Original Research Article

Migrants' remittances, agricultural producer service and wage inequality in the dual economy

Abstract: Previous literature finds that migrants' remittance narrows down wage inequality between skilled and unskilled labor, since the external funds flow into the rural area and raise wage rate of unskilled labor. However, it should be noted that the structure of agricultural production has also changed and small-scale agriculture utilizes remittance to purchase producer service that could substitute unskilled labor. The paperestablishes three-sector general equilibrium models and theoretically analyzes the impact of an increase in remittance rate on wage inequality between skilled and unskilled labor. In the primary stage of service sector, an increase in remittance rate reduces both skilled and unskilled wage rate and has an ambiguous impact on wage inequality. The obtained result of wage inequality is robusteven when we extend the basic theoretical model by considering the popularization stage of service sector.

Keywords: Remittance; Agricultural producer service; Wage inequality;Rural labor migration.

1. Introduction

The last several decades have witnessed economic growth and development in many less developed countries. Along with the process of industrialization, the rural areas have experienced deep-going transformation. One noticeable transformation is the massive rural-urban migration. Take China for example. In 1978, the first industry locates 70.5% of total employment. After 40 years, this figure reduces to 25.1%.

Migrants move from rural to urban regions, while remittances flow in the opposite way within the economy (remittance refers to internal remittance rather than international remittance). Along with migration and migrants' increasing incomes, the flow of remittance to the rural regions is expected to accelerate.

The family members of migrant workers could benefit a lot from migrant remittance, and their use of remittance is an influential component of economic development in the rural region or even in the whole country, especially in the background of small-scale agriculture. For example, remittance plus outflow of rural labor lead to the transformation of agricultural production significantly. Agriculture production in developing economies tends to produce agricultural goods on a much smaller scale than in developed countries[1]. Peasants operate in tiny land plots and make the use of modern input and capital extremely difficult. Therefore, it is essential to utilize an intermediate sector to facilitate the employment of modern input. Wang et al (2020) use the National Fixed Points dataset of more than 20,000 households from 1995 to 2017, and find intermediate inputs become increasingly important and the contribution of labor is decreasing, and the contribution of capital keeps at an extremely low level (around 0.02) due to small-scale agricultural production(see Figure. 1). We argue in this paper that if we ignore an intermediate sector, we could not explain the phenomenon that: with the large-scale outflow of rural labor and extremely low capital elasticity, how small-scale agriculture utilizes an increasing intermediate input to sustain high agricultural output. In practice, family members of migrant workers utilize remittance to purchase service from agricultural producer service sector, and employ service to replenish the outflow of rural labor. At the same time, firms in the producer service sector introduce modern inputs into traditional agriculture and realize the transformation of agricultural production.

[1]Sarah et al(2016) offer a comprehensive summary on the size of farms worldwide. They show that farms greater than 5 ha in size cover 27% of the farmland in low-income countries, while 97% in high-income countries. The share of farmland controlled by larger farms is higher in countries with larger average incomes.

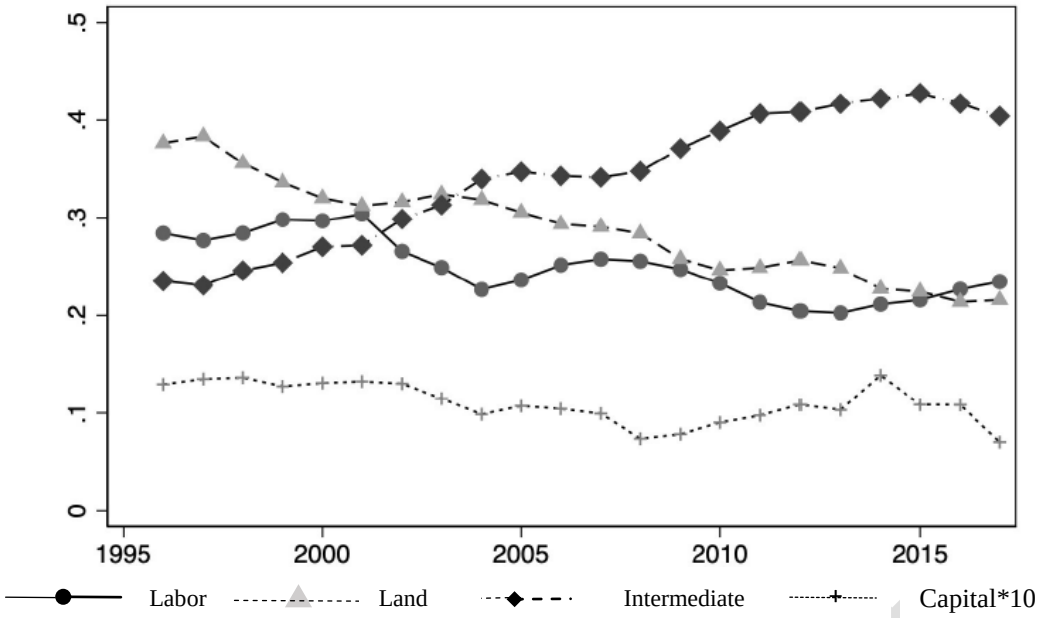

Figure 1 Input elasticity in agriculture

Data source:Wang et al (2020)

