equality the LHS will also have to change. Given the interlinked nature of the economy, other sectors will also experience some changes. Rise in RHS of (1) implies the producers now fetch a higher value for their service. This encourages them to expand their output. Consequently demand for skilled labor (S) and capital (K) rises. Higher demand of S raises their wage but following equation (2), the parameters on which r depends remains unchanged causing r to stick to its initial value. Since there is no change in r, equation (3) reveals that there would not be any change in w either. Now, moving to equation (5), rise in w_S, therefore, leads to a rise in R. This implies that rise in demand for S also raises the demand for E, an essential input for S formation. Higher demand of E within the country makes R relatively higher than international R. As a result, there is inflow of educational capital from abroad. Availability of E makes way for unskilled labor to get trained and secure a job in X. This squeezes out unskilled labor from other sectors thus affecting their outputs. Following equation (5), it can be presumed that unskilled labors will come out of Z and N leading to a contraction of the two sectors. Y may also be expected to fall. Since X uses same amount of skilled labor (S)

and physical capital (K), and Z being unskilled labor (L) intensive, the amount of K released from Z will be less than that of L. Therefore, there will be a high demand for K in the economy. This indicates that there will be a short-term rise in its rent (r) leading to a fall in Y releasing K and also L. It can also be noticed from the endowment equation (8) that if a fall in Z doesn't compensate the demand of K then there will also be a reduction in Y. The following sub-sections illustrate the mathematical analysis and results.

3.1 Change in factor prices

Differentiating equations (1), (2), (3) and (5), and expressing relative change by '^' notation we have respectively:

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

$$\theta_{KY}\hat{r} = 0$$

$$\theta_{LZ}\widehat{w} + \theta_{KZ}\hat{r} = 0$$

$$\theta_{ES}\widehat{R} + \theta_{LS}\widehat{w} = \widehat{w}_S$$

where, θ_{ij} is the value share of i^{th} factor in the price of j^{th} commodity $(i = S, K, L, E; j = X, Y, Z, S)$. Following Cramer's rule, we get the required values of relative change:

$$\widehat{w}_S = \frac{1}{\theta_{SX}}\delta\widehat{\delta} > 0$$

$$\widehat{r} = 0$$

$$\widehat{w} = 0$$

$$\widehat{R} = \frac{1}{\theta_{ES}\theta_{SX}}\delta\widehat{\delta} > 0$$

Since $\widehat{\delta}$ is positive, change in w_S and R both are positive. Thus, we make the following proposition

Proposition I: Utilization of time zones for production of a service raises the income of skilled labor and the returns to educational capital while the income of other factors remains unchanged. ■

3.2 Effect on output

Following the previous sub-section, rise in R raises the supply of E in the country. From equation (10), as a_{ES} is constant there is a rise in S' which will cause some changes in equations (9) and (7). Equation (7) shows that a rise in S' will lead to a rise in X. Equation (8) and (9) can show the subsequent effects on Y and Z.

To know relative change in outputs of different sector we need the following equations of relative change derived respectively from (4), (6), (7), (8), (9), (10) and (11)

$$\hat{L}_N = \hat{Z} \tag{12}$$

$$\lambda_{LP}\hat{L}_P + \lambda_{LN}\hat{L}_N + \lambda_{LS}\hat{L}_S = 0 \tag{13}$$

$$\widehat{X} - \lambda_{S'S}\widehat{S'} = 0 \tag{14}$$

$$\lambda_{KX}\widehat{X} + \lambda_{KY}\widehat{Y} + \lambda_{KZ}\widehat{Z} = 0 \quad (15)$$

$$\lambda_{LY}\widehat{Y} + \lambda_{LZ}\widehat{Z} + \lambda_{LN}\hat{L}_N - \lambda_{LP}\hat{L}_P - \lambda_{LN}\hat{L}_N = 0 \quad (16)$$

$$\widehat{S'} = \widehat{E} \quad (17)$$

$$\hat{L}_S = \widehat{S'} \quad (18)$$

Here, λ_{ij} is the proportion of i^{th} factor employed in j^{th}sector $(i = S, K, L, E; j = X, Y, Z, S, N)$. Equation (17) shows the relative change in S is equal to that of E which by equation (18) is equal to the relative change in L_S i.e. the number of unskilled labors who opt for training. Substituting equation (17) in (14) we get the relative change in X.

