

# Original Research Article

## **International factor mobility, rural development policies and wage inequality in the presence of industrial goods as intermediate input in agriculture**

**ABSTRACT:** The paper develops a three-sector small open economy model with two final good sectors and a non-trade good sector producing industrial intermediate goods in agriculture. It is shown that an increase in either type of labour endowment (capital endowment) raises (lowers) the unemployment rate of either type of labour if the scale elasticity of output is very low. On the other hand, if the industrial sector is more capital intensive than the agricultural sector and if efficiency functions of both types of labour are identical, then an increase in either type of labour endowment (capital endowment) lowers (raises) the skilled–unskilled wage ratio. However, the effect of a change in capital endowment on the Gini Coefficient of wage income distribution is ambiguous in sign.

**KEYWORDS:** International factor mobility; Rural development policies; Wage inequality; Industrial intermediate input.

**JEL CLASSIFICATION:** F2; J31; O2; Q18

### **1. Introduction**

Rapid technological advancement has contributed to improving living standards and economic growth in the world; however, the benefits of technological advancement are not equally distributed among sectors. In the transportation sector, it is widely accepted that technological development led to a considerable reduction in its cost.

Lower transportation and communication cost comes a remarkable increase in international trade and factor mobility. According to Stolper-Samuelson theorem, developing countries are expected to experience lower wage inequality due to the trade liberalization. However, many developing countries suffer from the widened wage gap(see e.g.Wood ,1997;Feenstra and Hanson, 2003;Banga ,2005; Anwar and Sun,2012).

Rising wage gap is a concern for developing countries, theoretical studies have tried to identify factors that may have brought to wage gap in developing countries: labour market imperfections (Chaudhuri &Yabuuchi, 2007),capital market distortion(Pi and Chen,2016), public infrastructure provision (Pi and Zhou,2012), privatization (Chao et al, 2016), migrants' remittances(Li and Zhou, 2013), taxation of income(Anwar and Sun,2015), trade and market congestion(Santra, 2012),skill bias of technical change(Behar, 2016). Some scholars paid special attention to international factor mobility when considered the wage inequality from various perspectives.Beladi et al. (2008) considered a model with unemployment and the impact of international factor mobility on wage inequality crucially depends on the difference in the intersectoral factor intensities. Chaudhuri(2008) showed that the results of international factor mobility on wage inequality may not necessarily depend on the difference in the factor intensity. Only when the unskilled wage in the low-skill urban sector is positively related to rural wage, factor intensity condition matters. Chaudhuria and Dibyendu Banerjee(2010) investigated "fair wage hypothesis" in skilled wage and concluded that the effects of international factor mobility crucially hinge on the properties efficiency function of skilled labor. Pan and Zhou (2013) established a model by accommodating environmental pollution and highlighted the role of environmental pollution in the determination of wage inequality when there

exists international factor mobility. Li and Xu(2016) investigated how the international factor movements affect wage inequality with the existence of a modern agricultural sector, and found that unskilled labor outflow certainly decreases the wage inequality and the results that skilled labor movement and capital inflow have on wage inequality are dependent on the factor intensity between the urban and modern agricultural sectors.

Unfortunately, much of the existing studies ignores the role of industrial goods as intermediate input in agriculture. As the population increases, crop lands are unable to meet the growing demand for food without employing some methods of crop enhancement. Increasing fertilizer and chemical material usage are common practices in developing countries to meet the growing demand, which created a large agrichemical industry (the industry produces various products designed to increase crop production and protect crops from disease and pests). Meanwhile, the development of industrial sector gradually lowers the price of industrial products relative to agricultural products, which makes the adoption of industrial intermediate goods reality in recent years. In addition, many developing countries are also experiencing massive rural-urban migration and huge amount of rural labor are migrating to the urban region, forcing farmers to use more industrial equipment to replace transferred labor in the process of agricultural production. Take China for example, the share of labor employed primarily in agriculture fell from 68.7 % in 1980 to 28.3 % in 2015 according to the 2016 China Statistical Year Book, while industrial intermediate goods input in agriculture has experienced remarkable increase. For instance, fertilizer input was 12.69 million tons in 1980, and in 2015, the figure was 60.22 million tons. The total power of China's agricultural machinery was 147.45million kW in 1980, 684.0 million kW in 2005, 1117.28 million kW in 2015. It

is obvious that a considerable increase in industrial intermediate goods input has greatly contributed to sustaining high yields with dramatically less employment. Since industrial intermediate goods input accounts large proportions, it is reasonable for us to image that the change of agricultural output resulted from the fluctuation of intermediate goods price brings the movement of production factors between sectors, exerting an influence on wage inequality. Therefore, it is necessary for us to investigate the effects of international factor mobility on wage inequality in the presence of industrial goods as intermediate input in agriculture.

Rural development is a main obstacle for many development countries toward industrialization and government poses numerous policies to promote agriculture. Agricultural subsidy to is often implemented by government in developing countries. Its effects are explored by scholars from different aspects. Gupta(1993) developed a model with unemployment and informal sector in urban area and rural wage subsidy increases unemployment. Chaudhuri(2000) found a wage or a price subsidy policy to the rural sector reduces the urban unemployment level. Yabuuchi and Beladi(2001) considered a model with both open unemployment and the informal sector that produces final goods and found wage subsidies to the agricultural sector increase welfare and decrease urban unemployment. Li and Shen(2012) divided agricultural sector into modern and traditional agricultural sector, and concluded interest subsidies and wage subsidies have opposite effects on urban unemployment. Li et al(2014) established four sectors general equilibrium model with advanced and traditional rural sector and conclude that wage subsidizing policies is stronger than that of interest subsidies. Since the subsidy policies have different effects on rural development and whole economy, it is worthy to analyze the impacts of such policies on wage inequality and national income in the presence of industrial goods as intermediate

input. However, the existing literature on rural subsidy neglects to consider the issue of wage inequality, and thus fails to investigate the effect of rural subsidy on the wage inequality in the presence of industrial goods as intermediate input in agriculture.

The paper attempts to integrate international factor mobility and rural subsidy policy into a unified framework of wage inequality in the presence of industrial goods as intermediate input in agriculture. The economic intuition of this paper is described as follows briefly. An inflow or outflow of factor increases or decreases the supply of that factor, resulting in a fall or raise of that factor's price. The change of factor's price also brings other factors movement among sectors, exerting influences on other factor's price. Take an outflow of skilled labor as an example, an outflow of skilled labor decreases the supply of skilled labor and increase its wage. Meanwhile, the change of skilled labor affects marginal product of unskilled labor and capital, which lead to the change of factor employment. Capital and unskilled labor move into the other sector in the urban region: the intermediate goods sector and affect the cost and price of intermediate goods. The change of price intermediate goods sector affects the employment of intermediate input and wage of unskilled labor. Strengthen rural subsidy policy encourages agriculture to employ more relevant factor to production, causing not only the relevant factor movement but also other factors flow. Like, if government increase the price subsidy of intermediate goods, agriculture increases the input of intermediate goods, which affects the factor movement between urban region, and rural wage rate be affected at last. Combining those aspects, we obtain that how international factor mobility and rural development policy exert their impacts on wage inequality and national income in the existence of industrial goods as intermediate input in agriculture.