From the facts above, remittance exerts a great impact on the whole economy, which provokes the research interest of many theoretical economists. Scholars try to investigate this phenomenon from different angles of view. The related theoretical literature can be mainly divided into three strands. The first strand of literature investigate the impact of remittance on urban region (see, e.g., Li and Zhou ,2013; Li and Wang,2015). For instance, Li and Zhou (2013) find unskilled migrants increase their remittance rate will decrease the skilled-unskilled wage inequality in the urban region. The second strand of literature explores the environmental effects of remittance through different channels (see, e.g.,Li and Zhou, 2015;Li and Fu,2020). For example, Li and Fu(2020) incorporate the agricultural producer service sector into the general equilibrium model, and study the effects ofthe changes of remittance rate on environmentalpollution. The third strand of literature analyzes the income distributional effect of remittance (see, e.g.,Wu and Li,2020). In addition to remittance, many developing countries also suffer from the growing wage inequality. This issue has captured the attention of many theoretical scholars. Initially, studies in the determination of wage inequality generally focus on international factor mobility

and trade (Marjit and Kar, 2005;Beladi et al, 2008;Anwar, 2010). Until recently, scholars pay more attention to domestic factors to explain wage inequality in developing countries. In these studies, a variety of mechanisms are proposed to model the impact of a change in a domestic factor on the wage inequality, such as privatization (Chao et al,2016), skill formation (Zhang, 2019), urban bias(Pi and Fan,2019)capital market distortion (Beladi et al, 2019), appropriation activities (Yu and Chao, 2021).

However, the existing theoretical studies neglect the role that remittance and agricultural producer service play in determining the skilled–unskilled wage inequality. For example, Li and Fu (2020) consider the agricultural producer service into the general equilibrium model. However,from the settings of Li and Fu (2020), we obtain that an increase in remittance raises the demand for service, and rising service leads to more agricultural employment. In reality, the farmers utilize service to substitute rural labor instead of raising the demand for labor. Wu and Li (2020) analyze the effects of rural-urban migrants' remittances on wage inequality and remittance has a positive role on agricultural production. However, Wu and Li (2020) neglect the role of agricultural producer service and the change of agricultural production structure. Under the framework of Wu and Li (2020), the rural region obtains funds from outside and raises wage rate of unskilled labor that contributes to reducing wage inequality between skilled and unskilled labor.

In order to fill the current research gap, this paper incorporates agricultural producer service sector and builds three-sector general equilibrium models to discuss the relation between an increase in remittance rate and the skilled-unskilled wage inequality. Incorporating the service sector is to reflect the changing structure of small-scale agricultural production. We highlight the role of producer service, and agriculture utilizes the service to substitute rural unskilled labor in agricultural production. We firstly consider the situation where the service sector is at the primary stage, and argue that a rise in remittance affects resources allocation within urban sectors and skilled wage rate. Resources allocation combining with the substitution between service and unskilled labor leads to the decrease of unskilled wage rate.

Therefore, a rise of remittance rate falls wage rate of unskilled labor instead, and the change of wage inequality is ambiguous. The result of wage inequalityis robust even when we extend the basic theoreticalmodel by considering the popularization stage of agricultural producer service.

In sum, the contributions of this paper are mainly embodied in thefollowing two aspects. The first aspect is that we try to address theissue concerning the increasing skilled–unskilled wage inequalityfrom the perspective of the remittance and agricultural producer service. When considering the service sector and its substitution with unskilled labor, the paper offers a quite different angle to investigate this issue. The second aspect is that the paper tries to detect the impact of remittance rate and wage inequality by considering two different development stages of agricultural producer service sector. The discussion of two stages confirms that an increase in the remittance rate has an ambiguous effect on wage inequality.

The rest of the parts are organized as follows.We establish the basic theoreticalmodel and deal with the primary stage in Section 2. InSection 3,we extend the model by considering the popularization stage. Concluding remarks are given inSection 4.

2.The primary stage of agricultural producer service

We consider the primary stage of agricultural producer service sector with the following characteristics: (1) the agricultural service provides service with little differentiation. At this stage, the service concentrates on few fields, such as harvesting service, plow and sow service; (2) the service sector employs capital and unskilled labor for production;(3)firms enter into this sector with little barriers, and we consider the market structure of service sector is competitive competition with the constant return to scale; (4) during agricultural production, there exists an imperfect substitution between service and unskilled labor.

