Research Article

Subsidy of Land Rent and Wage Inequality in a Dual Agricultural Economy

Dianshuang Wang[1,2*] (iD), **Xiaochun Li**[3] (iD)

[1]School of Economics, Anhui University of Finance and Economics, Bengbu, 233030, China
[2]Urban and Rural Development Research Center, Anhui University of Finance and Economics, Bengbu, 233030, China
[3]School of Business, Nanjing University, Nanjing, 210093, China
 Email: wangds07@126.com

Abstract: Through the establishment of general equilibrium models with different development stages of modern agriculture, this paper examines the impact of subsidy on land rent in modern agriculture on the wage inequality between skilled labor and unskilled labor in a dual agricultural economy. Moreover, we also take the financing constraint into consideration, and the source of subsidy comes from taxes. The main conclusions are: at the preliminary stage of modern agriculture, enforcement of subsidy on land in the modern agriculture narrows down wage inequality. While at the development stage, implement of this policy obtains an opposite result and expands wage inequality instead.

Keywords: modern agriculture, subsidy of land, land transfer, wage inequality

JEL Codes: O23, J31, J61

1. Introduction

According to the internationally comparable data from the World Census of Agriculture, developing countries tend to produce agricultural goods on a much smaller scale than developed countries [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 the high-income countries. The share of farmland controlled by larger farms is higher in countries with larger average incomes]. Adamopoulos and Restuccia (2014) show that small-scale land is an important factor in explaining the low productivity problem in agriculture and poverty in developing countries. Therefore, enlarging the scale of land operations and promotion of land transfer from traditional agriculture have been seen as the prerequisite for the development of modern agriculture. Take China for example. After 1978, Household Responsibility System was established that allowed each peasant household to manage agricultural production on a certain amount of tiny land plots. This kindled peasants' enthusiasm, accelerated agricultural production and resulted in a remarkable increase in productivity and the development of the rural economy. However, this egalitarian land distribution led to tremendous fragmentation of farmland, which increasingly came to be seen as inconsistent with China's overall rapid economic development. Nowadays, in the process of agricultural modernization,

the state has been promoting the transfer of land from traditional agriculture into modern agriculture with advanced management approaches in order to the modernization of agriculture. Thus, land transfer and modern agriculture have become salient and overwhelming aspects of rural China and are supported by policies (Ye, 2015). Among them, the enforcement subsidy of land rent is one of the significant policies to facilitate land transfer and expand the modern agriculture. In 2007, laws and policy documents have established a solid foundation for promoting and supporting land transfer in China's countryside. After that, the volume of land transfer has increased rapidly (see Figure 1). According to data, by the end of 2017, the total land transferred was 512 million mu, accounting for around 37% of the total land contracted to the peasant households. In a future period, the volume of land transfer will be an important index to indicate China's agricultural modernization process. It should be noted that, although there is a great growth in the amount of transferred land every year, the average scale of land operations is still far less than developed countries [From China Agricultural Yearbook 2017, average scale of land is only 0.407 ha]. Since the speed and degree of land transfer affect the process of agricultural modernization, we would expect to see that government will introduce more policies to facilitate land transfer.
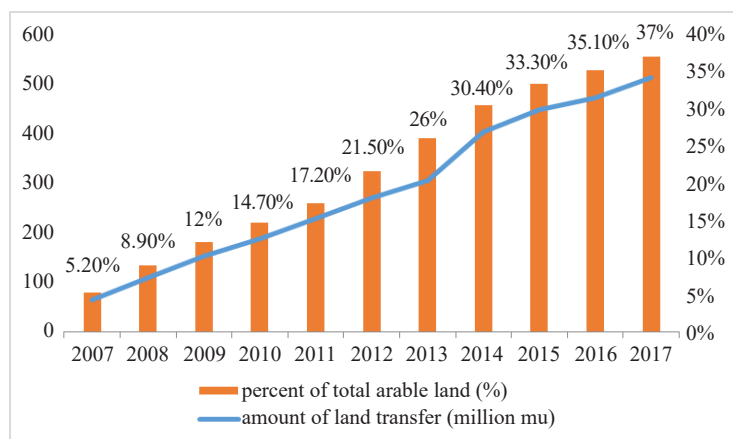
Data source: Data before 2015 data are from Agricultural Development Reports, 2016~17 data are from China Agricultural Yearbook