In order to fill the current research gap, this paper constructs a three-sector model: one urban industrial sector and one urban sector that produces industrial intermediate input in agriculture and rural agricultural sector. We find that an outflow of skilled labor benefits the development of agricultural sector while an outflow of unskilled labor deteriorates it. The impact of an inflow of capital on agriculture depends on the elasticity of substitution between skilled labor and unskilled labor in the industrial sector. Their impacts on wage inequality depends on capital-labor relative distributive share in industrial and agricultural sector. The economic impacts of rural development policies, an increase in wage and purchase of intermediate goods subsidy narrows down the wage inequality. However, their impacts on national income are different: an increase in wage subsidy raises national income unambiguously; while the impact of an increase in subsidy of intermediate goods on national income is not clear.

The rest of the paper is organized as follows. We establish a model in Section 2. And investigate the effects of international factor mobility public in the first part of Section 3. In the second part of Section 3, we discuss the effects of rural development policies, wage and purchase of intermediate goods subsidy. Concluding remarks are made in Section 4.

## **2. The model**

Consider a small open economy composed of three sectors, two urban industrial sectors and one rural agricultural sector. One of industrial sector (sector 1, hereafter call it “industrial sector”) produces import-competing goods  $X_1$  by employing skilled labor  $L_{S1}$ , unskilled labor  $L_{U1}$  and capital  $K_1$ , the other industrial sector (sector 2, hereafter call it “intermediate goods sector”) uses unskilled labor  $L_{U2}$  and capital  $K_2$  to produce non-trade intermediate goods  $X_2$  for agricultural production. The rural

agricultural sector utilizes unskilled labor and intermediate goods  $X_2$  to produce exportable goods. Capital moves freely between the urban sectors. There exists segmentation in the labor market: skilled labor concentrates in the sector 1, while unskilled labor moves between three sectors. Unskilled labor allocation mechanism is Harris-Todaro type and there exists the unemployment of unskilled workers in the urban area due to rigid wage rate. The production functions of three sectors can be expressed as  $X_1 = F^1(L_{S1}, K_1)$ ,  $X_2 = F^2(L_{U2}, K_2)$  and  $X_3 = F^3(L_{U3}, X_{23})$ , respectively, where the three functions satisfy the neoclassical properties (i.e., strict quasi-concavity and linear homogeneity). It is worth noting that the agricultural production method, employing industrial goods as intermediate input for production, is different with the method of industrial agriculture which is a form of modern capital-intensive farming and widespread in developed nations. Though industrial equipment is used in agricultural production, agriculture in developing countries is still a labor-intensive sector.

Before the establishment of the model, we would like to point three points concerning the intermediate goods sector and agricultural sector. First, the intermediate goods sector produces chemical products (like fertilizer and pesticides, etc) and low-end agricultural equipment and makes it hard to attract skilled labor. Therefore, most of labor employed by this sector is unskilled labor and it is reasonable to assume that the intermediate goods sector only employs unskilled labor and capital. The setting of intermediate goods sector here is similar to that in Chaudhuri(2002). Second, the goods of intermediate goods sector is agriculture-oriented product and mainly used for agricultural production. Moreover, most of products in the intermediate goods sector are produced within the developing countries due to the high transportation cost and environment regulation in developed

countries. Thus, we assume that the product of the intermediate goods sector is non-trade goods and only used into agricultural production, which is in accordance with Beladi and Marjit (1996). Third, the assumption that the agricultural sector does not employ capital as the factor of production is to emphasize that agricultural sector uses little capital to production apart from the intermediate goods in developing countries. Capital is used in the production of the intermediate goods sector and thus, indirectly employed by the agricultural sector.

In a competitive equilibrium with all goods being produced, unitcost of production in each sector reflects the market price. Taking the goods of agriculture asnumeraire, we have:

$$p_1 = a_{s1}w_s + a_{u1}\bar{w}_u + a_{k1}r \quad (1)$$

$$p_2 = a_{u2}\bar{w}_u + a_{k2}r \quad (2)$$

$$1 = a_{x3}(\alpha p_2) + a_{u3}(\beta w_u) \quad (3)$$

where  $p_1$  and  $p_2$  are goods prices of industrial sector and intermediate goods sector relative to that of agriculture goods, respectively, and  $p_1$  is assumed to be given and constant in a small open economy.  $a_{ij}$  ( $i = S, U, K; j = 1, 2, 3$ ) represents that the factor  $i$  used in producing one unit of goods in the  $j$ th sector.  $w_s$  is the wage rate of skilled labor in the sector 1.  $\bar{w}_u$  is the wage rate of unskilled labor in the urban region, which is downward rigid due to protection of labor unions.  $w_u$  is the wage rate of unskilled labor in the agriculture, which is fully elastic.  $r$  is the interest rates of capital.  $\alpha$  ( $0 < \alpha \leq 1$ ) and  $\beta$  ( $0 < \beta \leq 1$ ) are parameters, expressing the government implements policy to subsidize the purchase of industrial intermediate inputs and wage in the agriculture, respectively.  $\alpha = 1$  ( $\beta = 1$ ), means no subsidy. When the government starts the subsidy to promote rural development, the value of  $\alpha$  or  $\beta$  decreases.

Use  $\mu = L_{uu} / (a_{u1}X_1 + a_{u2}X_2)$  to denote the unemployment rate of unskilled labor in urban region. The Harris-Todaro unskilled labor market equilibrium condition is given by

$$w_U = \frac{a_{U1}X_1 + a_{U2}X_2}{a_{U1}X_1 + a_{U2}X_2 + L_{UU}} \bar{w}_U = \frac{\bar{w}_U}{1 + \mu} \quad (4)$$

Full employment conditions are:

$$a_{S1}X_1 = L_S \quad (5)$$

$$(1 + \mu)(a_{U1}X_1 + a_{U2}X_2) + a_{U3}X_3 = L_U \quad (6)$$

$$a_{K1}X_1 + a_{K2}X_2 = K \quad (7)$$

$$a_{X3}X_3 = X_2 \quad (8)$$

The basic model has been established so far. Eight endogenous variables,  $w_S$ ,  $w_U$ ,  $r$ ,  $\mu$ ,  $p_2$ ,  $X_1$ ,  $X_2$  and  $X_3$ , are determined by Eqs. (1)–(8). Other variables are exogenous.