2.1 The model

Considering a small open developing economy with three sectors. Two sectors locate in the urban region. One is the manufacturing sector (sector *M*), and the other is the

agricultural producer servicesector (sector X). Sector M uses skilled laborS_M,unskilled labor L_M and capital K_M to produce an exportable good M, while sector X uses unskilled labor L_X and capital K_X to produce non-tradable services X. Sector$X$is an upstream sector in the sense that it supplies intermediate inputs to imperfectly substitute rural labor during agricultural production. To avoid complexity,we use Cobb-Douglas type of production functions in sector M and sector X:M= $\alpha^{\alpha}\beta^{\beta}(1-\beta-\alpha)^{(1-\beta-\alpha)}S_M^{\alpha}L_M^{\beta}K_M^{1-\beta-\alpha}$, X= $\gamma^{\gamma}(1-\gamma)^{(1-\gamma)}L_X^{\gamma}K_X^{1-\gamma}$, where α,β,$\gamma$are parameters that all belong to (0,1). The costminimization conditions of sector M and Xyield:

$$w_S^{\alpha}\bar{w}^{\beta}r^{1-\beta-\alpha}=p_M \quad (1)$$

$$\bar{w}^{\gamma}r^{1-\gamma}=p_X \quad (2)$$

wherep_M(p_X) is the price of sector$M$ (X). $w_s$is the wage rates of skilled labor. However, unskilled labor in the urban region faces the regulated wage rate $\bar{w}$ that is higher than the market-clearing wage rate, causing unemployment in the urban region. r isthe interest rate of capital.

Agricultural sector (sector A)lies in rural region. This sector uses unskilled labor L_A, services from sector X and land T. Agricultural goods A are produced under perfect competition with constant returns to scale, $A=\varepsilon^{\varepsilon}(1-\varepsilon)^{1-\varepsilon}U_A^{\varepsilon}T^{1-\varepsilon}$, where $0<\varepsilon<1$.U_A is not just raw unskilled labor, but rather a CES aggregate of unskilled labor and services X,$U_A=\left[(1-\psi)L_A^{(\rho-1)/\rho}+\psi X^{(\rho-1)/\rho}\right]^{\rho/(\rho-1)}$,where ψ governs the weight of unskilled labor and $\rho>1$ is the elasticity of substitution between unskilled labor and intermediate goods. Price of composite labor U_A is

$W=\left[(1-\psi)^{\rho}w^{1-\rho}+\psi^{\rho}p_X^{1-\rho}\right]^{1/(1-\rho)}$, where w is the flexible wage rate of unskilledlabor in the rural area. The price of the agricultural sector is set as numeraire, and cost minimization condition yields:

$$W^{\varepsilon}\tau^{1-\varepsilon}=1 \quad (3)$$

whereτ is the land rent. By Shephard's lemma, demands for unskilled labor L_A, service X and land T are $\varepsilon AW^{\rho-1}(1-\psi)^{\rho}w^{-\rho}$, $\varepsilon AW^{\rho-1}\psi^{\rho}p_X{}^{-\rho}$ and $(1-\varepsilon)A/\tau$, respectively.

Generally, developing countries lack skilled labor, and we assume that skilled labor is fully employed. Due to the rural-urban human capital disparity, we assume migrants act as unskilled labor in the urban area. Because of the high downward rigid wage rate of unskilled labor, there exist rural-urban migration and unemployment in the urban region. Following the Harris-Todaro labor allocation mechanism,

$$\bar{w} = (1+\lambda)w \quad (4)$$

whereλexpresses the urban unemployment rate in the sense of Harris-Todaro type (Harris and Todaro,1970).

Migrants remit part of their income to rural household by providing additional assistance. To simplify analysis, we assume all remittances are used to purchase agricultural producer service to replenish the outflow of rural labor. Assume the remittance accounts $\theta(0<\theta<1)$ proportion of total income of unskilled labor, $R=\theta(\beta p_M M+\gamma p_X X)$.Thus, the following condition is obtained:

$$\theta(\beta p_M M+\gamma p_X X)=p_X X \quad (5)$$

where the left hand expresses the remittance and the right hand denotes the expenditure on agricultural producer services.

Since the demand for service comes from agricultural production, by using the demand for X, we obtain the demand-supply equilibrium condition as

$$X=\varepsilon AW^{\rho-1}\psi^{\rho}p_X^{-\rho} \qquad (6)$$

The factor market-clearing conditions are

$$\alpha p_M M w_S^{-1}=\bar{S} \quad (7)$$

$$(1+\lambda)\bar{w}^{-1}\left(\beta p_M M+\gamma p_X X\right)+\varepsilon AW^{\rho-1}(1-\psi)^{\rho}w^{-\rho}=\bar{L} \quad (8)$$

$$(1-\alpha-\beta)p_M M r^{-1}+(1-\gamma)\varepsilon p_X X r^{-1}=\bar{K} \quad (9)$$

$$(1-\varepsilon)A/\tau=\bar{T} \quad (10)$$

where $\bar{S}$, $\bar{L}$, $\bar{K}$ and $\bar{T}$ represent the endowment of skilled labor, unskilled labor, capital and land, respectively. Using (5) and (6), we rewrite(8) and (9) as

$$(1+\lambda)\bar{w}^{-1}\varepsilon AW^{\rho-1}\psi^{\rho}p_X^{1-\rho}\theta^{-1}+\varepsilon AW^{\rho-1}(1-\psi)^{\rho}w^{-\rho}=\bar{L} \quad (8')$$

$$(1-\alpha-\beta)p_M Mr^{-1}+(1-\gamma)\varepsilon AW^{\rho-1}(1-\psi)^{\rho}p_X^{1-\rho}r^{-1}=\bar{K} \quad (9')$$

From (8') and(9') , the agriculture utilizes capital through intermediate service indirectly, and an increase in remittances benefit the agriculture and attract labor employment in the agriculture. So far, the establishment of the economy is completed. Eqs. (1) to (4),(7),(8'),(9') and (10) determine eight endogenous variables w_S,w, τ, p_x, r, M, A, and λ.