Figure 1. Agricultural land transfer in China

However, economic development is influenced by many factors and income inequality is a certain aspect to affect the successful development. With the promotion of modern agriculture, it is inevitable that outflow of land occurs in traditional agriculture, which further leads to the mobility of other production factors. Meanwhile, agriculture production uses land-intensive techniques instead of traditional labor-intensive production. Both changes will have ramifications on wage inequality between skilled and unskilled labor and income inequality between urban and rural. The widening wage inequality in developing countries has received extensive attention from different aspects by employing the dual-economy structure. Previously, scholars explained this phenomenon from international trade and international factor mobility (Yabuuchi, 2007; Beladi et al., 2008; Li & Xu, 2016). Recent theoretical literature pays attention to the role of domestic factors in explaining wage inequality and puts forward various mechanisms. Here, we first review the studies on wage inequality with an eye on agricultural development policies. Pi and Chen (2016) consider an economy with an urban low-skill sector, an urban high-skill sector and one rural sector. Capital market distortion exists between urban and rural regions, and rural agricultural use capital is more expensive than urban sectors. Pi and Chen (2016) show that a decrease in capital market distortion reduces the wage inequality between skilled and unskilled labor. Wang (2019) introduce manufacturing and agricultural pollution into a general equilibrium model and analyzed the impacts of environmental protection policies and a rise in the self-mitigation cost of skilled and unskilled labor on wage inequality. Wang and Li (2022) consider capital market distortion within urban regions and incorporate the agricultural producer service sector into a three-sector general equilibrium model. Wang and Li (2022) obtain a mitigation of capital market

distortion that may not decrease wage inequality when the substitution elasticity of service and labor is relatively large. However, existing literature ignores the issue of land transfer and could not answer the impact of land subsidy policy on wage inequality.

Seeing that traditional agriculture still owns a large amount of land resources and there is much room for land transfer, it is imperative to investigate the impact of land transfer on wage inequality. Moreover, when land is transferred, those peasants without off-farm work are deprived of their incomes and there is a potential risk of poverty again, and the government is cautious about the land transfer. Nevertheless, agricultural modernization usually requires the scaling up of farmland plots and the encouragement of land transfer. Thus, the government needs to trade-off economic development and wage inequality, highlighting the significance of the research issue.

The existing theoretical literature, scholars divide the agriculture sector into two distinct sectors: traditional and modern agriculture and analyze the impacts of the development of modern agriculture on the economy and environment (Chaudhuri, 2007; Li et al., 2013; Dong & Li, 2019; Wu & Li, 2021). In particular, Li et al. (2013) analyze land rent subsidy for modern agriculture increases the land employment in modern agriculture and reduces that in traditional agriculture. Dong and Li (2019) study the effects of several modern-agricultural factor price subsidy policies on the income inequality between skilled and unskilled labor. However, the existing theoretical literature sheds little insight on the impact of subsidy of land rent on wage inequality. In view of the fact that land rent subsidy of modern agriculture promotes land transfer, it is necessary to investigate the impact of enforcement of the subsidy policy on wage inequality between skilled and unskilled labor in a dual agricultural economy. Regarding empirical research, Gao et al. (2019) investigate the relationship between social benefits policies and income inequality and find rural residents gain from agricultural and livelihood subsidies in China.

In the paper, "modern agriculture" refers to a newly emerged agriculture that is market-oriented and utilizes modern technologies to produce high value-added agricultural products (Li et al., 2013). Compared with developed countries, the degree of modern agriculture stills in low level in developing countries. In addition, since this sector is a newly emerged sector with a relatively low production capacity, here we assume, its product is just being able to provide for domestic consumption. Following the development characteristics of modern agriculture, there are two situations under consideration: the initial stage and the development stage. In the first situation, modern agriculture centers on the surroundings of urban regions or important transport corridors, and the development of modern agriculture are greatly affected by urban sectors. In the development stage, modern agriculture develops into remote rural areas far away from urban districts, and modern agriculture is easily affected by the traditional sector. Thus, land restriction that exists in the initial stage has vanished and land could be mobile between two agricultural sectors. Under the premise that the government encourages the development of modern agriculture, we consider that the government subsidies modern agriculture to facilitate land transfer between traditional agriculture and modern agriculture. Here, this is a land transfer-coupled subsidy policy that aims to promote the development of modern agriculture and land transfer.

We adopt a comparative static method and develop three-sector general equilibrium models to investigate the effects of the subsidy on land rent in modern agriculture on the wage inequality between skilled labor and unskilled labor at different stages. Concerning the source of subsidy, we follow a standard assumption in the literature that revenue from taxes that further affects household income and expenditure. Consequently, enforcement of subsidy exerts impacts on the demand side of the economy. This will trigger ramifications on the price of modern agriculture and the output of three sectors. The main conclusions are: at the initial stage of modern agriculture, enforcement of subsidy on land rent in modern agriculture raises the wage of unskilled labor and narrows down wage inequality between skilled and unskilled labor. While at the development stage, implement of this policy reduces the wage of unskilled labor and expands wage inequality instead. The opposite results are derived due to the mobility of land and indicate the mobility of land is a key factor to determine the wage inequality. When land is a specific factor, this policy exerts a limited effect on labor mobility, thus, benefits unskilled labor and narrows down wage inequality. When land mobiles between two agricultural sectors, this policy promotes land mobility into the modern agricultural sector, and enlarges the demand for skilled labor and exerts a greater impact on the wage rate of skilled labor, expanding wage inequality.