$$\widehat{X} = \lambda_{S'S}\widehat{E} \quad (19)$$

Since $\lambda_{S'S}$ is positive, X also changes in the same direction as that of E and the change is $\lambda_{S'S}$ times higher. Using (19) in (15), and (12), (13), (17) and (18) in (16) we get the following equations

$$\lambda_{KY}\widehat{Y} + \lambda_{KZ}\widehat{Z} = -\lambda_{KX}\lambda_{S'S}\widehat{E} \quad (20)$$

$$\lambda_{LY}\widehat{Y} + (\lambda_{LZ} + \lambda_{LN})\widehat{Z} = -\lambda_{LS}\widehat{E} \quad (21)$$

Using Cramer's rule, equations (20) and (21) gives us the change in Y and Z

$$\widehat{Y} = -\frac{1}{|\lambda|}\widehat{E}\{\lambda_{KX}\lambda_{S'S}(\lambda_{LZ}+\lambda_{LN}) - \lambda_{LS}\lambda_{KZ}\} < 0$$

$$\widehat{Z} = \frac{1}{|\lambda|}\widehat{E}(\lambda_{KX}\lambda_{LY}\lambda_{S'S} - \lambda_{KY}\lambda_{LS}) < 0$$

where $|\lambda| = \lambda_{KY}(\lambda_{LZ}+\lambda_{LN}) - \lambda_{KZ}\lambda_{LY} > 0$; since Y is K intensive and Z is L intensive. It turns out that both Y and Z falls due to inflow of E. The results are conditional upon the factor intensity assumption. The fall in Z is due to the fact that L is leaving for training and the fall in Y is because of rising demand of K. On the other hand since Z is contracting equation (12) indicates that there should be a fall in number of people engaged in corrupt activities. This means L moves out from N to acquire necessary training and to get qualified as S.

Thus, we have the following proposition;

Proposition II: Rise in δ induced inflow of E leads to

a) An increase in X

b) Decrease in Y, Z and

c) Decrease in the number of extortionist in the economy, L_N ■

4. Fall in α

In this section, we explore how a fall in the per-unit cost of corruption or the income share of the extortionists affects the economy. Fall in α will raise the returns of Z production which in turn raises the returns to the factors involved in it. As equation (2) suggests that r will remain unchanged; therefore, from equation (3) w will go up. Since there is no change in r, there

will be no change in w_S (From (1)). Given this, the condition provided by (5) is violated and L is no longer encouraged to opt for training. Consequently, there will be a fall in the demand of E and hence a fall in R. Mathematical results derived using equations (1), (2), (3) and (5) conform to the given intuition as we see a rise in w, a fall in R while returns to S and K are unchanged:

$$\widehat{w}_S = 0$$

$$\hat{r} = 0$$

$$\widehat{w} = -\frac{1}{\theta_{LZ}}\hat{\alpha}\alpha > 0$$

$$\widehat{R} = \frac{\theta_{LS}}{\theta_{ES}\theta_{LZ}}\hat{\alpha}\alpha < 0$$

Since $\widehat{\alpha} < 0$, $\widehat{w} > 0$ and $\widehat{R} < 0$. Rise in unskilled wage with no change in skilled wage implies shrinking wage disparity, which is definitely a welcome result in income inequality. Again, following a fall in R in the domestic market there will be an outflow of E. Therefore, we encounter $\widehat{E} < 0$. Together with this as w has become costlier, the use of L in Z production will fall and K will be required more. We can examine the change in input coefficients with the help of the formula for elasticity of substitution between L and K in Z, σ_Z:

$$\sigma_Z = \frac{\hat{a}_{LZ} - \hat{a}_{KZ}}{\hat{r} - \widehat{w}}$$

$$\hat{a}_{LZ} = \hat{a}_{KZ} - \sigma_Z\widehat{w}$$

Using the above equation along with the Envelope condition

$$\theta_{LZ}\hat{a}_{LZ} + \theta_{KZ}\hat{a}_{KZ} = 0$$

we get

$$\hat{a}_{KZ} = -\frac{1}{\theta_{KZ} + \theta_{LZ}}\sigma_Z\hat{\alpha}\alpha \ > 0 \tag{22}$$

$$\hat{a}_{LZ} = \frac{\theta_{KZ}}{\theta_{LZ}(\theta_{KZ} + \theta_{LZ})}\sigma_Z\hat{\alpha}\alpha \ < 0 \tag{23}$$