2.2 Comparatively Analysis

Taking total differentiation to Eqs. (1) to (4),(7)(8'), (9')and (10), and writing in a matrix notation, we can obtain the following equation:

$$\begin{pmatrix} J_1 & \varepsilon\theta_{LU} & 1-\varepsilon \\ J_2 & (\rho-1)(\theta_{LU}-\lambda_{LA})-1 & 1 \\ J_3 & \lambda_{KX}(\rho-1)\theta_{LU} & \lambda_{KX} \end{pmatrix}\begin{pmatrix} \hat{w}_S \\ \hat{w} \\ \hat{A} \end{pmatrix}=\begin{pmatrix} 0 \\ (1-\lambda_{LA}) \\ 0 \end{pmatrix}\hat{\theta} \quad (11)$$

where "∧"denotes percentage change, λ_{ij} (i=S,L,K;j=M,X,A) is allocative share of factor i in jth sector. $\theta_{LU}=w^{1-\rho}(1-\psi)^{\rho}/W^{(1-\rho)}$ and $\theta_{LU}=p_X^{1-\rho}\psi^{\rho}/W^{(1-\rho)}$.

$J_1=-\varepsilon\alpha(1-\gamma)\theta_{XU}/(1-\alpha-\beta)<0$, $J_2=\alpha(\rho-1)(1-\gamma)(\theta_{LU}-\lambda_{LA})/(1-\alpha-\beta)$, and $J_3=\lambda_{KM}+\alpha/(1-\alpha-\beta)+\lambda_{KM}+\lambda_{KX}\alpha(\rho-1)(1-\gamma)/(1-\alpha-\beta)>0$ .In addition, we assume the substitution between unskilled labor and service ρ is smaller than 1/(1-ε), which means the substitution is not sufficiently large. Use Δ_1 to denote the value of the determinant of the coefficient matrix,

$$\Delta_1=\alpha(1-\gamma)\lambda_{KX}[\varepsilon\theta_{XU}+\varepsilon(\rho-1)\lambda_{LA}+(\rho-1)(1-\varepsilon)\theta_{LU}]/(1-\alpha-\beta)+$$
$$[\lambda_{KM}+\alpha/(1-\alpha-\beta)]\{(1-\gamma)[1+\lambda_{LA}(\rho-1)]+\theta_{LU}[1-\rho(1-\varepsilon)]\}>0$$

According to Cramer's Rule, we can induce the effects of the change of remittance rate θ on endogenous variables:

$$\frac{\hat{w}_S}{\hat{\theta}} = -\frac{(1-\lambda_{LA})\lambda_{KX}\theta_{LU}[1-\rho(1-\varepsilon)]}{\Delta_1} < 0 \quad (12)$$

$$\frac{\hat{w}}{\hat{\theta}} = \frac{(1-\lambda_{LA})[J_1\lambda_{KX} - J_3(1-\varepsilon)]}{\Delta_1} < 0 \quad (13)$$

$$\frac{\hat{A}}{\hat{\theta}} = -\frac{(1-\lambda_{LA})\theta_{LU}[J_1\lambda_{KX}(\rho-1) - \varepsilon J_3]}{\Delta_1} > 0 \quad (14)$$

In view of Eqs. (12)-(14),

$$\frac{\hat{R}}{\hat{\theta}} = \frac{\theta_{LU}(1-\lambda_{LA})\left(\lambda_{KM} + \alpha/(1-\alpha-\beta)\right)[1-\rho(1-\varepsilon)]}{\Delta_1} > 0$$

$$\frac{\hat{X}}{\hat{\theta}} = \frac{\theta_{LU}(1-\lambda_{LA})[1-\rho(1-\varepsilon)]}{\Delta_1}\left\{\lambda_{KM} + \frac{\alpha\left[1-(1-\gamma)\lambda_{KX}\right]}{1-\alpha-\beta}\right\} > 0$$

$$\frac{\hat{L}_A}{\hat{\theta}} = \frac{(1-\lambda_{LA})}{\Delta_1}\left\{J_3\left[\rho(1-\varepsilon)\theta_{XU} + \theta_{LU}\right] - \rho\lambda_{KX}J_1 + \frac{(\rho-1)\theta_{XU}(1-\gamma)\alpha\lambda_{KX}\theta_{LU}[1-\rho(1-\varepsilon)]}{1-\alpha-\beta}\right\} > 0$$

and

$$\frac{\hat{W}}{\hat{\theta}} = -\frac{(1-\lambda_{LA})}{\Delta_1}\left[\theta_{LU}(1-\varepsilon)\lambda_{KM} + \alpha\frac{(1-\gamma)\lambda_{KX}\theta_{LU}(1-\varepsilon)(\rho-1) + \theta_{LU}(1-\varepsilon)[1-\rho]}{1-\alpha-\beta}\right] < 0$$

From the above result, we establish Proposition 1 to illustrate the impacts of a larger of θ on wage rate of skilled and unskilled labor, rural employment and agricultural output.

