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Environment and labor movement of skilled labor and unskilled labor between sectors

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ABSTRACT

In this paper, we divide the labor into skilled and unskilled labor to investigate the impact that the heterogeneous labor movement between sectors has on the environment under the international skilled and unskilled labor flows and the price change of the agricultural products. The main conclusions are: under certain conditions, skilled labor inflow deteriorates the environment while its outflow improves the environment; unskilled labor inflow improves the environment while its outflow deteriorates the environment; the increasing price of the agricultural products improves the environment while the decreasing price deteriorates the environment.

1. Introduction

The movement of heterogeneous labor force between different sectors is often considered in studies of income disparity and employment. Marjit and Kar (2005) divided the labor force in an economy into skilled and unskilled labor, and established a general equilibrium model of a two-sector economy. They studied the income disparity under the assumption that there is no unemployment or capital movement between sectors. Yabuuchi and Chaudhuri (2007) took skilled labor as a specific factor whereas unskilled labor could move freely between sectors. Based on the assumption of non-existence of unemployment in either sector, they analyzed the impact of international factors on changes of income. Beladi et al. (2008) analyzed the impact of inflow of international factors on the wage disparity between the skilled labor and unskilled labor through a two-sector general equilibrium model. This paper is based on the assumptions of full employment and free movement of skilled labor between sectors, and existence of unemployment of the unskilled labor. Gupta and Dutta (2010) made an assumption that skilled labor moves between trade and non-trade sectors, while unskilled labor does not, upon which they established a general equilibrium model and studied the impact of changes in factor endowments and in the price of tradable goods on unemployment and the relative wages of skilled and unskilled labor. Chaudhuri and Banerjee (2010) divided the rural sector into the advanced and the backward subsectors and established a general four-sector equilibrium model. They studied the income effect of capital inflow under the premise of existence of unemployment of skilled labor and immobility of them between sectors, as well as full employment and full mobility of the unskilled labor between the two rural sectors and immobility of unskilled labor between the rural and urban sectors. However, with regard to the real-world economic activities in the developing countries, the impact of the heterogeneous movement labor is not limited to income disparity and employment.

On the other hand, since the 1990s, there have been many studies in academia on the impact of inter-sector labor movement in developing countries on the environment from different perspectives, particularly the impact of labor movement on pollution based on the Harris-Todaro Model, such as Beladi and Rapp (1993), Beladi and Frasca (1999), Daitoh (2003), Daitoh (2008), Tawada and Sun (2010), Daitoh and Omote (2011) and Kondoh and Yabuuchi (2012), which involve taxation, environmental policy and improvement of labor market. However, we note that all the aforesaid studies on the labor movement and environment are based on a common premise, namely, labor is homogeneous, which is different from the reality where labor is actually heterogeneous. In fact, the impact of labor quality on environment is a focus of academic studies in developing countries. Some Chinese scholars (Li and Ding, 2012; Peng, 2008) pointed out that increasing skilled labor endowment would have an impact of improving the environment. Therefore, we would like to study the impact of heterogeneous labor movement between sectors on the environment.

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In this paper, we will divide the entire labor force into the skilled and unskilled and study the impact of heterogeneous labor movement between sectors on the environment under the conditions of free flow of international labor factors and a change in the agricultural products price. The main conclusion of this paper is that, under certain circumstances, the inflow of skilled labor could deteriorate the environment; on the other hand, the outflow of labor could improve the environment. The inflow of unskilled labor would, however, improve the environment; and the outflow would deteriorate the environment. In the following, we will establish a theoretical model in the second section, made a theoretical analysis in the third section, and draw a conclusion thereupon the last section would.

2. The model

We consider a small open developing economy with two sectors, namely, the urban sector and the agricultural sector. The economy uses four production factors, which are skilled labor L_S, unskilled labor L_U, capital K and land N. The urban sector uses skilled labor, unskilled labor and capital to produce import-competing goods. The agricultural sector uses skilled labor, unskilled labor and land to produce exportable goods. The urban sector is skilled labor intensive and the agricultural sector is unskilled labor intensive. The production functions of the urban and agricultural sectors are given by:

$$X_1 = F^1(L_{S1}, L_{U1}, K) \tag{1}$$

$$X_2 = eF^2(L_{S2}, L_{U2}, N) \tag{2}$$

F^1 and F^2 are production functions increasing corresponding to each factor and satisfying linear homogenous and strictly quasi-concave properties.

In the production function of the agricultural sector,

$$e = \frac{\overline{E} - \mu X_1}{\overline{E}} \tag{3}$$

where e represents the environment of the economy. When $e = 1$, the environment is in the best condition. It becomes worse when e decreases. $\overline{E}$ represents the environment endowment when there is no pollution in the economy. μ is the pollution that the urban sector discharges for producing one unit of good. We assume that only the production of the urban sector causes pollution emission to make the environment worse. The harmful substance emitted, such as waste gas, waste residue and waste water, pollute water and soil for agricultural use through atmosphere, rivers and other media. Hence, the product efficiency of the agricultural sector decreases.