### 3. The comparative static analysis

Differentiating the Eqs. (1)–(8) and writing in a matrix notation, we can obtain the following equation:

$$\begin{pmatrix} \theta_{S1} & 0 & \theta_{K1} & 0 & 0 & 0 \\ 0 & \theta_{U3} & \theta_{X3}\theta_{K2} & 0 & 0 & 0 \\ \sigma_{SS}^1 & 0 & \sigma_{SK}^1 & 0 & 1 & 0 \\ \lambda_{K1}\sigma_{KS}^1 & 0 & \lambda_{K1}\sigma_{KK}^1 + \lambda_{K2}\sigma_{KK}^2 & \lambda_{K1} & \lambda_{K2} & 0 \\ \lambda_{U1}^\mu\sigma_{US}^1 & \lambda_{U3}\sigma_{UU}^3 - \lambda_U^\mu & \Omega_1 & \lambda_{U1}^\mu & \lambda_{U2}^\mu & \lambda_{U3} \\ 0 & \sigma_{XU}^3 & \sigma_{XX}^3\theta_{K2} & 0 & -1 & 1 \end{pmatrix} \begin{pmatrix} \hat{w}_S \\ \hat{w}_U \\ \hat{r} \\ \hat{X}_1 \\ \hat{X}_2 \\ \hat{X}_3 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ \hat{L}_S \\ \hat{K} \\ \hat{L}_U \\ 0 \end{pmatrix} - \begin{pmatrix} 0 \\ \theta_{X3} \\ 0 \\ 0 \\ \lambda_{U3}\sigma_{UX}^3 \\ \sigma_{XX}^3 \end{pmatrix} \hat{\alpha} - \begin{pmatrix} 0 \\ \theta_{U3} \\ 0 \\ 0 \\ \lambda_{U3}\sigma_{UU}^3 \\ \sigma_{XU}^3 \end{pmatrix} \hat{\beta} \quad (9)$$

where “\$” represents the rate of change (e.g.,  $\hat{w}_S = dw_S/w_S$ ),

$\theta_{ij}$  ( $i = S, U, K; j = 1, 2, 3$ ) is the distributive share of factor  $i$  in the  $j$ th sector (e.g.

$\theta_{S1} = a_{S1}w_S/p_1$ ),  $\lambda_{ij}$  is the allocated share of factor  $i$  in the  $j$ th sector (e.g.

$\lambda_{U3} = a_{U3}X_3/L_U$ ),  $\sigma_{ij}^h$  ( $i, j = S, U, K; h = 1, 2, 3$ ) is the partial elasticity of substitution

between factors  $i$  and  $j$  in the  $h$ th sector (e.g.  $\sigma_{UU}^3 = \frac{\partial a_{U3}}{\partial w_U} \frac{w_U}{a_{U3}}$ ),  $\sigma_{ij}^h > 0$  ( $i \neq j$ )

and  $\sigma_{ij}^h < 0$  ( $i = j$ ). We use  $\lambda_U^\mu$  to denote labor (including unemployment) located in

urban region,  $\lambda_U^\mu = (1 + \mu)(\lambda_{U1} + \lambda_{U2})$ . In addition,  $\Omega_1 = \lambda_{U1}^\mu\sigma_{UK}^1 + \lambda_{U2}^\mu\sigma_{UK}^2 + \theta_{K2}\lambda_{U3}\sigma_{UX}^3 > 0$ ,

$\lambda_{U1}^\mu = \lambda_{U1}(1 + \mu)$  and  $\lambda_{U2}^\mu = \lambda_{U2}(1 + \mu)$ . The detailed derivations of the distributive shares

and the allocative shares of factors can be referred to Jones (1965). Moreover, in

developing countries, assume the size of population living in rural is greater than that

of urban, and  $\lambda_{U3} > \lambda_{U1}^{\mu} + \lambda_{U2}^{\mu} = \lambda_{U}^{\mu}$  holds; capital allocated in the industrial sector is larger than that of intermediate goods sector,  $\lambda_{K1} > \lambda_{K2}$  holds. In our expression, the Allen–Uzawa partial elasticity of substitution is defined as  $\sigma_{ij}^h / \theta_{jh}$ . In the industrial sector, capital and skilled labor are more scarce resources than unskilled labor in developing countries. Since the skilled labor is sector-specific factor in the model, it is reasonable to assume that unskilled labor is more substitutable with capital than with skilled labor in the sector 1. Thus, we have  $\sigma_{UK}^1 / \theta_{K1} > \sigma_{US}^1 / \theta_{S1}$ . Such assumption is also used by Li. et al (2014) when the industrial sector employs same three factors. Consider the feature of agricultural production, the ratio of intermediate goods to agricultural output lies in a certain interval, which means the absolute value of  $\sigma_{XX}^3$  is relative small.

$\Delta$  is the determinant of the coefficient matrix of the equation (9) and we have

$$\Delta = \theta_{S1} \theta_{U3} \{ \lambda_{K2} (\lambda_{U1}^{\mu} \sigma_{UK}^1 + \lambda_{U2}^{\mu} \sigma_{UK}^2) - (\lambda_{U2}^{\mu} + \lambda_{U3}) (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2) - \sigma_{SK}^1 [\lambda_{K2} \lambda_{U1}^{\mu} - \lambda_{K1} (\lambda_{U2}^{\mu} + \lambda_{U3})] \}$$

$$- \theta_{S1} \theta_{X3} \theta_{K2} \lambda_{K2} [\lambda_{U3} (\sigma_{UU}^3 - \sigma_{XU}^3) - \lambda_{U}^{\mu}] + \theta_{U3} \theta_{K1} [\lambda_{K1} (\lambda_{U2}^{\mu} + \lambda_{U3}) (\sigma_{KS}^1 - \sigma_{SS}^1) - \lambda_{K2} \lambda_{U1}^{\mu} (\sigma_{US}^1 - \sigma_{SS}^1)] > 0$$

### 3.1. The impacts of international factor mobility on wage inequality and rural development

International factor mobility is actually a trade in factors and another form of international integration. International factor movement, in our model, involves movements of skilled and unskilled labor and capital across national boundaries. In developing countries, an outflow of skilled and unskilled labor are common because of low wages in domestic market, while an inflow of capital is common at the present.

First, we consider the impacts of an outflow of skilled labor. Solving Eq. (9) by the Cramer's rule with the respect of the decrease of endowment of skilled labor, we get:

$$\hat{w}_S / \hat{L}_S = -\theta_{K1} \theta_{U3} [\lambda_{K1} (\lambda_{U2}^{\mu} + \lambda_{U3}) - \lambda_{K2} \lambda_{U1}^{\mu}] / \Delta < 0$$

$$\hat{w}_U / \hat{L}_S = -\theta_{X3} \theta_{K2} \theta_{S1} [\lambda_{K1} (\lambda_{U2}^{\mu} + \lambda_{U3}) - \lambda_{K2} \lambda_{U1}^{\mu}] / \Delta < 0$$

$$\hat{r} / \hat{L}_S = \theta_{S1} \theta_{U3} [\lambda_{K1} (\lambda_{U2}^{\mu} + \lambda_{U3}) - \lambda_{K2} \lambda_{U1}^{\mu}] / \Delta > 0$$