Proposition 1. Consider a small, open developing country with an agricultural producer service sector at the primary stage. An increase in remittance rate θ reduces both wage rate of skilled and unskilled labor and increases rural labor employment and agricultural output.

An increase in remittance rate results in a positive effect on agriculture production and raises agricultural wage rate. However, when we consider the agriculture uses the remittance to purchase service that could substitute agricultural labor, an increase in remittance rate will decrease agricultural wage rate instead.

When migrants increase the remittance rate, rural region obtains more remittance

and raises its demand for agricultural service. As a result, price of service increases and more capital is attracted into the service sector. Thus, the marginal productivity of skilled labor employed in the manufacturing sector falls. Since the price of goods *M* is exogenous, the wage rate of skilled labor as well as the output of sector *M* reduce. In addition, contraction of sector *M* leads to a decrease in the employment of unskilled labor. While expansion of sector *X* raises unskilled labor employment, and total urban employment depends on two conflicting effects. And by calculation, we arrive that total urban employment falls.

A raise in service price brings to the substitution of service and unskilled labor and agriculture reduces its demand for service. However, we assume all remittance is used for purchasing producer service. Thus, regardless of the change of service price, agriculture employs service first. As a result, an increase in remittance rate increases the utilization of service and puts downward pressure on wages in agriculture. In addition, a decrease in urban employment also leads to an inflow of unskilled labor into agriculture. Consequently, the wage rate in agriculture decreases.

Using (12) and (13), the skilled-unskilled wage inequality can be expressed as:

$$\frac{\hat{w}_S - \hat{w}}{\hat{\theta}} = \frac{(1-\lambda_{LA})}{\Delta_1}\left[(1-\varepsilon)(J_3 + \rho\lambda_{KX}\theta_{LU}) - (J_1 + \theta_{LU})\lambda_{KX}\right]$$

Next, we use Proposition 2 to show how an increase in remittance rate exerts an impact on skilled-unskilled wage inequality.

Proposition 2. At the primary stage of agricultural service sector, an increase in remittance rate θ has an ambiguous effect on wage inequality. When the elasticity of substitution between unskilled labor and service is relatively large, an increase in remittance rate expands wage inequality.

According to Proposition 1, a larger of θreduces both the wage rate of skilled and unskilled labor. However, the causes of wage reduction are different. The outflow of capital brings to the fall of skilled labor. While the reduction of wage rate of unskilled labor is the result of two aspects: substitution between service and unskilled labor and inflow of urban unemployment. If the elasticity of substitution between unskilled labor and service is relatively large, then the substitution of service for unskilled labor

will be relatively easy. Thus, the expansion of service will increase slightly, leading to the relatively small capital allocation effect. In this case, the fall of wage rate of skilled labor is smaller than that of unskilled labor, which leads to the expansion of the wage inequality.

3.Extension and discussion

With the development of industrialization, rural unskilled labor migrates into urban region persistently that raises the demand for service in small-scale agriculture. Meanwhile, agricultural producer service in developing countries is increasingly technology or knowledge intensive,whichmakes economiesof scale internal to the firms in theservice sector. The growth in both demand and supply side lead to the popularization of agricultural service in agricultural production. Thus, it is necessary to test the robustness of the results by considering the popularization of service sector. After the popularization of sector *X*, (1) firms could provision differential services, for instance,agricultural market information service,agricultural production trusteeship service, supply service of agricultural means of production;(2) the service sector utilizes not only unskilled labor and capital but also skilled labor;(3) firms can enter this market by paying a fixed set-up cost and market structure of service sector is monopolistic competition; (4) service could perfectly substitute unskilled labor in agricultural production.

3.1 The model

The relationships between the production of sector *M* and unskilled labor migration mechanism are the same as before, shown as Eq. (1) and (4).

Service sector*X*. Each variety $x_i$is produced by a monopolistically competitive firm in the urban area and production is under the increasing returns-to-scale technology.In this sector,the cost of each firm involves fixed cost, $w_S^{\delta} r^{1-\delta}$,where $0<\delta<1$. Since firms need to pay a fixed cost to enter this sector, thus, the number of firms is finite, and assume sector *X* exists *n* firms. After investing in fixed inputs, production requires unskilled labor and capital with the marginal cost given by $\overline{w}^{\varphi} r^{1-\varphi}$, where

$0<\varphi<1$.Total cost faced by each service firm is $TC_i = w_S^{\delta} r^{1-\delta} + \bar{w}^{\varphi} r^{1-\varphi} x_i$. Due to the internal economies of scale, each firm specializes in the production of a single variety, and the number of firms equals the number of varieties.