Fall in α, outflow of E and variation of input coefficients to make the production cost effective entail changes in the full employment equations and subsequently the outputs of different sectors. Differentiating equation (6)

$$\hat{L}_N = \hat{Z} + \hat{\alpha} - \hat{w} \tag{24}$$

Following the procedure similar to the previous section, we have the percentage changes in output as follows:

$$\hat{X} = \lambda_{S'S}\hat{E} < 0 \tag{25}$$

$$\widehat{S'} = \hat{E} < 0 \tag{26}$$

$$\hat{Y} = \frac{1}{|\lambda|}[\{\lambda_{KZ}\lambda_{LN}(\hat{\alpha} - \hat{w}) - \lambda_{KZ}(\lambda_{LZ} + \lambda_{LN})\hat{a}_{KZ} + \lambda_{KZ}\lambda_{LZ}\hat{a}_{LZ}\} + \{\lambda_{KZ}\lambda_{LS}\hat{E} - \lambda_{KX}\lambda_{S'S}(\lambda_{LZ} + \lambda_{LN})\hat{E}\}] \tag{27}$$

$$\hat{Z} = \frac{1}{|\lambda|}\left[-\lambda_{KY}\{\lambda_{LN}(\hat{\alpha} - \hat{w}) + \lambda_{LZ}\hat{a}_{LZ}\} + \left(\lambda_{LY}\lambda_{KX}\lambda_{S'S}\hat{E} - \lambda_{KY}\lambda_{LS}\hat{E}\right)\right.$$
$$\left. + \lambda_{LY}\lambda_{KZ}\hat{a}_{KZ}\right] > 0 \tag{28}$$

The expressions for changes in X and S' are the same as in the previous section but as $\widehat{E} < 0$, both $\hat{X}$ and $\widehat{S'}$ become negative. The effect on Y is ambiguous; $\hat{Y} \gtrless 0$ if

$$|\{\lambda_{KZ}\lambda_{LN}(\hat{\alpha} - \hat{w}) - \lambda_{KZ}(\lambda_{LZ} + \lambda_{LN})\hat{a}_{KZ} + \lambda_{KZ}\lambda_{LZ}\hat{a}_{LZ}\}|$$
$$\lesseqgtr \left|\{\lambda_{KZ}\lambda_{LS}\hat{E} - \lambda_{KX}\lambda_{S'S}(\lambda_{LZ} + \lambda_{LN})\hat{E}\}\right|$$

Z is seen to expand but the positive effect depends on the factor intensity condition. Now let us see the effect of a fall in α on the intermediation activity. Putting the values of $\hat{Z}$ and $\hat{w}$ in (24)

$$\hat{L}_N = \left[\frac{1}{|\lambda|}\{\left(\lambda_{LY}\lambda_{KX}\lambda_{S'S}\hat{E} - \lambda_{KY}\lambda_{LS}\hat{E}\right) + \lambda_{LY}\lambda_{KZ}\hat{a}_{KZ} - \lambda_{KY}\lambda_{LZ}\hat{a}_{LZ}\}\right]$$
$$+ \left[\left\{\left(\hat{\alpha} + \frac{\hat{\alpha}\alpha}{\theta_{LZ}}\right)\left(1 - \frac{\lambda_{KZ}\lambda_{LN}}{|\lambda|}\right)\right\}\right] \tag{29}$$

In the above equation, the first expression separated by the square brackets is positive while the second is negative. Therefore,

$\hat{L}_N \gtrless 0$ depends on whether

$$\left|\frac{1}{|\lambda|}\{\left(\lambda_{LY}\lambda_{KX}\lambda_{S'S}\widehat{E} - \lambda_{KY}\lambda_{LS}\widehat{E}\right) + \lambda_{LY}\lambda_{KZ}\hat{a}_{KZ} - \lambda_{KY}\lambda_{LZ}\hat{a}_{LZ}\}\right|$$
$$\lesseqgtr \left|\left\{\left(\hat{\alpha} + \frac{\hat{\alpha}\alpha}{\theta_{LZ}}\right)\left(1 - \frac{\lambda_{KZ}\lambda_{LN}}{|\lambda|}\right)\right\}\right|$$

The ambiguity arises due to the fact that, on the one hand, expansion of Z attracts L towards its production, and on the other hand expansion of Z also raises the need of unproductive

intermediation activities. And since workers get identical return in these two activities they are indifferent to choose between the two options.