$$\begin{aligned}\hat{X}_1/\hat{L}_S &= \left\{ \theta_{K1}\theta_{U3}[\lambda_{K1}(\lambda_{U2}^\mu + \lambda_{U3})\sigma_{KS}^1 - \lambda_{K2}\lambda_{U1}^\mu\sigma_{US}^1] - \theta_{S1}\theta_{X3}\theta_{K2}\lambda_{K2}[\lambda_{U3}(\sigma_{UU}^3 - \sigma_{XU}^3) - \lambda_U^\mu] \right\} / \Delta > 0 \\ \hat{X}_2/\hat{L}_S &= \left\{ \begin{aligned} &\theta_{S1}\theta_{U3}[\lambda_{U1}^\mu(\lambda_{K1}\sigma_{KK}^1 + \lambda_{K2}\sigma_{KK}^2) - \lambda_{K1}(\lambda_{U1}^\mu\sigma_{UK}^1 + \lambda_{U2}^\mu\sigma_{UK}^2)] \\ &+ \theta_{S1}\theta_{X3}\theta_{K2}\lambda_{K1}[\lambda_{U3}(\sigma_{UU}^3 - \sigma_{XU}^3) - \lambda_U^\mu] - \lambda_{U1}^\mu\lambda_{K1}\theta_{K1}\theta_{U3}(\sigma_{KS}^1 - \sigma_{US}^1) \end{aligned} \right\} / \Delta < 0 \\ \hat{X}_3/\hat{L}_S &= \left\{ \begin{aligned} &\theta_{S1}\theta_{U3}[\lambda_{U1}^\mu(\lambda_{K1}\sigma_{KK}^1 + \lambda_{K2}\sigma_{KK}^2) - \lambda_{K1}\Omega_1] + \theta_{S1}\theta_{X3}\theta_{K2}\lambda_{K1}(\lambda_{U3}\sigma_{UU}^3 - \lambda_U^\mu) \\ &+ \theta_{S1}\theta_{K2}\sigma_{XX}^3(\lambda_{K2}\lambda_{U1}^\mu - \lambda_{K1}\lambda_{U2}^\mu) - \theta_{K1}\theta_{U3}\lambda_{K1}\lambda_{U1}^\mu(\sigma_{KS}^1 - \sigma_{US}^1) \end{aligned} \right\} / \Delta < 0\end{aligned}$$

We use Lemma 1 to illustrate how an outflow of skilled labor affects the outputs and factor prices.

**Lemma 1** *An outflow of skilled labor leads to an increase in the wage rate of skilled and unskilled labor and an decrease in the interest rate of the capital. As for outputs of three sectors, an outflow of skilled labor contracts the industrial sector and expands intermediate goods sector and agricultural sector.*

The economic mechanism behind Lemma 1 is as follows. An outflow of skilled labor decreases the skilled supply and lead to an increase of marginal product of skilled labor given constant industrial price and the wage rate of skilled labor increases. Meanwhile, the value of marginal product of unskilled labor and capital reduce because of an decrease of skilled labor. Since unskilled labor is protected by rigid wage rate, the industrial sector decreases the employment unskilled skilled, while capital in the industrial sector moves to the intermediate goods sector. Less amount of factors are used in the industrial sector and its output reduces. The marginal product of unskilled labor in the intermediate goods sector increases because of an inflow of capital. Since the sector can employ unskilled with constant wage rate, the intermediate goods sector employs more unskilled labor rather than capital, reducing the demand of capital and the interest rate. Thus, the cost as well as the price of the intermediate sector reduce, which encourage the agricultural sector use more industrial intermediate input. In the agricultural sector, an increase in the industrial intermediate input enhances the marginal productivity of unskilled labor and consequently raise the wage rate of unskilled labor.

Second, we consider the impacts of an outflow of unskilled labor. Solving Eq. (9) by the Cramer's rule with the respect of the decrease of endowment of unskilled labor, we get:

$$\hat{w}_s / \hat{L}_U = -\theta_{K1} \theta_{U3} \lambda_{K2} / \Delta < 0$$

$$\hat{w}_U / \hat{L}_U = -\theta_{X3} \theta_{K2} \theta_{S1} \lambda_{K2} / \Delta < 0$$

$$\hat{r} / \hat{L}_U = \theta_{S1} \theta_{U3} \lambda_{K2} / \Delta > 0$$

$$\hat{X}_1 / \hat{L}_U = -\lambda_{K2} \theta_{U3} (\theta_{S1} \sigma_{SK}^1 - \theta_{K1} \sigma_{SS}^1) / \Delta < 0$$

$$\hat{X}_2 / \hat{L}_U = -\theta_{U3} [\theta_{S1} (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2 - \lambda_{K1} \sigma_{SK}^1) - \theta_{K1} \lambda_{K1} (\sigma_{KS}^1 - \sigma_{SS}^1)] / \Delta > 0$$

$$\hat{X}_3 / \hat{L}_U = \{ \theta_{K1} \theta_{U3} \lambda_{K1} (\sigma_{KS}^1 - \sigma_{SS}^1) - \theta_{S1} [\theta_{U3} (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2 - \lambda_{K1} \sigma_{SK}^1) + \theta_{K2} \lambda_{K2} \sigma_{XX}^3] \} / \Delta > 0$$

We use Lemma 2 to illustrate how an outflow of unskilled labor affects the outputs and factor prices.

**Lemma 2** *An outflow of unskilled labor leads to an increase in the wage rate of skilled and unskilled labor and an decrease in the interest rate of the capital. As for outputs of three sectors, an outflow of unskilled labor expands the industrial sector and contract intermediate goods sector and agricultural sector.*

The economic intuition behind Lemma 2 can be explained as follows. An outflow of unskilled labor decreases the unskilled supply and output in the agricultural sector due to Rybczynski effect. Since the intermediate goods provides intermediate goods in agriculture production, the demand of industrial intermediate goods as well as the demand of unskilled labor and capital in the intermediate goods sector reduce consequently. Unskilled labor and capital move to the industrial sector and expand this sector. As for prices of skilled labor, the demand and wage increase because of sector-specific factor. However, the demand of capital is mixed: on the one hand, expansion of industrial sector raises the demand of capital; on the other hand, the expansion of industrial sector can employ more unskilled labor with constant wage rate and reduce the demand of capital. In addition, capital moves from the intermediate goods sector into industrial sector. Thus, demand and interest rate of capital reduce eventually. The price of intermediate goods reduces due to the

decreased interest rate, which encourages agricultural sector to raise the intermediate input in producing one unit of agricultural goods. Thus, marginal product of unskilled labor as well as the wage of unskilled labor increase.