The total output of sector *X* is assumed to be of the CES type, $X = \left[\sum_{i=1}^{n} x_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$, where $\sigma > 1$ is a parameter and represents the elasticity of substitution among varieties. $P = \left[\sum_{i=1}^{n} p_i^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$ is the price index of service intermediate goods *X*, p_i is the relative price of variety *i*. Given *X*, the agricultural sector generates the demand for each variety $x_i = p_i^{-\sigma} P^{\sigma} X$. Following the demand function and cost function of each variety, a firm sets the price to maximize its profit, which yields

$$p_i = \frac{\sigma}{\sigma - 1} \bar{w}^{\varphi} r^{1-\varphi} \quad (15)$$

From equation (15), the pricing rule is independent of the variety index *i*. Since p_i and marginal costare the same for all firms, each firm would also produce the same amount of output, and set $x_i = x_j = x, p_i = p_j = p$, we have $P = pn^{1/(1-\sigma)}$, and $X = xn^{\sigma/(\sigma-1)}$. Because of $\sigma > 1$, expansion of the number of varieties, *n*, reduces the price index *P* and raises *X*, even if each firm keeps its price and output constant. As the value of σ goes to infinite, the influence of *n* on *P* and *X*disappears. The reason is that, *X* becomes the simple sum of the quantities of service and varieties become perfect substitution foreach other. On the other hand, as the value of σ declines towards 1, the importance of diversity becomesmore significant. From Shepard's Lemma and cost function, employments of skilled and unskilled labor in the service sector are $\delta w_S^{\delta-1} r^{1-\delta} n$ and $\varphi \bar{w}^{\varphi} r^{1-\varphi} xn$, along with the usage of capital is: $[(1-\delta) w_S^{\delta} r^{1-\delta} + (1-\varphi) \bar{w}^{\varphi} r^{-\varphi} x] n$.

Agricultural sector. This sector uses unskilled labor L_A, service from sector *X* and land *T*. We assume the service does routine farm work and could substitute

unskilled labor in sector *A* perfectly. Hence, we can define effective labor U_A used in this sector as follows: $U_A = L_A + sX$,where*s* represents the substitution between unit service and unskilled labor, and a larger *s* implies unit service could substitute unskilled labor in a greater margin. The perfect substitution implies sector *A* employs the services do farm work only if the unit price of service is no larger than the unskilled wage rate *w* multiples *s*, and in equilibrium, we must have

$$pn^{1/(1-\sigma)} = sw \quad (16)$$

Production function in sector *A*is same as that in the section 2. Thecost minimization condition yields:

$$w^{\varepsilon}\tau^{1-\varepsilon} = 1 \quad (17)$$

Following assumption of migrants' remittance, *R* could rewrite as *R*= $\theta(\beta p_M M + \varphi \bar{w}^{\varphi} r^{1-\varphi} xn)$. The equilibrium condition

$$\theta(\beta p_M M + \varphi \bar{w}^{\varphi} r^{1-\varphi} xn) = PX \quad (18)$$

Next, we turn to the factor market. The market-clearing conditions of factors yield:

$$\alpha p_M M w_S^{-1} + \delta w_S^{\delta-1} r^{1-\delta} n = \bar{S} \quad (19)$$

$$(1+\lambda)\left(\beta p_M M \bar{w}^{-1} + \varphi \bar{w}^{\varphi} r^{1-\varphi} xn\right) + L_A = \bar{L} \quad (20)$$

$$(1-\alpha-\beta) p_M M r^{-1} + [(1-\delta) w_S^{\delta} r^{1-\delta} + (1-\varphi)\bar{w}^{\varphi} r^{-\varphi} x] n = \bar{K} \quad (21)$$

$$(1-\varepsilon) A \tau^{-1} = \bar{T} \quad (22)$$

$$\varepsilon A w^{-1} = L_A + sX \quad (23)$$

In the long-run, firms can enter or exit in the service sector. Using (15),the long-run equilibrium is therefore characterized by zero profit shown as follows:

$$\frac{x\bar{w}^{\varphi} r^{1-\varphi}}{\sigma - 1} = w_S^{\delta} r^{1-\delta} \quad (24)$$

Using (16) and (18) , we rewrite(20) and (23) as

$$(1+\lambda)\bar{w}^{-1} pnx\theta^{-1} + L_A = \bar{L} \quad (20')$$

$$\varepsilon A = wL_A + pnx \quad (23')$$

The above general equilibrium framework will be employed to analyze the impacts of an increase in the remittance rate on income distribution of skilled and unskilled labor in the popularization stage of agricultural producer service. Accordingly, the long-run equilibrium involves eleven equations ((1),(4),(15),(16), (17),(19),(20'),(21),(22),(23')and(24)) and eleven endogenous variables: w_S,w, p,τ,λ,r, A,x,M, n, and L_A.

3.2 Comparatively Analysis

Totally differentiating those eleven equations, we can obtain the following matrix:

$$\begin{pmatrix} \Omega_1 & 1 & 0 & 0 & 1/(\sigma-1) \\ \Omega_2 & 0 & \lambda_{SM} & 0 & \lambda_{SX} \\ \Omega_3 & 0 & \lambda_{KM} & 0 & \lambda_{KX} \\ \Omega_4 & -1 & 0 & \lambda_{LA}/(1-\lambda_{LA}) & 1 \\ \theta_{LA}^X\Omega_4 & \varepsilon/(1-\varepsilon)+\theta_{LA}^L & 0 & \theta_{LA}^L & \theta_{LA}^X \end{pmatrix} \begin{pmatrix} \hat{w}_S \\ \hat{w} \\ \hat{M} \\ \hat{L}_A \\ \hat{n} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \\ 0 \end{pmatrix} \hat{\theta} \quad (25)$$

where $\theta_{LA}^L = wL_A/\varepsilon A$, $\theta_{LA}^X = pnx/\varepsilon A$,and $\theta_{LA}^L + \theta_{LA}^X = 1$. $\Omega_1 = \alpha(1-\varphi)/(1-\alpha-\beta) > 0$,