Therefore, we have the following proposition:

Proposition III: Fall in α leads to

a) *Fall in wage inequality*

b) *Outflow of E*

c) *Contraction of service sector and skill formation*

d) *Expansion of informal productive activity*

e) *Expansion of Y if*

$$|\{\lambda_{KZ}\lambda_{LN}(\hat{\alpha}-\hat{w})-\lambda_{KZ}(\lambda_{LZ}+\lambda_{LN})\hat{a}_{KZ}+\lambda_{KZ}\lambda_{LZ}\hat{a}_{LZ}\}|$$
$$<\left|\{\lambda_{KZ}\lambda_{LS}\hat{E}-\lambda_{KX}\lambda_{S'S}(\lambda_{LZ}+\lambda_{LN})\hat{E}\}\right|$$

f) *Contraction of L_N if*

$$\left|\frac{1}{|\lambda|}\{(\lambda_{LY}\lambda_{KX}\lambda_{S'S}\hat{E}-\lambda_{KY}\lambda_{LS}\hat{E})+\lambda_{LY}\lambda_{KZ}\hat{a}_{KZ}-\lambda_{KY}\lambda_{LZ}\hat{a}_{LZ}\}\right|$$
$$<\left|\left\{\left(\hat{\alpha}+\frac{\hat{\alpha}\alpha}{\theta_{LZ}}\right)\left(1-\frac{\lambda_{KZ}\lambda_{LN}}{|\lambda|}\right)\right\}\right|$$ ■

5. Simultaneous Change in α and δ

In this section, we examine the effects of change in α and δ together and find out the eventual effect on the economy. Therefore, we consider a situation where the service sector opts for virtual trade and fragments its production process to a country with opposite time zone, and there is a fall in the share of extortionist in the price of Z. Rise in δ favors an expansion in X increasing the demand of skilled labor which is followed by a rise in skilled wage. Similarly, fall in α makes Z production lucrative leading to an increase in demand of the intensively used factor—unskilled labor. As a result unskilled wage rises. Since both X and Z utilize K,

there will also be a temporary rise in r causing a fall in Y. Y being capital intensive, its contraction will increase the supply of K in the economy reducing r. Mathematical results show no change in r implying that the initial level of r is restored. The change in factor prices is as below:

$$\widehat{w_S} = \frac{1}{\theta_{SX}} \delta\widehat{\delta} > 0$$

$$\widehat{w} = -\frac{1}{\theta_{LZ}} \hat{\alpha}\alpha > 0$$

$$\hat{r} = 0$$

$$\widehat{R} = \frac{\delta\widehat{\delta}}{\theta_{ES}\theta_{SX}} + \frac{\theta_{LS}}{\theta_{ES}\theta_{LZ}} \hat{\alpha}\alpha$$

Therefore, effect on r is same as in previous sections and the wage of both skilled and unskilled labor rises. The skilled wage is seen to depend on change in δ while the unskilled wage depends on variation in α. The difference between the relative changes is

$$\widehat{w_S} - \widehat{w} = \frac{1}{\theta_{SX}} \delta\widehat{\delta} + \frac{1}{\theta_{LZ}} \hat{\alpha}\alpha$$

If the first part of the RHS is less than the second, then there will be a fall in wage gap, and conversely. This gives us the following proposition:

Proposition IV: With the exploitation of time zone difference through virtual trade and a reduction in extortionists' fee

a) *Both L and S benefit*

b) *Effect on wage disparity is ambiguous* ■

Coming to $\hat{R}$, it depends both on $\widehat{\delta}$ and $\hat{\alpha}$, since they change in opposite directions the eventual effect on R depends on whether

$$\left|\frac{\delta\widehat{\delta}}{\theta_{ES}\theta_{SX}}\right| \gtreqless \left|\frac{\theta_{LS}}{\theta_{ES}\theta_{LZ}}\hat{\alpha}\alpha\right|$$

Depending on the direction of $\hat{R}$ there will be either inflow or outflow of E and so is the expansion and contraction of different sectors. The expressions for $\hat{X}$ and $\hat{S}$ are the same as in previous sections. $\hat{Y}$, $\hat{Z}$ and $\hat{L}_N$ are found to be same as shown by equations (27), (28) and (29) respectively. For convenience, we rewrite them below,

$$\hat{X} = \lambda_{S'S}\hat{E}$$

$$\widehat{S'} = \hat{E}$$

$$\hat{Y} = \frac{1}{|\lambda|}\left[\{\lambda_{KZ}\lambda_{LN}(\hat{\alpha}-\hat{w}) - \lambda_{KZ}(\lambda_{LZ}+\lambda_{LN})\hat{a}_{KZ} + \lambda_{KZ}\lambda_{LZ}\hat{a}_{LZ}\}\right.$$
$$\left. + \{\lambda_{KZ}\lambda_{LS}\hat{E} - \lambda_{KX}\lambda_{S'S}(\lambda_{LZ}+\lambda_{LN})\hat{E}\}\right]$$