Next, we consider the impacts of an inflow of capital. Solving Eq. (9) by the Cramer's rule with the respect of the increase of endowment of capital, we get:

$$\begin{aligned}\hat{w}_S/\hat{K} &= \theta_{K1}\theta_{U3}(\lambda_{U2}^\mu + \lambda_{U3})/\Delta > 0 \\ \hat{w}_U/\hat{K} &= \theta_{X3}\theta_{K2}\theta_{S1}(\lambda_{U2}^\mu + \lambda_{U3})/\Delta > 0 \\ \hat{r}/\hat{K} &= -\theta_{S1}\theta_{U3}(\lambda_{U2}^\mu + \lambda_{U3})/\Delta < 0 \\ \hat{X}_1/\hat{K} &= \theta_{U3}(\lambda_{U2}^\mu + \lambda_{U3})(\theta_{S1}\sigma_{SK}^1 - \theta_{K1}\sigma_{SS}^1)/\Delta > 0 \\ \hat{X}_2/\hat{K} &= \left\{ \begin{aligned} &\theta_{S1}[\theta_{U3}(\lambda_{U1}^\mu\sigma_{UK}^1 + \lambda_{U2}^\mu\sigma_{UK}^2) - \theta_{X3}\theta_{K2}(\lambda_{U3}\sigma_{UU}^3 - \lambda_{U3}\sigma_{XU}^3 - \lambda_U^\mu)] \\ &- \lambda_{U1}^\mu\theta_{U3}(\theta_{S1}\sigma_{SK}^1 + \theta_{K1}\sigma_{US}^1 + \theta_{K1}\sigma_{SK}^1 + \theta_{K1}\sigma_{SU}^1) \end{aligned} \right\} / \Delta \\ \hat{X}_3/\hat{K} &= \left\{ \begin{aligned} &\theta_{S1}[\theta_{U3}(\Omega_1 + \lambda_{U2}^\mu\theta_{K2}\sigma_{XX}^3) - \theta_{X3}\theta_{K2}(\lambda_{U3}\sigma_{UU}^3 - \lambda_U^\mu + \lambda_{U2}^\mu\sigma_{XU}^3)] \\ &- \theta_{K1}\theta_{U3}\lambda_{U1}^\mu(\sigma_{US}^1 - \sigma_{SS}^1) - \lambda_{U1}^\mu\theta_{S1}\theta_{U3}\sigma_{SK}^1 \end{aligned} \right\} / \Delta\end{aligned}$$

Use Lemma 3 to illustrate how an inflow of capital affects the outputs and factor prices.

**Lemma 3** *An inflow of capital leads to an increase in the wage rate of skilled and unskilled labor and an decrease in the interest rate of the capital. As for outputs of three sectors, an inflow of capital expands the industrial sector; however, the changes of output of the intermediate and agricultural sector are ambiguous, depending on the elasticity of substitution between skilled labor and unskilled labor in the industrial sector.*

An inflow of capital raises the supply of capital and the interest rate falls consequently. The price of intermediate goods reduces due to the decreased interest rate, which raises the intermediate input in producing one unit of agricultural goods. Meanwhile, the marginal product and wage of skilled labor rises in the industrial sector due to the increased capital. The inflow of capital expands the industrial sector, capital-intensive sector, and initially contracts the intermediate goods sector due to Rybczynski effect. However, reduced price of intermediate goods promotes the

demand of intermediate goods, which has a positive effect on its output. The output of the intermediate goods sector is determined by the movement of unskilled labor. Urban sectors increase the demand of unskilled labor because of an inflow of capital and rural agricultural sector experiences a loss of unskilled labor. The amount of transferred labor depends on the increased demand in the industrial sector and its effect on agricultural output. The former aspect is decided by the elasticity of substitution among three factors. With decreased interest rate, substitution among three factors in the industrial sector occurs. Capital substitutes skilled labor first because its wage rate increases. Given the skilled labor is sector-specific, skilled labor substitutes unskilled labor which decreases the demand of unskilled labor. If the elasticity of substitution between skilled labor and capital ( $\sigma_{SK}^1$ ) is small, the amount of increased unskilled labor in the industrial sector depends on the the elasticity of substitution between skilled labor and unskilled labor ( $\sigma_{US}^1$ ). If  $\sigma_{US}^1$  is relatively small, which implies that the substitution is relatively hard, then this sector employs less unskilled labor so as to make full employment of skilled labor. The effect of latter aspect is follow. With the decreased price of intermediate goods and raised wage of unskilled labor, agricultural sector substitutes unskilled labor with intermediate goods. If the elasticity of substitution between unskilled labor and intermediate goods ( $\sigma_{XU}^3$ ) is relatively small, which implies that the substitution unskilled labor for intermediate goods is relatively hard, then demand of intermediate goods raises to make up the outflow of unskilled labor. If the less proportion of transferred unskilled labor employed in the industrial sector, the intermediate goods sector expands its output. Since the intermediate goods is input in agriculture, more proportion of transferred unskilled labor still work for agricultural production indirectly. In this way, more industrial equipment substitutes unskilled labor during agricultural production, which contributes to raising agricultural output. In reality, the substitution of skilled labor and capital generally not easy and considering the feature of industrial intermediate goods in agriculture, it is reasonable to assume that the elasticity of substitution between skilled labor and capital in the industrial sector and the elasticity of substitution between unskilled labor and intermediate goods in the agricultural sector are small. Therefore, the outputs of the intermediate goods sector and agricultural sector depends on the elasticity of substitution between skilled labor and unskilled labor in the industrial sector.

For developing countries, rural development and growth of national income are two central concerns, especially under the rural-urban migration. We use Proposition 1 to summarize international factor mobility on rural development and Proposition 2 to point their impacts on national income from the Lemma 1 to 3.

**Proposition 1** *An outflow of skilled labor benefits agricultural sector while an outflow of unskilled labor deteriorates the development of agriculture. The impact of an inflow of capital on agriculture depends on the elasticity of substitution between skilled labor and unskilled labor in the industrial sector. If  $\sigma_{US}^1$  is relatively small, an inflow of capital promotes agricultural development by employing more industrial intermediate inputs to substitute transferred labor.*

As we show in the Lemma 1 and 2, though an outflow of skilled and unskilled labor has same impacts on agricultural wage rate and interest rate, an outflow of skilled labor enlarges the production of intermediate goods sector and employment, increasing the agricultural output; while an outflow of unskilled labor falls the production of intermediate goods sector and promote rural labor to migrate which reduce the agricultural output. From the Lemma 3, an inflow of capital promote the development of industrial sector, its effect spills over to the agriculture if the elasticity of substitution between skilled labor and unskilled labor in the industrial sector is relatively small. If  $\sigma_{US}^1$  is relatively small, an expansion of industrial sector exerted by an inflow of capital employs relatively less proportion of transferred unskilled labor than the situation where  $\sigma_{US}^1$  is relatively large, and the industrial intermediate goods sector may enlarge the employment and benefit from an inflow of capital, which promotes agricultural output.

Next, we consider the national income. In our model, only two final goods, therefore the national income  $I$  can be described by:  $I = p_1X_1 + X_3$ . Generally, less factor endowment causes an decrease in national income. However, under certain condition, less factor endowment causes factor moves from low price sector to high price sector and the national income may increase in this situation. Now we

investigate the impacts of international factor mobility on the national income.