At this stage, the implementation of subsidy on land brings two effects on demand for unskilled labor: cost-reduction effect and land-transfer effect. The impact of the cost-reduction effect is similar to that in the Proposition 1 and raises the demand for unskilled labor in modern agriculture. However, from the Lemma 2, the land-transfer effect produces the opposite effect: reduction of employment of unskilled labor in traditional agriculture. Because the

traditional agriculture utilizes more unskilled labor than the modern agriculture in unit production, the latter effect overweights the former effect, bringing the fall of employment of two agriculture sectors.

The remainder of the paper is structured as follows. Section 2 considers the initial stage of modern agriculture and obtains comparative statics results, while section 3 deals with the development stage. Section 4 contains some concluding remarks.

2. The model with the initial stage of modern agriculture

First, we consider the preliminary stage of modern agriculture. At this stage, traditional agriculture locates in the hinterlands and regionally separated from the modern agriculture which surrounds an urban area (Lundborg, 1990; Wu & Li, 2021). Thus, the geographic restriction brings two characteristics: (1) land is a sector-specific factor; (2) and unskilled labor employed by the modern agriculture earns the same wage rate with its counterpart in the manufacturing sector.

Consider a small open developing economy that composes of three sectors: the urban manufacturing sector (sector 1), the modern agricultural sector (sector 2) and the transitional agricultural sector (sector 3). The economy uses three production factors, skilled labor (S), unskilled labor (L), and sector-specific land (T_2 and T_3) [Note that the input of capital is omitted in the manufacturing as well as the modern agricultural production function. Adding capital into the model will complicate the analytical results significantly and give little insight on the research theme]. Sector 1 employs skilled labor S_1, the unskilled labor L_1 to produce the import-competing product X_1. Sector 2 uses skilled labor S_2, unskilled labor L_2 and land T_2 to produce nontraded goods X_2. Unskilled labor L_3 and land T_3 are utilized in sector 3 to produce exportable goods X_3. Assuming the market structures of the three sectors are perfectly competitive, we get the following conditions:

$$a_{S1}w_S + a_{L1}\overline{w} = p_1 \tag{1}$$

$$a_{S2}w_S + a_{L2}\overline{w} + a_{T2}(\tau_2 - v) = p_2 \tag{2}$$

$$a_{L3}w + a_{T3}\tau_3 = 1 \tag{3}$$

where $a_{ij}(i = S, L, T; j = 1, 2, 3)$ denotes the amount of factor i used to produce one unit of good j. We normalize the price of X_3, and p_1 and p_2 are the relative price of the X_1 and X_2. w_S is the flexible wage rate of skilled labor. However, due to the minimum wage law and other reasons, the wage of unskilled labor in the sector 1 and sector 2 are given as $\overline{w}$. Nevertheless, its counterpart in traditional agriculture earns a flexible wage rate, w. τ_2 and τ_3 are the rent of land in two agricultural sectors, respectively. v is the unit subsidy on land rent in the sector 2, and the provision of the subsidy is assumed to be financed through tax [We will explain the source of subsidy in section 2.2].

Due to the difference in wage rate of unskilled labor, rural-urban migration occurs. In the model, we follow the Harris-Todaro type unskilled labor allocation mechanism, which requires rural wage equals the expected wage income in the manufacturing and modern agricultural sector. Use L_{UU} to denote the number of unemployed unskilled labor in sector 1 and 2, and use $\lambda = L_{UU}/(a_{L1}X_1 + a_{L2}X_2)$ to denote the unemployment rate of unskilled labor in these two sectors. Restoration of the labor market equilibrium requires the following condition

$$(1+\lambda)w = \overline{w} \tag{4}$$

Considering the economy where land is specific to two agricultural sectors, and we suppose that T_2 and T_3 are given and fixed and represent the endowments of modern agricultural land and traditional agricultural land, respectively. The clearing conditions of production factors, unskilled labor, skilled labor, and two sector-specific lands, could be shown as follows:

$$(1+\lambda)(a_{L1}X_1 + a_{L2}X_2) + a_{L3}X_3 = L \tag{5}$$

$$a_{S1}X_1 + a_{S2}X_2 = S \tag{6}$$

$$a_{T2}X_2 = T_2 \tag{7}$$

$$a_{T3}X_3 = T_3 \tag{8}$$

where L and S represent the endowments of unskilled labor and skilled labor, respectively.

The supply side of the economy can be described by (1) through (8). There are eight equations encompassing eight endogenous variables: w_S, w, τ_2, τ_3, λ, X_1, X_2, X_3, with one policy variable v. Given p_2, we can analyze the effects of the subsidy policy in modern agriculture v on endogenous variables. Furthermore, from (4) and (5), it is not hard to verify that the average wage rate of unskilled labor is w, which implies the average wage rate of unskilled labor is equal to that in traditional agricultural sector. Thus, we use the wage of skilled labor and the average wage of unskilled labor, as well as their change to investigate the effects of subsidy policy of land rent in the modern agriculture on skilled-unskilled wage gap.