$$\widehat{Z} = \frac{1}{|\lambda|}\left[-\lambda_{KY}\{\lambda_{LN}(\hat{\alpha}-\hat{w}) + \lambda_{LZ}\hat{a}_{LZ}\} + \left(\lambda_{LY}\lambda_{KX}\lambda_{S'S}\hat{E} - \lambda_{KY}\lambda_{LS}\hat{E}\right) + \lambda_{LY}\lambda_{KZ}\hat{a}_{KZ}\right]$$

$$\hat{L}_N = \left[\frac{1}{|\lambda|}\{\left(\lambda_{LY}\lambda_{KX}\lambda_{S'S}\hat{E} - \lambda_{KY}\lambda_{LS}\hat{E}\right) + \lambda_{LY}\lambda_{KZ}\hat{a}_{KZ} - \lambda_{KY}\lambda_{LZ}\hat{a}_{LZ}\}\right]$$
$$+ \left[\left\{\left(\hat{\alpha} + \frac{\hat{\alpha}\alpha}{\theta_{LZ}}\right)\left(1 - \frac{\lambda_{KZ}\lambda_{LN}}{|\lambda|}\right)\right\}\right]$$

Case I: If $\left|\frac{\delta\hat{\delta}}{\theta_{ES}\theta_{SX}}\right| = \left|\frac{\theta_{LS}}{\theta_{ES}\theta_{LZ}}\hat{\alpha}\alpha\right|$; then $\hat{R} = 0$. This implies there will be no change in E and accordingly $\hat{X}$ and $\hat{S}$ are also zero. However, change in unskilled wage will cause the input coefficients to change, as shown by (22) and (23), which entails changes in Y, Z and L_N. The percentage changes are hence,

$$\hat{Y} = \frac{1}{|\lambda|}\left\{\lambda_{KZ}\lambda_{LN}\left(\hat{\alpha} + \frac{\hat{\alpha}\alpha}{\theta_{LZ}}\right) - \lambda_{KZ}(\lambda_{LZ} + \lambda_{LN})\hat{a}_{KZ} + \lambda_{KZ}\lambda_{LZ}\hat{a}_{LZ}\right\} < 0$$

$$\hat{Z} = \frac{1}{|\lambda|}\left[-\lambda_{KY}\left\{\lambda_{LN}\left(\hat{\alpha} + \frac{\hat{\alpha}\alpha}{\theta_{LZ}}\right) + \lambda_{LZ}\hat{a}_{LZ}\right\} + \lambda_{LY}\lambda_{KZ}\hat{a}_{KZ}\right] > 0$$

$$\hat{L}_N = \left[\frac{1}{|\lambda|}\{\lambda_{LY}\lambda_{KZ}\hat{a}_{KZ} - \lambda_{KY}\lambda_{LZ}\hat{a}_{LZ}\}\right] + \left[\left\{\left(\hat{\alpha} + \frac{\hat{\alpha}\alpha}{\theta_{LZ}}\right)\left(1 - \frac{\lambda_{KZ}\lambda_{LN}}{|\lambda|}\right)\right\}\right]$$

The above results show that there is a fall in formal sector output Y and an expansion of the informal productive sector. The percentage changes are seen to be a function of $\hat{\alpha}$ and not of $\hat{\delta}$. Therefore, fall in α encourages Z production. Fall in Y may be because of outflow of K to Z or because of outflow of L. Since both the inputs are required in production, release of one will entail the release of the other leading to a fall in Y. Effect on the intermediation sector, however, is ambiguous; it will shrink only if

$$\left|\left[\frac{1}{|\lambda|}\{\lambda_{LY}\lambda_{KZ}\hat{a}_{KZ} - \lambda_{KY}\lambda_{LZ}\hat{a}_{LZ}\}\right]\right| < \left|\left[\left\{\left(\hat{\alpha} + \frac{\hat{\alpha}\alpha}{\theta_{LZ}}\right)\left(1 - \frac{\lambda_{KZ}\lambda_{LN}}{|\lambda|}\right)\right\}\right]\right|$$