According to the results, we can get

$$p_1 \frac{\hat{X}_1}{\hat{L}_S} + \frac{\hat{X}_3}{\hat{L}_S} = \left\{ \begin{aligned} & [\theta_{S1} \theta_{U3} (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2) - \theta_{K1} \theta_{U3} \lambda_{K1} \sigma_{KS}^1] [\lambda_{U1}^\mu - p_1 (\lambda_{U3} + \lambda_{U2}^\mu)] \\ & + \theta_{S1} \theta_{K2} [\sigma_{XX}^3 (\lambda_{K2} \lambda_{U1}^\mu - \lambda_{K1} \lambda_{U2}^\mu - p_1 \lambda_{K2} \lambda_{U3})] + \\ & (\lambda_{K1} - p_1 \lambda_{K2}) [\theta_{X3} \theta_{S1} \theta_{K2} (\lambda_{U3} \sigma_{UU}^3 - \lambda_U^\mu) - \theta_{U3} (\theta_{S1} \Omega_1 - \theta_{K1} \lambda_{U1}^\mu \sigma_{US}^1)] \end{aligned} \right\}$$

$$p_1 \frac{\hat{X}_1}{\hat{L}_U} + \frac{\hat{X}_3}{\hat{L}_U} = \left\{ \begin{aligned} & \theta_{U3} (\lambda_{K1} - p_1 \lambda_{K2}) (\theta_{S1} \sigma_{SK}^1 - \theta_{K1} \sigma_{SS}^1) + \theta_{K1} \theta_{U3} \lambda_{K1} \sigma_{KS}^1 \\ & - \theta_{S1} [\theta_{U3} (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2) + \theta_{K2} \lambda_{K2} \sigma_{XX}^3] \end{aligned} \right\}$$

and if  $\sigma_{XX}^3$  is relative small, we have

$$p_1 \frac{\hat{X}_1}{\hat{K}} + \frac{\hat{X}_3}{\hat{K}} = \left\{ \begin{aligned} & \theta_{U3} (\theta_{S1} \sigma_{SK}^1 - \theta_{K1} \sigma_{SS}^1) [p_1 (\lambda_{U3} + \lambda_{U2}^\mu) - \lambda_{U1}^\mu] - \lambda_{U1}^\mu \theta_{K1} \theta_{U3} \sigma_{US}^1 \\ & + \theta_{S1} [\theta_{U3} \Omega_1 - \theta_{X3} \theta_{K2} (\lambda_{U3} \sigma_{UU}^3 - \lambda_U^\mu) + \theta_{K2} \lambda_{U2}^\mu \sigma_{XX}^3] \end{aligned} \right\} > 0$$

We use Proposition 2 to express the impacts of international factor mobility on national income.

**Proposition 2** An inflow of capital raises the national income unambiguously. An outflow of skilled labor may raise the national income if  $p_1 < \lambda_{K1}/\lambda_{K2}$ , while an outflow of unskilled labor may raise the national income if  $p_1 > \lambda_{K1}/\lambda_{K2}$ .

From above results, an inflow of capital raises the national income unambiguously due to the expansion of industrial and agricultural sector. However, from the Lemma 1 and 2, an outflow of skilled labor decreases industrial output and increases agricultural output, national income reduces when  $p_1 > \lambda_{K1}/\lambda_{K2}$ . If

$p_1 < \lambda_{K1}/\lambda_{K2}$ , the gain from the expansion of the agricultural sector may offset the loss from the shrink of the industrial sector by the decrease in skilled labor. We can use similar economic intuition to explain the decreased in unskilled labor.

Last we consider the impacts of international factor mobility on wage inequality. From the allocation of unskilled labor, equation (4), we could get the average wage rate of unskilled labor is  $w_U$ . Hence, the paper treats the wage inequality between skilled and unskilled labor as the ratio of the wage rate of skilled labor and that of unskilled labor in agriculture, that is,  $\frac{w_S}{w_U}$ . Therefore, the change of wage inequality is

expressed by  $\hat{w}_S - \hat{w}_U$ . When  $\hat{w}_S - \hat{w}_U > 0 (< 0)$ , the inequality between skilled labor and unskilled labor increases (decreases). Similar definition of the wage inequality is employed in the previous studies such as Beladi et al.(2008), Pi and Zhou(2012), Pan and Zhou(2013) and Li and Xu(2016). Based on the results of Lemma 1 to 3, we can obtain that the impacts of international factor mobility on wage inequality ,

$$\frac{\hat{w}_S - \hat{w}_U}{\hat{L}_S} = \frac{(\theta_{X_3}\theta_{K_2}\theta_{S_1} - \theta_{K_1}\theta_{U_3})[\lambda_{K_1}(\lambda_{U_2}^\mu + \lambda_{U_3}) - \lambda_{K_2}\lambda_{U_1}^\mu]}{\Delta}$$

$$\frac{\hat{w}_S - \hat{w}_U}{\hat{L}_U} = \frac{\lambda_{K_2}(\theta_{X_3}\theta_{K_2}\theta_{S_1} - \theta_{K_1}\theta_{U_3})}{\Delta}$$

$$\frac{\hat{w}_S - \hat{w}_U}{\hat{K}} = \frac{(\theta_{K_1}\theta_{U_3} - \theta_{X_3}\theta_{K_2}\theta_{S_1})(\lambda_{U_2}^\mu + \lambda_{U_3})}{\Delta}$$

Use Proposition 3 to discuss how an outflow of skilled and unskilled labor and an inflow of foreign capital generate an impact on wage inequality.

**Proposition 3**(i) An outflow of skilled and unskilled labor decrease the wage inequality if  $\theta_{X_3}\theta_{K_2}/\theta_{U_3} > \theta_{K_1}/\theta_{S_1}$  holds; otherwise, an outflow of skilled and unskilled labor increase the wage inequality.(ii) An inflow of capital decreases the wage inequality if  $\theta_{X_3}\theta_{K_2}/\theta_{U_3} > \theta_{K_1}/\theta_{S_1}$  holds; otherwise, an inflow of capital widens the wage inequality.

The economic intuition of Proposition 1 is follow. From the Lemma 1 and 2, an outflow of skilled and unskilled labor increase the wage of skilled and unskilled labor and decrease the interest rate. An outflow of skilled and unskilled labor lead to the capital movement between two urban sectors. If the indirect capital-unskilled labor relative distributive share in the agricultural sector ( $\theta_{X_3}\theta_{K_2}/\theta_{U_3}$ ) is larger than the capital-skilled labor relative distributive share in the industrial sector( $\theta_{K_1}/\theta_{S_1}$ ), which means that compared with skilled labor in the industrial sector, the intermediate goods is more important for the production in the agricultural sector, the change of interest

rate exerts a larger impact on the wage rate of unskilled labor than that of skilled labor, the wage inequality reduces. On the contrary, the wage inequality expands. For the second part, from the Lemma 3, an inflow of capital decreases the interest rate and increase the wage of skilled and unskilled labor. The change of wage inequality is determined by which labor benefits more from the decreased interest rate. If  $\theta_{X3}\theta_{K2}/\theta_{U3}$  is larger than  $\theta_{K1}/\theta_{S1}$ , the unskilled labor benefits more from the change of interest rate and the wage inequality reduces. Otherwise, the wage inequality widens.

### 3.2. The impacts of rural subsidy policies on wage inequality and national income

To promote the development of agriculture, wage subsidy is often used by government. Moreover, in order to obtain high yield of agriculture and make industrial intermediate goods available to farmers at affordable price, government in developing countries usually implements subsidy policy to promote the purchase the industrial intermediate goods. In this section, we examine the impacts of wage and purchase of intermediate goods subsidy.