$\Omega_2 = -[\lambda_{SM} + \lambda_{SX}(1-\delta)(1-\beta)/(1-\alpha-\beta)] < 0$, $\Omega_3 = [(1-\beta)\delta\lambda_{KX} + \alpha\lambda_{KM}]/(1-\alpha-\beta) > 0$

and $\Omega_4 = [\delta(1-\beta)-\alpha]/(1-\alpha-\beta)$. To make the following analysis traceable, according to economic realities, we impose the following inequality relationship. In developing countries, the allocative share of unskilled labor in the rural region is larger than that in the urban region, which implies $\lambda_{LA} > 1-\lambda_{LA}$. The agricultural service sector starts late with a high starting point that contributes to gaining the advantages of backwardness by employing equipment and tools. Since training skilled labor needs more time than the time needed for capital accumulation, it is easy to generate the situation that the capital per capita of skilled labor in the servicesector is higher than that of manufacturing sector. Thus,we assume that the agricultural service sector is more capital intensive with respect to skilled labor than the manufacturing sector. In mathematical terms, this implies that $\lambda_{KM}\lambda_{SX} - \lambda_{SM}\lambda_{KX} < 0$. In addition, it may

be realistic to suppose that skilled labor serves more significantly in the manufacturing sector than in the service sector, $\alpha > \delta$, which further implies that $\Omega_4 < 0$.

Define the determinant of the matrix in Eq. (25) as Δ_2 and calculate Δ_2 to obtain:

$$\Delta_2 = \left(\lambda_{SM}\lambda_{KX} - \lambda_{SX}\lambda_{KM}\right)\left[\Omega_4\left(\theta_{LA}^L + \frac{\lambda_{LA}\theta_{LA}^X}{1-\lambda_{LA}}\right) + \Omega_1\theta_{LA}^L\left(1 - \frac{\lambda_{LA}}{1-\lambda_{LA}}\right) - \frac{\lambda_{LA}\Omega_1}{1-\lambda_{LA}}\frac{\varepsilon}{1-\varepsilon}\right]$$
$$+\left(\Omega_2\lambda_{KM} - \Omega_3\lambda_{SM}\right)\left[\frac{\sigma\theta_{LA}^L}{\sigma-1} + \frac{\lambda_{LA}\theta_{LA}^X}{1-\lambda_{LA}} - \frac{\lambda_{LA}}{1-\lambda_{LA}}\frac{1}{\sigma-1}\left(\frac{\varepsilon}{1-\varepsilon} + \theta_{LA}^L\right)\right]$$

Δ_2 is unambiguously negative as $\sigma \to \infty$. The provision of more varieties gives rise to external economies which can result in an unstable equilibrium. The stability problem does not arise as long as the size of external economies is sufficiently large which means σ is not extremely small[2]. The rest of this paper assumes stability and Δ_2 is negative.

According to Cramer's Rule,we have

$$\frac{\hat{w}_S}{\hat{\theta}} = \frac{\theta_{LA}^L\left(\lambda_{SM}\lambda_{KX} - \lambda_{SX}\lambda_{KM}\right)}{\Delta_2} < 0 \quad (26)$$

$$\frac{\hat{w}}{\hat{\theta}} = \frac{-\theta_{LA}^L\left(\lambda_{SM}\lambda_{KX} - \lambda_{SX}\lambda_{KM}\right)\Omega_1}{\Delta_2} - \frac{\theta_{LA}^L(\Omega_2\lambda_{KM} - \lambda_{SM}\Omega_3)}{(\sigma-1)\Delta_2} \quad (27)$$

$$\frac{\hat{L}_A}{\hat{\theta}} = \left[\Omega_1\left(\frac{\varepsilon}{1-\varepsilon} + \theta_{LA}^L\right) - \theta_{LA}^X\Omega_4\right]\frac{\left(\lambda_{SM}\lambda_{KX} - \lambda_{SX}\lambda_{KM}\right)}{\Delta_2} + \left[\frac{\left(\varepsilon/(1-\varepsilon) + \theta_{LA}^L\right)}{\sigma-1} - \theta_{LA}^X\right]\frac{(\Omega_2\lambda_{KM} - \lambda_{SM}\Omega_3)}{\Delta_2} \quad (28)$$

$$\frac{\hat{M}}{\hat{\theta}} = -\frac{\theta_{LA}^L\left(\Omega_2\lambda_{KX} - \lambda_{SX}\Omega_3\right)}{\Delta_2} < 0 \quad (29)$$

and

$$\frac{\hat{n}}{\hat{\theta}} = \frac{\theta_{LA}^L\left(\Omega_2\lambda_{KM} - \lambda_{SM}\Omega_3\right)}{\Delta_2} > 0 \quad (30)$$

In view of Eqs. (26)-(30),the following proposition can be obtained:

Proposition 3. Consider a small, open developing country with an agricultural producer service sector at the popularization stage. An increase in remittance rate θ reduces wage rate of skilled labor. However, its impacts on wage rate of unskilled

[2]A similar setting could refer to Anwar(2010).

labor, rural labor employment and agricultural output are ambiguous.