2.1 *Analysis the supply side*

At this stage, land cannot move between two agricultural sectors and enforcement of subsidy on land in the modern agriculture reduces the cost of this sector. Due to the rigid wage of unskilled labor, from Equation (1), the wage of skilled labor is affected only by the price of its product and subsidy policy does not affect the skilled wage rate. Thus, the impact of subsidy policy on wage inequality hinges on its impact on the wage of unskilled labor.

On the supply side, we conduct the analysis by treating the price of modern agricultural goods as an exogenous variable. By doing so, we can gain insights concerning the direct role of subsidy on endogenous variables evaluated at a constant goods price. Totally differentiating Equation (2) and (7) considering the initial value of the subsidy is zero, $\hat{\tau}_2 = (\hat{p}_2 + \theta_{v2}\hat{v})/\theta_{T2}$, and $\hat{X}_2 = -S_{TT}^2(\hat{p}_2 + \theta_{v2}\hat{v})/\theta_{T2}$, where "^" represents the rate of partial change($\hat{v} = \partial v/v$). S_{ij}^h is the partial elasticity of substitution between factors i and j in the hth sector, $S_{ij}^h > 0$ ($i \neq j$), $S_{ii}^h < 0$. $\theta_{ij}(i = S, L, T; j = 1, 2, 3)$ is the distributive share of factor i in the jth sector, and $\theta_{v2} = a_{T2}v / p_2$. From the results, one obtains that an increase in subsidy or goods price raises the land rent of modern agriculture and the expands output of this sector.

The relationship between subsidy or price of goods and manufacturing output could obtain from differentiating Equation (6), $\hat{X}_1 = \dfrac{\lambda_{S2}\left(S_{TT}^2 - S_{ST}^2\right)(\hat{p}_2 + \theta_{v2}\hat{v})}{\theta_{T2}\lambda_{S1}}$, where $\lambda_{ij}(i = S, L, T; j = 1, 2, 3)$ is the allocated share of factor i in the jth sector. Obviously, an increase in subsidy cuts down manufacturing output. Since a rise in price expands of modern agriculture by attracting the outflow of production factors from the manufacture, output of manufacture reduces.

Next, we investigate the impact of subsidy or good price on unskilled wage in sector 3. Totally differentiating Equation (3), (4), (5) and (8),

$$\hat{w} = \dfrac{(1+\lambda)\left[\lambda_{L2}S_{TT}^2\left(1 - \dfrac{\lambda_{L1}\lambda_{S2}}{\lambda_{S1}\lambda_{L2}}\right) + \dfrac{\lambda_{L1}\lambda_{S2}}{\lambda_{S1}}\left(S_{ST}^2 - \dfrac{\lambda_{L2}\lambda_{S1}}{\lambda_{L1}\lambda_{S2}}S_{LT}^2\right)\right]}{\theta_{T2}\left[\lambda_{L3}\left(S_{TT}^3\dfrac{\theta_{L3}}{\theta_{T3}} - S_{TL}^3\right) + \Omega_1\right]}(\hat{p}_2 + \theta_{v2}\hat{v}) \tag{9}$$

where $\Omega_1 = \lambda_{L3}S_{LL}^3 - (1+\lambda)(\lambda_{L1} + \lambda_{L2}) - \lambda_{L3}S_{LT}^3\theta_{L3}/\theta_{T3} < 0$. The sign is ambiguous because of the indeterminacy of numerator. According to the reality of a developing economy, the manufacturing sector employs more skilled labor and less unskilled labor comparatively, and we assume the amount of skilled labor corresponding to unit unskilled labor in the manufacturing sector is higher than that in the modern agricultural sector, and in mathematically $\lambda_{S1}/\lambda_{L1} > \lambda_{S2}/\lambda_{L2}$. Meanwhile, skilled labor plays a more significant role than unskilled labor in the production of modern agriculture,

which implies that unskilled labor is more substitutable with land than that of skilled labor, and we have $S_{ST}^2 < S_{LT}^2$. When those two inequalities hold, we have $\hat{w}/(\hat{p}_2 + \theta_{v2}\hat{v}) > 0$. Furthermore, $\hat{X}_3/(\hat{p}_2 + \theta_{v2}\hat{v}) < 0$.

Lemma 1 *Consider a supply side of the economy with a modern agricultural sector at the preliminary stage, enforcement of subsidy on land in modern agriculture or an increase in the price of modern agricultural goods raises the wage of unskilled labor in the tradition agriculture sector.*

The rationale for this lemma is as follows. After the rent is subsidized, modern agriculture faces a lower cost, and this sector enlarges the employment of both skilled and unskilled labor and expands its output correspondingly. Incremental skilled labor comes from the manufacturing sector, which also induces the outflow of unskilled labor in the same proportion due to the rigid wage rate. Note that the manufacture is skilled-intensive relative to modern agriculture, expansion of modern agriculture requires more unskilled labor than the outflow of unskilled labor from the manufacture, which encourages the outflow of unskilled labor from traditional agriculture and raises the wage of unskilled labor in the tradition agriculture sector.