First, we consider the impacts of an increase in wage subsidy in agricultural sector. Solving Eq. (9) by the Cramer's rule with the respect of  $\hat{\beta}$ , we get:

$$\begin{aligned}\hat{w}_s/\hat{\beta} &= \lambda_U^\mu \theta_{K1} \lambda_{K2} \theta_{U3} / \Delta > 0 \\ \hat{w}_U/\hat{\beta} &= \left\{ \begin{aligned} &\theta_{S1} \theta_{U3} [(\lambda_{U2}^\mu + \lambda_{U3}) (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2 - \lambda_{K1} \sigma_{SK}^1) - \lambda_{K2} (\Omega_1 - \theta_{K2} \lambda_{U3} \sigma_{XX}^3 - \lambda_{U1}^\mu \sigma_{SK}^1)] - \\ &\theta_{S1} \lambda_{U3} \theta_{X3} \theta_{K2} \lambda_{K2} (\sigma_{UX}^3 + \sigma_{XU}^3) - \theta_{K1} \theta_{U3} [\lambda_{K1} (\lambda_{U2}^\mu + \lambda_{U3}) (\sigma_{KS}^1 - \sigma_{SS}^1) - \lambda_{K2} \lambda_{U1}^\mu (\sigma_{US}^1 - \sigma_{SS}^1)] \end{aligned} \right\} / \Delta < 0 \\ \hat{r}/\hat{\beta} &= -\lambda_U^\mu \theta_{S1} \lambda_{K2} \theta_{U3} / \Delta < 0 \\ \hat{X}_1/\hat{\beta} &= \lambda_U^\mu \lambda_{K2} \theta_{U3} (\theta_{S1} \sigma_{SK}^1 - \theta_{K1} \sigma_{SS}^1) / \Delta > 0 \\ \hat{X}_2/\hat{\beta} &= \lambda_U^\mu \theta_{U3} [\theta_{S1} (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2 - \lambda_{K1} \sigma_{SK}^1) - \theta_{K1} \lambda_{K1} (\sigma_{KS}^1 - \sigma_{SS}^1)] / \Delta < 0 \\ \hat{X}_3/\hat{\beta} &= \lambda_U^\mu \{ \theta_{S1} [\theta_{U3} (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2 - \lambda_{K1} \sigma_{SK}^1 + \lambda_{K2} \theta_{K2} \sigma_{XX}^3) - \lambda_{K2} \theta_{X3} \theta_{K2} \sigma_{XU}^3] - \lambda_{K1} \theta_{U3} \theta_{K1} (\sigma_{KS}^1 - \sigma_{SS}^1) \} / \Delta < 0\end{aligned}$$

Use Lemma 4 to summarize the impacts of an increase in wage subsidy in agricultural sector on the outputs and factor prices.

**Lemma 4** *An increase in wage subsidy in agricultural sector has the following economic impact: (1) it falls skilled labor wage and raise unskilled labor wage and interest rate; (2) it falls industrial output and raise intermediate goods output and agricultural output.*

The economic intuition of Lemma 4 is given as follow. An increase in wage subsidy means that a decrease in  $\beta$ , and the agricultural sector enlarges the employment as well as the intermediate goods, which promote the demand of intermediate goods and unskilled labor. The expansion of intermediate goods sector attracts labor and capital from the industrial sector, reducing industrial output. The wage of skilled labor fall because its demand decreases. Since more unskilled labor employed in the agricultural sector, the expansion of intermediate goods sector mainly relies on capital which raises the interest rate. The increased interest rate pushes the cost and price of intermediate goods, discouraging the demand from agricultural sector. However

The increased demand of intermediate goods incurred by the expansion of agriculture is larger than the decreased demand led by the raised price, and the demand of intermediate goods increases at last.

Second, we consider the impacts of an increase in subsidy of intermediate goods in agricultural sector. Solving Eq. (9) by the Cramer's rule with the respect of  $\hat{\alpha}$ , we get:

$$\begin{aligned} \hat{w}_s / \hat{\alpha} &= \theta_{K1} \lambda_{K2} \{ \theta_{U3} \lambda_{U3} (\sigma_{UX}^3 - \sigma_{XX}^3) - \theta_{X3} [\lambda_{U3} (\sigma_{UU}^3 - \sigma_{XU}^3) - \lambda_U^\mu] \} / \Delta > 0 \\ \hat{w}_U / \hat{\alpha} &= \theta_{X3} \left\{ \begin{aligned} &\theta_{S1} [(\lambda_{U2}^\mu + \lambda_{U3}) (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2 - \lambda_{K1} \sigma_{SK}^1) - \lambda_{K2} (\lambda_{U1}^\mu \sigma_{UK}^1 + \lambda_{U2} \sigma_{UK}^2 - \lambda_{U1}^\mu \sigma_{SK}^1)] \\ &- \theta_{K1} [\lambda_{K1} (\lambda_{U2}^\mu + \lambda_{U3}) (\sigma_{KS}^1 - \sigma_{SS}^1) - \lambda_{K2} \lambda_{U1}^\mu (\sigma_{US}^1 - \sigma_{SS}^1)] \end{aligned} \right\} / \Delta < 0 \\ \hat{r} / \hat{\alpha} &= \theta_{S1} \lambda_{K2} [-\theta_{U3} \lambda_{U3} (\sigma_{UX}^3 - \sigma_{XX}^3) + \theta_{X3} \lambda_{U3} (\sigma_{UU}^3 - \sigma_{XU}^3) - \theta_{X3} \lambda_U^\mu] / \Delta < 0 \\ \hat{X}_1 / \hat{\alpha} &= \lambda_{K2} (\theta_{S1} \sigma_{SK}^1 - \theta_{K1} \sigma_{SS}^1) [\lambda_{U3} \theta_{U3} (\sigma_{UX}^3 - \sigma_{XX}^3) - \theta_{X3} \lambda_{U3} (\sigma_{UU}^3 - \sigma_{XU}^3) + \lambda_U^\mu \theta_{X3}] / \Delta > 0 \\ \hat{X}_2 / \hat{\alpha} &= \frac{[\theta_{S1} (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2 - \lambda_{K1} \sigma_{SK}^1) - \theta_{K1} \lambda_{K1} (\sigma_{KS}^1 - \sigma_{SS}^1)]}{[\theta_{U3} \lambda_{U3} (\sigma_{UX}^3 - \sigma_{XX}^3) - \theta_{X3} \lambda_{U3} (\sigma_{UU}^3 - \sigma_{XU}^3) + \theta_{X3} \lambda_U^\mu]} / \Delta < 0 \\ \hat{X}_3 / \hat{\alpha} &= \left\{ \begin{aligned} &\lambda_{U1}^\mu \lambda_{K2} \sigma_{XX}^3 (\theta_{S1} \sigma_{SK}^1 - \theta_{K1} \sigma_{SS}^1) + \sigma_{XX}^3 \lambda_{K2} [\theta_{K1} \lambda_{U1}^\mu \sigma_{US}^1 - \theta_{S1} (\lambda_{K1} \sigma_{KK}^1 + \sigma_{KK}^2 \sigma_{KK}^2)] \\ &+ [\theta_{S1} (\lambda_{K1} \sigma_{KK}^1 + \lambda_{K2} \sigma_{KK}^2) - \theta_{K1} \lambda_{K1} \sigma_{KS}^1 - \lambda_{K1} (\theta_{S1} \sigma_{SK}^1 - \theta_{K1} \sigma_{SS}^1)] \\ &[\theta_{U3} (\lambda_{U3} \sigma_{UX}^3 + \lambda_{U2} \sigma_{XX}^3) - \theta_{X3} (\lambda_{U3} \sigma_{UU}^3 - \lambda_U^\mu + \lambda_{U2} \sigma_{XU}^3)] \end{aligned} \right\} / \Delta \end{aligned}$$

Use Lemma 5 to summarize the impacts of an increase in subsidy of intermediate goods in agricultural sector on the outputs and factor prices.