Case II: If $\left|\frac{\delta\hat{\delta}}{\theta_{ES}\theta_{SX}}\right| > \left|\frac{\theta_{LS}}{\theta_{ES}\theta_{LZ}}\hat{\alpha}\alpha\right|$; $\hat{R} > 0$ this indicates $\hat{E} > 0$. Therefore, there will be a rise in skill formation and an expansion of X following (17) and (19). With a positive $\hat{E}$, Y is seen to contract [from (27)]. Referring (28), Z will contract if the given condition holds

$$\left|\frac{1}{|\lambda|}[-\lambda_{KY}\{\lambda_{LN}(\hat{\alpha}-\hat{w})+\lambda_{LZ}\hat{a}_{LZ}\}+\lambda_{LY}\lambda_{KZ}\hat{a}_{KZ}]\right| < \left|\frac{1}{|\lambda|}\left(\lambda_{LY}\lambda_{KX}\lambda_{S'S}\hat{E}-\lambda_{KY}\lambda_{LS}\hat{E}\right)\right|$$

Following this, the condition for number of extortionists to decline is

$$\left|\frac{1}{|\lambda|}\left(\lambda_{LY}\lambda_{KX}\lambda_{S'S}\hat{E}-\lambda_{KY}\lambda_{LS}\hat{E}\right)+\left\{\left(\hat{\alpha}+\frac{\hat{\alpha}\alpha}{\theta_{LZ}}\right)\left(1-\frac{\lambda_{KZ}\lambda_{LN}}{|\lambda|}\right)\right\}\right| > |\lambda_{LY}\lambda_{KZ}\hat{a}_{KZ}-\lambda_{KY}\lambda_{LZ}\hat{a}_{LZ}|$$

Compared to the effect on output when we considered the case of a rise in δ alone, the expressions of $\hat{X}$ and $\hat{S'}$ are seen to be unaffected by an additional change in α. In case of Y the direction of change is also same though the magnitude is larger in the present case. The effect on Z and L_N is noticed to be affected with the added change of α. A fall in α favors the production of Z, which clearly tries to offset the effect of rise in δ and the result depends on which one is larger. The combined effect of $\hat{\delta}$ and $\hat{\alpha}$ also makes $\hat{L}_N$ uncertain.

Case III: If $\left|\frac{\delta\hat{\delta}}{\theta_{ES}\theta_{SX}}\right| < \left|\frac{\theta_{LS}}{\theta_{ES}\theta_{LZ}}\hat{\alpha}\alpha\right|$; $\hat{R} < 0$. The effect on output and L_N will be same as discussed in section 2.2.

Therefore, expansion of skill formation activities and service output majorly depends on the availability of E. Y is most likely to contract whereas the effect on Z is conditional. The effect on L_N depends on whether the positive effect of probable rise in Z dominates the negative effect of fall in their income. With this, we have the following proposition

Proposition V: Inflow or outflow of educational capital and its consequent effect on the size of different sectors of the economy largely depends on whether $\left|\frac{\delta\hat{\delta}}{\theta_{ES}\theta_{SX}}\right| \gtreqless \left|\frac{\theta_{LS}}{\theta_{ES}\theta_{LZ}}\hat{\alpha}\alpha\right|$. ■

6. Conclusion

Taking advantage of the sound development in communication technology, services are being made more tradable by providing it through a virtual platform. In this paper we have taken the production of a service to be undertaken with the help of virtual trade and remarked that it

will be the most beneficial if it is traded between countries whose time zones are entirely non-overlapping in such a way that one country's day matches with other country's night. First, we see what effect virtual trade, in order to utilize time zone differences, has on an economy where both formal and informal sectors are present; with the informal sector being subject to extortion. Results show that skilled labor enjoys a wage hike and there is also a rise in rent of educational capital. The service sector expands due to inflow of educational capital and subsequent rise in skill formation. The physical good producing formal sector that uses unskilled labor and capital for production shrinks. Together with this, there is also a contraction of the informal sector and a fall in number of extortionists. Next, we see what effect a fall in per unit intermediation cost has on the economy. We find there is a rise in unskilled wage and informal production. Rent of educational capital falls leading to its outflow and hence there is a reduction in skill formation and service output. The effect on the size of the intermediation sector and the formal good producing sector is ambiguous. Thirdly, we combine both the effect of utilization of time zones and a fall in extortionists' income share to check the possible outcome. In this case wage of both skilled and unskilled labor rises. Effect on skill formation and correspondingly the sectoral composition primarily depends on what happens to the return to educational capital. It turns out that virtual trade alone is sufficient for an economy's development towards a skilled-based one with lesser degree of informality and corruption. However, if the desire is to have a society with a lower income inequality the second or third approach can be more beneficial.

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