The effects of changes in modern agricultural goods prices are similar to those of implement of subsidies. Because w_S is only influenced by p_1, an increase in p_2 enlarges the output of modern agriculture by attracting the outflow of both skilled and unskilled labor from manufacture. Hence, the similar logic of changes in v can be applied to the change of p_2.

2.2 *Subsidy, price of modern agriculture and wage inequality*

At section 2.1, we do the analysis by evaluating at a constant goods price of modern agricultural goods. After incorporating the demand side, enforcement of subsidy exerts an impact on expenditure and the price of modern agriculture, through which exercises influence over endogenous variables. Thus, the effect of the implement of subsidy on endogenous variables, take w as an example, can be expressed as $w = w(v, p_2(v))$, and differentiating it with respect to v yields

$$\frac{dw}{dv} = \frac{\partial w}{\partial v} + \frac{\partial w}{\partial p_2}\frac{dp_2}{dv}$$

that is

$$\frac{v}{w}\frac{dw}{dv} = \frac{\hat{w}}{\hat{v}} + \frac{\hat{w}}{\hat{p}_2}\frac{dp_2}{dv}\frac{v}{p_2}$$

where $\hat{w}/\hat{v}$ expresses the direct effect of subsidy at a constant goods price, and the second term of the above equation captures the price-induced effect of change in subsidy [Here, we follow the decomposition technique from Chao et al. (2006)].

To determine the impact of subsidy on the price of modern agriculture, we illustrate the demand side of the economy. Assuming the social welfare function exhibited by the Cobb-Douglas type: $U = D_1^\alpha D_2^\beta D_3^{1-\alpha-\beta}$, where D_1, D_2, and D_3 are the demands for the manufacturing, modern agricultural and traditional agricultural goods, respectively, and α and β are in range (0, 1), and $\alpha + \beta < 1$. The national income after tax is given by $I = p_1X_1 + p_2X_2 + X_3 - va_{T2}X_2$, and the last term is tax that also equals total amount of subsidy. Demand for modern agricultural product D_2 is $\beta(p_1X_1 + p_2X_2 + X_3 - va_{T2}X_2)/p_2$. Market clearing condition for modern agricultural goods is

$$X_2 = D_2 = \beta\left(p_1X_1 + p_2X_2 + X_3 - va_{T2}X_2\right)/p_2 \tag{10}$$

We can now solve for the impacts of subsidy policy on the modern agricultural goods price p_2. Totally differentiating the Equation (10), and then utilizing the results in section 2.1 gives:

$$\frac{v}{p_2}\frac{dp_2}{dv} = -\frac{\theta_{v2}\Theta_2}{\Theta_2 + \psi_2 - 1} < 0$$

where $\psi_i = p_i X_i / I$ $(i = 1, 2, 3)$ and $\psi_v = v a_{T2} X_2 / I$. $\Theta_1 = \dfrac{\hat{w}}{\hat{p}_2 + \theta_{v2}\hat{v}} > 0$ and $\Theta_2 = \dfrac{\psi_1 \lambda_{S2}(S_{TT}^2 - S_{ST}^2)}{\theta_{T2}\lambda_{S1}} + (1 - \psi_2)\dfrac{S_{TT}^2}{\theta_{T2}} + \Theta_1 \psi_3 \left(S_{TT}^3 \dfrac{\theta_{L3}}{\theta_{T3}} \right.$

$\left. - S_{TL}^3 \right) < 0$. Enforcement of subsidy, on the one hand, raises the supply of modern agricultural product; and on the other hand, reduces national income that has a negative effect on the demand. Thus, implementation of subsidy falls the price of modern agricultural product.

So far, we conclude the impacts of subsidy policy on two partial effects: the direct effect evaluated at a given modern agricultural goods price and the indirect price-induced effect. Although two effects influence the endogenous variables in a conflicting direction, and the overall effect is expressed as

$$\theta_{v2} + \frac{v}{p_2}\frac{dp_2}{dv} = \frac{\theta_{v2}(\psi_2 - 1)}{\Theta_2 + \psi_2 - 1} > 0 \tag{11}$$

which implies the direct effect dominates the overall effect.

At the present, the effect of subsidy policy on average wage of unskilled labor and wage inequality can be easily deduced. Combining (9) and (11),

$$\frac{v}{w}\frac{dw}{dv} = \left(\frac{v}{p_2}\frac{dp_2}{dv} + \theta_{v2} \right) \frac{(1+\lambda)\left[\lambda_{L2}S_{TT}^2 \left(1 - \dfrac{\lambda_{L1}\lambda_{S2}}{\lambda_{S1}\lambda_{L2}} \right) + \dfrac{\lambda_{L1}\lambda_{S2}}{\lambda_{S1}} \left(S_{ST}^2 - \dfrac{\lambda_{L2}\lambda_{S1}}{\lambda_{L1}\lambda_{S2}} S_{LT}^2 \right) \right]}{\theta_{T2}\left[\lambda_{L3}\left(S_{TT}^3 \dfrac{\theta_{L3}}{\theta_{T3}} - S_{TL}^3 \right) + \Omega_1 \right]} > 0$$

and

$$\frac{dw_S - dw}{dv} < 0$$

Thus, we state the following proposition:

Proposition 1 *Consider a developing economy with a modern agricultural sector at the preliminary stage, enforcement of subsidy on land in modern agriculture raises the wage of unskilled labor and narrows down wage inequality between skilled and unskilled labor.*

When land is a specific factor for modern and traditional agriculture, the implementation of subsidies on land in modern agriculture has two opposite effects on the wage of unskilled labor. The direct effect is the cost-reduction effect that expands the modern agricultural sector and raises the demand for unskilled labor and its wage rate. The indirect effect is related to its impact on the demand of modern agricultural products. Considering the expenditure reduces as a result of the subsidy policy, the demand falls and cuts down the employment of unskilled labor in modern agriculture. According to (11), the overall effect is dominated by the direct effect. And modern agriculture increases the demand for unskilled labor and raises its wage. Since the subsidy policy does not affect skilled wages and enforcement of subsidy narrows down wage inequality between skilled and unskilled labor.

3. The development stage of modern agriculture

In the preliminary stage of modern agriculture, two agricultural sectors have little connection because of regional restrictions. With the development of modern agriculture, land limitation gradually becomes a noticeable issue. Meanwhile, governments in the developing countries view the development of modern agriculture as an approach to the transformation of traditional agriculture and endeavour to enlarge the scale of modern agriculture. Thus, as the development of modern agriculture, we suppose (1) land restriction has vanished; (2) the wage rate of unskilled labor is influenced greatly by traditional agriculture, and unskilled labor in two agricultural sectors receives the same wage rate. Note that even in this stage with rapid development, compared with developed countries, the level of modern agriculture locates in a low level and the products of modern agriculture still confine to those with high added value. After incorporating the new aspects of the development stage, equations (2) and (3) have been replaced by

$$a_{S2}w_S + a_{L2}w_2 + a_{T2}(\tau - v) = p_2 \tag{12}$$

$$a_{L3}w_3 + a_{T3}\tau = 1 \tag{13}$$

where w_2 and w_3 are the wage rates of unskilled labor in modern and traditional agriculture, respectively. τ is land rent. Let T be the endowment of land, and land market clearing condition requires

$$a_{T2}X_2 + a_{T3}X_3 = T \tag{14}$$

In the unskilled labor market equilibrium, the wage rate in traditional agriculture equals the wage rate in the modern agricultural sector. Therefore, we have

$$w_2 = w_3 = w \tag{15}$$

Meanwhile, unskilled labor earns the same fixable wage rate w, and unskilled labor market clearing condition has changed,

$$(1+\lambda)a_{L1}X_1 + a_{L2}X_2 + a_{L3}X_3 = L \tag{16}$$

Note $\lambda = L_{UU}/(aL_1X_1)$ at this section. The supply side of the economy can be described by (1), (4), (6), (12) to (16), with eight endogenous variables: w_S, w_2, w_3, τ, λ, X_1, X_2, X_3. From (4), (15) and (16), the average wage rate of unskilled labor is w. Similar with the section 2, we analyze the supply side first.

3.1 *Analysis the supply side*

In this section, we use the same approach with the 2.1. Since land mobiles between two agricultural sectors, enforcement of rent subsidy on modern agriculture not only reduces its cost but also promotes land to transfer from traditional to modern agriculture. Equation (1) remains unchanged, subsidy policy does not affect the skilled wage rate. Totally differentiating Equation (12) and (13),

$$\hat{w} = \frac{\theta_{T3}(\hat{p}_2 + \theta_{v2}\hat{v})}{\theta_{L2}\theta_{T3} - \theta_{T2}\theta_{L3}} \quad \text{and} \quad \hat{\tau} = -\frac{\theta_{L3}(\hat{p}_2 + \theta_{v2}\hat{v})}{\theta_{L2}\theta_{T3} - \theta_{T2}\theta_{L3}} \tag{17}$$

From the above equation, the impact of subsidy policy on unskilled wage rate depends on the sign of $\theta_{L2}\theta_{T3} - \theta_{T2}\theta_{L3}$ which further relies on factor intensity. Since modern agriculture applies more advanced technology, it is reasonable to hold that the unskilled labor that unit land needed to produce is less, and $a_{T3}/a_{L3} < a_{T2}/a_{L2}$. Furthermore, we have $\theta_{L2}\theta_{T3} < \theta_{T2}\theta_{L3}$. By considering this inequality, we have

Lemma 2 *Consider a supply side of the economy with a modern agricultural sector at the development stage, enforcement of subsidy on land in the modern agriculture or an increase in p_2 reduces the average wage of unskilled labor and raises the land rent.*

Contrast to the Lemma 1, implementation of subsidies reduces the unskilled wage rate at the development stage. After the rent is subsidized, the demand for land in modern agriculture increases, which leads to a higher nominal rent. Consequently, land is transferred from traditional agriculture to modern agriculture. Because the amount of land corresponding to unit unskilled labor in modern agriculture is higher than that of traditional agriculture, the reduction of land in traditional agriculture releases more unskilled labor than incremental unskilled labor in modern agriculture. Thus, enforcement of subsidies on land in modern agriculture brings relatively surplus unskilled labor and falls its wage. An increase in p_2 causes a higher nominal rent from (12). Therefore, the reasoning for the effects of an increase in p_2 can be applied to the case of subsidy and we do not repeat the process.