Under the condition that the markets are perfectly competitive, we could obtain that:

$$p_1 = a_{S1}w_{S1} + a_{U1}\overline{w_U} + a_{K1}r \tag{4}$$

$$p_2 = a_{S2}w_{S2} + a_{U2}w_{U2} + a_{N2}R \tag{5}$$

where $a_{ij}(i = S, U, K, N; j = 1, 2)$ represents the factor i used in producing one unit of goods in the jth sector. w_{S1} is the wage rate of skilled labor in the urban sector. w_{S2} is the wage rate of skilled labor in the agricultural sector. $\overline{w_U}$ is the wage rate of unskilled labor in the urban sector. w_{U2} is the wage rate of unskilled labor in the agricultural sector. r is the interest rate of capital in the urban sector. R is the rent of land used in the agricultural sector. $p_j(j = 1, 2)$ represents the product prices of the urban sector and the agricultural sector, respectively. In this paper, we assume that all the products are tradable and hence the product prices are given internationally.

Generally, developing countries lack skilled labor. Therefore, we assume that skilled labors are fully employed with no unemployment and they move freely between the urban and agricultural sectors. This paper assumes that the wage rate of unskilled labor in the urban sector is given exogenously, which means that it is downward rigid. However, in the agricultural sector, the wage rate of unskilled labor w is fully elastic. We use L_{UU} to denote the number of unemployed unskilled labor in the urban sector and λ to denote the unemployment rate of unskilled labor in this sector. Hence, $\lambda = L_{UU}/L_{U1} = L_{UU}/a_{U1}X_1$. Therefore, in the unskilled labor market equilibrium, the wage rate in the agricultural sector equals the expected wage income in the urban sector, which equals to the downward rigid wage rate $\overline{w_U}$ multiplied by the probability of obtaining a job in this sector $L_{U1}/(L_{U1} + L_{UU})$. Thus, the allocation mechanism of the skilled labor and unskilled labor are shown as:

$$w_{S1} = w_{S2} \tag{6}$$

$$w_{U2} = \frac{L_{U1}}{L_{U1} + L_{UU}}\overline{w_U} \tag{7}$$

or:

$$(1 + \lambda)w_{U2} = \overline{w_U}. \tag{7'}$$

The market clearing conditions of the four production factors: skilled labor, unskilled labor, capital and land, could be shown as follows:

$$a_{S1}X_1 + a_{S2}X_2 = L_S \tag{8}$$

$$a_{U1}X_1 + a_{U2}X_2 + \lambda a_{U1}X_1 = L_U \tag{9}$$

$$a_{K1}X_1 = K \tag{10}$$

$$a_{N2}X_2 = N \tag{11}$$

where L_S, L_U, K, N represent the endowment of skilled labor, unskilled labor, capital and land, respectively.

The basic theoretical model has been built, which consists of nine Eqs. (3)–(11). Nine endogenous variables are determined, and they are w_{S1}, w_{S2}, w_{U2}, r, R, λ, e, X_1 and X_2.

3. Environment and labor movement between sectors

Differentiating the Eqs. (4)–(11) and writing in a matrix notation, we can obtain the following equation:

$$\begin{pmatrix} \theta_{S1} & 0 & \theta_{K1} & 0 & 0 & 0 \\ \theta_{S2} & \theta_{U2} & 0 & \theta_{N2} & 0 & 0 \\ A & \lambda_{S2}S^2_{SU} & \lambda_{S1}S^1_{SK} & \lambda_{S2}S^2_{SN} & \lambda_{S1} & \lambda_{S2} \\ B & C & D & \lambda_{U2}S^2_{UN} & (1+\lambda)\lambda_{U1} & \lambda_{U2} \\ S^1_{KS} & 0 & S^1_{KK} & 0 & 1 & 0 \\ S^2_{NS} & S^2_{NU} & 0 & S^2_{NN} & 0 & 1 \end{pmatrix} \begin{pmatrix} \hat{w}_{S1} \\ \hat{w}_{U2} \\ \hat{r} \\ \hat{R} \\ \hat{X}_1 \\ \hat{X}_2 \end{pmatrix} = \begin{pmatrix} \hat{p}_1 \\ \hat{p}_2 \\ \hat{L}_S \\ \hat{L}_U \\ \hat{K} \\ \hat{N} \end{pmatrix} \tag{12}$$

and differentiating the Eq. (3), we can get the following:

$$e\hat{e} + (1-e)\hat{X}_1 = 0 \tag{13}$$

where "^" represents the rate of change, $\theta_{ij}(i = S, U, K, N; j = 1, 2)$ is the distributive share of factor i in the jth sector (e.g. $\theta_{S1} = a_{S1}w_{S1}/p_1$), $\lambda_{ij}(i = S, U, K, N; j = 1, 2)$ is the allocated share of factor i in the jth sector (e.g. $\lambda_{S1} = a_{S1}X_1/L_S$), $S^h_{ij}(i, j = S, U, K, N; h = 1, 2)$ is the partial elasticity of substitution between factors i and j in the hth sector (e.g. $S^2_{SU} = \frac{\partial a_{S2}}{\partial w_{U2}}\frac{w_{U2}}{a_{S2}}$), $S^h_{ij} > 0(i \neq j)$ and $S^h_{ij} < 0(i = j)$. We also have:

$$A = \lambda_{S1}S^1_{SS} + \lambda_{S2}S^2_{SS} < 0, B = (1+\lambda)\lambda_{U1}S^1_{US} + \lambda_{U2}S^2_{US} > 0,$$
$$C = \lambda_{U2}S^2_{UU} - (1+\lambda)\lambda_{U1} < 0, D = (1+\lambda)\lambda_{U1}S^1_{UK} > 0.$$