An increase in θ results in more remittance and agriculture raises its demand for service. Consequently, price of service rises. From (24), firms obtain a positive profit and the number of firms, n , increases. Meanwhile, the higher price of service leads to the redistribution of capital and skilled labor between the service sector and manufacturing sector, which results in the decrease of wage rate of skilled labor and the increase of interest rate. Thus, the output of the manufacturing sector and the employment of unskilled labor decrease.

However, the urban total unskilled labor may increase or decrease, depending on the magnitude of elasticity of substitution among varietiesσ. When $\sigma$is relatively small[3], which implies an increase in n has relatively large external economies on X. In this case, fewer resources are needed to satisfy the increase demand for X. Thus, service sector increases the employment of unskilled labor in a relatively small margin, resulting in total urban employment decreases and unemployment rate rises. From the labor transfer mechanism, a rise in the unemployment rate brings to a decrease in wage rate of unskilled labor and discourages labor migration and increases rural labor employment. In addition, according to (16), wage rate of unskilled labor depends on p and n. The difference of factor intensity leads to an increase in p, which exerts a positive effect on w. While a larger of n lowers w. Parameter σdetermines the final result. When $\sigma$is relatively small, the change of w is dominated by the effect generated from a larger of n, and wage of unskilled labor decreases. Since agriculture employs more service and unskilled labor, its output increases.

The similar logic can be applied to the case of relative large σ. A relatively large value of σimplies an increase in n has relatively little external economies on X. In this case, more resources are needed to expansion X. As a result, service sector raises the employment of unskilled labor in a relatively large margin, contributing to the increase of total urban employment and the decrease of unemployment rate. In this case, an increase in θencourages labor migration and raises wage rate of unskilled

[3]By calcualtion, the threshold of "relatively small" is larger than the critical value that ensures the stability of the model.

labor. Though agriculture obtains more remittance, an outflow of unskilled labor leads to a decrease of agricultural output.

Using (26) and (27), the skilled-unskilled wage inequality can be expressed as:

$$\frac{\hat{w}_S - \hat{w}}{\hat{\theta}} = \frac{(1-\alpha\varphi-\beta)\theta_{LA}^{L}(\lambda_{SM}\lambda_{KX} - \lambda_{SX}\lambda_{KM})}{\Delta_2(1-\alpha-\beta)} + \frac{\theta_{LA}^{L}(\Omega_2\lambda_{KM} - \lambda_{SM}\Omega_3)}{\Delta_2(\sigma-1)}$$

We use Proposition 4 to show the impact of an increase in remittance rate on skilled-unskilled wage inequality.

Proposition 4. At the popularization stage of agricultural service sector, an increase in remittance rate has an ambiguous effect on wage inequality. When the elasticity of substitution among varieties is sufficiently large(relatively small), an increase in remittance rate narrows down (expands) wage inequality.

According to Proposition 3, a larger of θreduces the wage rate of skilled labor, and raises wage rate of unskilled labor if the elasticity of substitution among varieties is sufficiently large. In this case, wage inequality will be narrowed down. When the elasticity is relatively small, an increase in θreduces both the wage of skilled and unskilled labor. Since the external economies are relatively large, the expansion of sector *X* needs less resources from sector *M*, and the demand for skilled labor decreases slightly. Consequently, the decrease of thewage rate of skilled labor is relatively limited, resulting in the expansion of wage inequality.

4. Concluding remarks

The industrialization process in developing countries is quite different from the previously developed countries, especially in the rural region. With the massive rural migrants, rural area receives a large amount of remittance. Meanwhile, small-scale agriculture also affects by this process and has changed its production structure by utilizing more producer service to substitute rural labor. Such phenomena will exert an impact on wage inequality between skilled and unskilled labor. This paper builds

three-sector static general equilibrium models and tries to answer this issue from different angles. In the primary stage of service sector, an increase in remittance rate reduces both wage rate of skilled and unskilled labor and has an ambiguous impact on wage inequality. The obtained result of wage inequality is robusteven when we extend the basic theoretical model by considering the popularization stage of service sector.

Here, we give some possible extensions for future research. Firstly, in this paper, the prices of final goods are exogenous. When we consider the close economy, the prices are endogenous, and an outflow of funds from the urban could affect urban economy from demand side. Secondly, in this paper,the industrial and service sectors have no upstream and downstream linkages. Small-scale agriculture could utilize modern equipment indirectly through the service sector that needs industry-supplied intermediate input. When the manufacturing sector acts as an upstream industry for the service sector, we may draw different conclusions. Thirdly, urban informal sector should be incorporated in future research. With the persistence of rural labor migration,a large amount of migrants who are unemployed chose to stay in the urban region and work in the informal sector. And in this situation, the labor transfer mechanism should change accordingly.

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