Next, we consider its impacts on the output of three sectors. Differentiating (4), (6), (14) and (16), and writing in a matrix notation, we can obtain the following equation:

$$\begin{pmatrix} (1+\lambda)\lambda_{L1} & \lambda_{L2} & \lambda_{L3} \\ \lambda_{S1} & \lambda_{S2} & 0 \\ 0 & \lambda_{T2} & \lambda_{T3} \end{pmatrix} \begin{pmatrix} \hat{X}_1 \\ \hat{X}_2 \\ \hat{X}_3 \end{pmatrix} = \begin{pmatrix} \phi_1 \\ \phi_2 \\ \phi_3 \end{pmatrix} (\hat{p}_2 + \theta_{v2}\hat{v}) \tag{18}$$

where $\phi_1 = \{\theta_{T3}[(1+\lambda)\lambda_{L1} - \lambda_{L2}S_{LL}^2 - \lambda_{L3}S_{LL}^3] + \theta_{L3}(\lambda_{L3}S_{LT}^3 + \lambda_{L2}S_{LL}^2)\}/(\theta_{L2}\theta_{T3} - \theta_{T2}\theta_{L3}) < 0$, $\phi_2 = \lambda_{S2}(\theta_{L3}S_{ST}^2 - \theta_{T3}S_{SL}^2)/(\theta_{L2}\theta_{T3} - \theta_{T2}\theta_{L3})$, and $\phi_3 = [\theta_{L3}(\lambda_{T2}S_{TT}^2 + \lambda_{T3}S_{TT}^3) - \theta_{T3}(\lambda_{T2}S_{TL}^2 + \lambda_{T3}S_{TL}^3)]/(\theta_{L2}\theta_{T3} - \theta_{T2}\theta_{L3}) > 0$.

Δ is the determinant of the matrix in (18). By solving the determinant, we obtain

$$\Delta = (1+\lambda)\lambda_{L1}\lambda_{S2}\lambda_{T3} - \lambda_{S1}(\lambda_{T3}\lambda_{L2} - \lambda_{L3}\lambda_{T2}) > 0$$

Solving (17),

$$\hat{X}_1 = \frac{(\lambda_{L3}\lambda_{T2} - \lambda_{T3}\lambda_{L2})\phi_2 + \lambda_{S2}\lambda_{T3}\phi_1 - \lambda_{L3}\lambda_{S2}\phi_3}{\Delta}(\hat{p}_2 + \theta_{v2}\hat{v}) = J_1(\hat{p}_2 + \theta_{v2}\hat{v})$$

$$\hat{X}_2 = \frac{\lambda_{S1}\lambda_{L3}\phi_3 + \lambda_{T3}[(1+\lambda)\lambda_{L1}\phi_2 - \lambda_{S1}\phi_1]}{\Delta}(\hat{p}_2 + \theta_{v2}\hat{v}) = J_2(\hat{p}_2 + \theta_{v2}\hat{v})$$

and

$$\hat{X}_3 = \frac{[(1+\lambda)\lambda_{L1}\lambda_{S2} - \lambda_{S1}\lambda_{L2}]\phi_3 + [\phi_1\lambda_{S1} - (1+\lambda)\lambda_{L1}\phi_2]}{\Delta}(\hat{p}_2 + \theta_{v2}\hat{v}) = J_3(\hat{p}_2 + \theta_{v2}\hat{v})$$

Unfortunately, we can not determine the signs of the above results. The indeterminacy sign of ϕ_2 complicates the discussion. When the absolute value of ϕ_2 is relatively small, subsidy policy expands modern agriculture and contracts the other two sectors. Nevertheless, when S_{ST}^2 is small enough and satisfies $S_{ST}^2 < \theta_{T3}S_{SL}^2/\theta_{L3}$, which means variation of land rent has little effect on unit employment of skilled labor in modern agriculture. At this situation, $\phi_2 > 0$, $J_2 > 0$, $J_3 < 0$, and the expansion of modern agriculture is mainly driven by the outflow of unskilled labor and land from traditional agriculture. Skilled labor may flow from modern agriculture into the manufacturing sector and expands the manufacturing sector instead.