**Lemma 5** *An increase in subsidy of intermediate goods in agricultural sector has the following economic impacts: (1) it falls skilled labor wage and raise unskilled labor wage and interest rate; (2) it reduces industrial output and raise intermediate goods output; (3) if own elasticity of intermediate goods in agriculture is small, it raises agricultural output.*

An increase in subsidy of intermediate goods means that a decrease in  $\alpha$ , and the agricultural sector could purchase the intermediate goods at a lower price initially. And the substitution between the intermediate goods and unskilled labor occurs and the marginal product of unskilled labor and its wage raise. Part of rural labor moves to urban region. The intermediate goods sector expands its production because of increased demand from agriculture, and increases its demand of unskilled labor and capital consequently. Increased demand of capital pushes the interest rate and cost of intermediate goods. Increased price and subsidy of intermediate goods have opposite effect on the purchase price of intermediate goods in agriculture ( $\alpha p_2$ ). In the model, the change of subsidy dominates the change of price, and the purchase price of intermediate goods falls at last. The output of industrial sector falls since capital and unskilled labor moves to the intermediate goods sector, and the demand and wage of skilled labor reduce. Though the input of intermediate goods increases, the output of agricultural sector also depends on the amount of unskilled labor. In developing countries, the agricultural sector is still labor-intensive. If the own elasticity of intermediate goods in agriculture ( $\sigma_{xx}^3$ ) is small, which implies that the substitution is relatively hard when facing the decreased price of intermediate goods, and the increased input of intermediate goods is limited. Consequently, the output and employment of the intermediate goods sector are limit. agricultural sector can raise its wage rate to retain needed labor and its output increases.

Next we investigate the impacts of subsidy on wage inequality and national income. From the Lemma 4 and 5, we get Proposition 3.

**Proposition 3** *An increase in wage and purchase of intermediate goods subsidy narrows down the wage inequality.*

The economic intuition behind the Proposition 3 can be referred to the discussion of the Lemma 4 and 5.

Now we investigate the impacts of rural development policies on the national income. According to the results, we can get

$$p_1 \frac{\hat{X}_1}{\hat{\alpha}} + \frac{\hat{X}_3}{\hat{\alpha}} = (\theta_{S1}\sigma_{SK}^1 - \theta_{K1}\sigma_{SS}^1)[p_1\lambda_{K2}\lambda_{U3}\theta_{U3}(\sigma_{UX}^3 - \sigma_{XX}^3) - p_1\lambda_{K2}\lambda_{U3}\theta_{X3}(\sigma_{UU}^3 - \sigma_{XU}^3) + p_1\lambda_{K2}\theta_{X3}\lambda_U^\mu + \lambda_{U1}^\mu\lambda_{K2}\sigma_{XX}^3 - \theta_{U3}\lambda_{K1}(\lambda_{U3}\sigma_{UX}^3 + \lambda_{U2}^\mu\sigma_{XX}^3) + \lambda_{K1}\theta_{X3}(\lambda_{U3}\sigma_{UU}^3 - \lambda_U^\mu + \lambda_{U2}^\mu\sigma_{XU}^3)] / \Delta$$

and

$$p_1 \frac{\hat{X}_1}{\hat{\beta}} + \frac{\hat{X}_3}{\hat{\beta}} = \lambda_U^\mu \{ \theta_{S1} [ \theta_{U3} (\lambda_{K1}\sigma_{KK}^1 + \lambda_{K2}\sigma_{KK}^2 - \lambda_{K1}\sigma_{SK}^1 + \lambda_{K2}\theta_{K2}\sigma_{XX}^3) - \lambda_{K2}\theta_{X3}\theta_{K2}\sigma_{XU}^3 ] - \lambda_{K1}\theta_{U3}\theta_{K1}\sigma_{KS}^1 + (p_1\lambda_{K2} - \lambda_{K1})\theta_{U3}\lambda_U^\mu (\theta_{S1}\sigma_{SK}^1 - \theta_{K1}\sigma_{SS}^1) \} / \Delta$$

The sign of  $p_1 \frac{\hat{X}_1}{\hat{\alpha}} + \frac{\hat{X}_3}{\hat{\alpha}}$  is ambiguous even though  $\sigma_{XX}^3$  is small. If  $p_1 < \lambda_{K2}/\lambda_{K1}$  holds, we can get  $p_1 \frac{\hat{X}_1}{\hat{\beta}} + \frac{\hat{X}_3}{\hat{\beta}} < 0$ .

**Proposition 4** *An increase in wage subsidy raises national income; while the impact of an increase in subsidy of intermediate goods on national income is ambiguous.*

From Lemma 4, if  $p_1 < \lambda_{K2}/\lambda_{K1}$  holds, an increase in wage subsidy raise the national income. However, its impact on national income is ambiguous even with the condition that  $\sigma_{XX}^3$  is small. The difference effect of two subsidy on national income lies on their impacts on price of intermediate goods. Subsidy of wage and intermediate goods raises the interest rate and pushes the cost, which discourages the demand of intermediate goods; however, subsidy of intermediate goods makes the purchase price of intermediate goods down, which encourages the demand of intermediate goods sector. The greater expansion of intermediate goods sector attracts

capital and labor in the industrial sector, dropping the industrial output largely. wage subsidy also falls the industrial output, its impact on industrial output is limit because the increased price of intermediate goods reduces its demand which leads to limit expansion of intermediate goods sector.

#### **4. Concluding remarks**

Economic growth, rural development and skilled-unskilled wage inequality are three main task for developing countries. Meanwhile, the developing countries also experiences massive factor mobility domestically and internationally.

In this paper, we investigate the issue of the effects of international factor mobility and rural development policies on wage inequality in a three sector general equilibrium model, where agricultural sector uses industrial goods as intermediate input in agriculture.

In this paper, we extended the Beladi et al.'s (2012) model to include skilled labor in order to examine the effects of labor-saving technological progress on the inequality between skilled and unskilled wages. Our analysis confirms the robustness of some of Beladi et al.'s (2012) results with regard to developing countries.

More importantly, though, our analysis sheds light on the factors that impact wage inequality, which has been a subject of great concern for developing countries.

Our results should be of great use to policy makers in developing countries who seek to improve wage inequality.

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