3.2 Subsidy, price of modern agriculture and wage inequality

Totally differentiating the Equation (10), and then utilizing the results in section 3.1 gives:

$$\frac{v}{p_2}\frac{dp_2}{dv} = -\frac{\theta_{v2}J}{J+(\psi_2-1)\Delta} \tag{19}$$

where $J = \psi_1 J_1 + (\psi_2 - \psi_v - 1)J_2 + \psi_3 J_3 + \psi_v S_{TT}^2 \Delta\theta_{L3}/(\theta_{L2}\theta_{T3} - \theta_{T2}\theta_{L3})$ and the sign of J is ambiguous. We assume that the price of modern agricultural goods is adjusted instantly to clear the market. The price adjustment process can be established by utilizing the excess demand function $D_2 - X_2$. Around the equilibrium price of the modern agricultural good, Walrasian stable requires that $\dfrac{\hat{D}_2}{\hat{p}_2} - \dfrac{\hat{X}_2}{\hat{p}_2} < 0$. Using results in the section 3.1, we have

$$\frac{\hat{D}_2 - \hat{X}_2}{\hat{p}_2} = \frac{J+(\psi_2-1)\Delta}{\Delta} < 0 \ \text{ and } \ J+(\psi_2-1)\Delta < 0$$

In the preliminary stage of modern agriculture, we have the definite conclusion that the implementation of subsidies reduces the price of modern agricultural products because of the expansion of output and reduction of demand of modern agricultural goods at the same time; however, at the development stage, enforcement of subsidy has ambiguous impacts on output of three sectors, which complicates the relationship between subsidy and price. Nevertheless, the overall effect is definite. This can be seen as,

$$\theta_{v2} + \frac{v}{p_2}\frac{dp_2}{dv} = \frac{\theta_{v2}(\psi_2-1)\Delta}{J+(\psi_2-1)\Delta} > 0 \tag{20}$$

Using (17) and (20),

$$\frac{v}{w}\frac{dw}{dv} = \frac{\theta_{v2}(\psi_2-1)\Delta}{J+(\psi_2-1)\Delta}\frac{\theta_{T3}}{\theta_{L2}\theta_{T3}-\theta_{T2}\theta_{L3}} < 0$$

and

$$\frac{dw_S - dw}{dv} > 0$$

Thus, we state the following proposition:

Proposition 2 *Consider a developing economy with a modern agricultural sector at the development stage, enforcement of subsidy on land in modern agriculture reduces the wage of unskilled labor and expands wage inequality between skilled and unskilled labor.*

The result shows a sharp contrast to those obtained in Proposition 1 and indicates the mobility of land is a key factor to determine the wage inequality. At this stage, the implementation of subsidy on land brings two effects on demand for unskilled labor: the cost-reduction effect and land-transfer effect. The impact of cost-reduction effect is similar to that in the Proposition 1 and raises the demand for unskilled labor in modern agriculture. However, from the Lemma 2, the land-transfer effect produces the opposite effect: reduction of employment of unskilled labor in traditional agriculture. Because traditional agriculture utilizes more unskilled labor than modern agriculture in unit production, the

latter effect overweights the former effect, bringing the fall of employment of two agriculture sectors. In addition, the enforcement of subsidies also influences the price of modern agricultural goods. Even though the relationship between subsidy and price is ambiguous, from (20), the impact of subsidy could offset the possible negative effect of the fall in price. And two agriculture sectors cut down the demand for unskilled labor and reduces its wage. Similar with the section 2, the policy does not change the skilled wage rate, and enforcement of subsidy on land in modern agriculture reduces the wage of unskilled labor and expands wage inequality between skilled and unskilled labor.

4. Concluding remarks

This paper has examined theoretically the impacts of the enforcement of land subsidy policy in modern agriculture on wage inequality between skilled and unskilled labor under economic dualism and agricultural dualism. When the financing constraint of subsidy is taken into account, we obtain that under different stages of modern agriculture, the impacts of the implement of subsidy on wage inequality are in sharp contrast. At the preliminary stage, subsidizing land narrows down wage inequality. While when land could mobile between two agricultural sectors, the government enforces a subsidy policy on the land of modern agriculture promotes land transfer. The enlargement of land also contributes to the movement of unskilled labor, which causes unskilled labor relatively surplus and reduces the wage of unskilled labor and expands wage inequality instead.

The settings of this paper are different from the existing literature and we obtain new conclusions. Two propositions have great practical significance and can be used as references for the policymakers in their promotion of modern agricultural development at different stages. For example, the results from section 2 state that enforcement the subsidy policy at the initial stage of modern agriculture could bring the expansion of modern agriculture and improvement of wage inequality simultaneously. However, implement of subsidies at the development stage may promotion of modern agriculture but deteriorate wage inequality, as we can see from the results in section 3. Thus, along with the development of modern agriculture and acceleration of land transfer, the government should give more attention to the employment of unskilled labor and wage inequality issues.

Due to the constraint on the discussion scope, we do not incorporate the case that modern agricultural goods are tradable. After the popularization of the modern agricultural sector, this sector produces value-added goods that compete in the international market. We do not analyze the impact of subsidy on wage inequality in this situation, which is a good avenue for future research.

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Conflict of interest

We confirm that this manuscript has not been published elsewhere and is not under consideration by another journal. All authors have approved the manuscript and agree with submission to Regional Economic Development Research. The authors have no conflicts of interest to declare.

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