Global Economics Science
http://ojs.wiserpub.com/index.php/GES/

UNIVERSAL WISER PUBLISHER

Research Article

Subsidy Policies of Agricultural Producer Service and Wage Inequality in Developing Economy

Fangfang Cheng[1], Dianshuang Wang[1,2*]

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

Received: 3 September 2022; **Revised:** 24 July 2023; **Accepted:** 24 July 2023

Abstract: This study examines the effects of subsidy policies of agricultural producer service on wage disparity while taking into account the modernization of small-scale farming in developing nations. Due to small-scale operations, agriculture needs an intermediary sector-an agricultural producer service sector-to help modernization by facilitating the entry of non-agricultural intermediate inputs. Main conclusions are wage subsidy policy on skilled labor expands it in the short term. In the long run, the results of wage subsidy of skilled labor depend on the elasticity of substitution among varieties in service sector. When the elasticity of substitution is relatively small (large), subsiding skilled labor narrows down (expands) the wage inequality.

***Keywords*:** agricultural producer service, factor price subsidy policy, wage inequality

JEL classification: O23, J31, J61, O14

1. Introduction

Development economists generally agree that introducing non-agricultural modern inputs is essential for transforming traditional agriculture and improving agricultural productivity (Restuccia et al., 2008). Existing research on how to introduce modern inputs typically presupposes that non-agricultural inputs could be used directly in agricultural output following a straightforward translation (Restuccia et al., 2008; Yang & Zhu, 2013; Whang, 2017; Donovan, 2021). This premise is used to illustrate how large-scale agricultural production is modernizing agriculture and causing structural change in industrialized nations.

However, small-scale agriculture is still the norm in many developing nations (Sarah et al., 2016). Therefore, it is challenging for small-scale agriculture to use such modern non-agricultural intermediate inputs directly. On the one hand, farmers do not have the financial means to purchase relatively pricey modern inputs like agricultural gear. On the other hand, because of their small-scale operations, they are also unable to take advantage of economies of scale. To indirectly use intermediate inputs, small-scale agriculture needs an intermediary sector. Several agricultural production processes can be outsourced, and acquiring services from the agricultural producer service sector (APS sector for short) is seen as a practical way to increase the rate at which non-agricultural inputs are used (Yang et al., 2013; Zhang et al., 2017; Belton et al., 2021). This industry is called “Producer Organizations” in India and “New Agricultural Service

DOI: https://doi.org/10.37256/ges.4220231895

Providers" in China.

Accommodating an intermediate sector is motivated by three concurrent events that have occurred in China during the past two decades. First, the well-known fact that massive rural labor flows into the urban region but agricultural output keeps growing. Second, the less well-known fact is that the growth rate of the price index of agricultural means of production (abbreviation for AMPI) is more sluggish than that of rural migrants' income (see Figure 1). Third, perhaps the least known fact is that agricultural production structure has changed in the past few decades with the intermediate inputs becoming increasingly popular followed by decrease of labor with the contribution of capital keeping at an extremely low level. By using the National Fixed Points dataset of more than 20,000 households from 1995 to 2017, Wang et al. (2020) estimate that the capital elasticity remained at an extremely low level (around 0.02) due to small-scale agricultural production (see Figure 2).

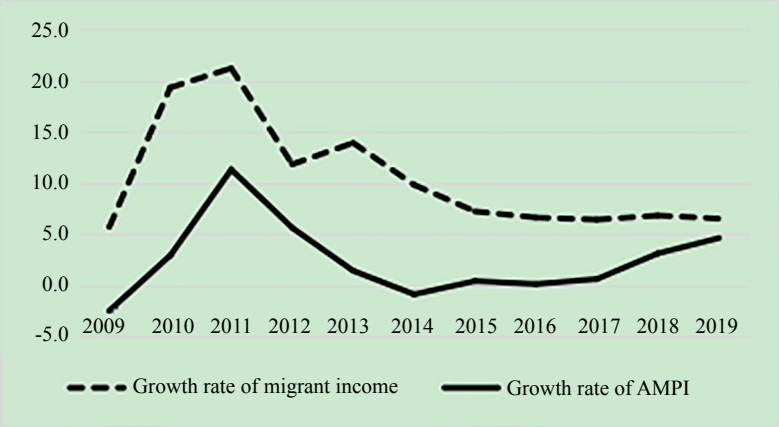

Figure 1. Growth rate of migrants' income and Growth rate of AMPI
Source: The data for rural migrants' income are from Department of Household Surveys National Bureau of Statistics of China. The growth rate of AMPI comes from National Bureau of Statistics of China

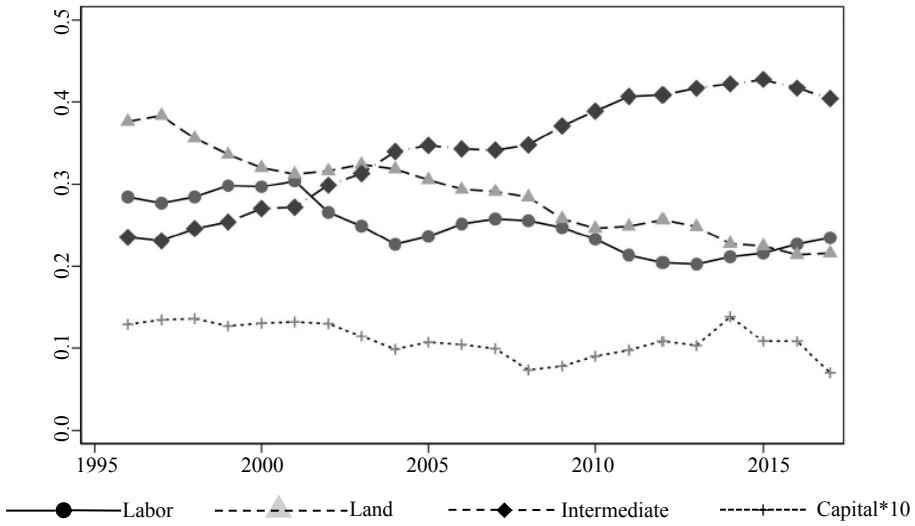

Figure 2. Input elasticity in agriculture
Data source: Wang et al. (2020)

We hold that three events are causally linked. When the wage growth is greater than that of the price of

intermediate inputs, agricultural production uses more intermediate inputs. This contributes to labor migration and the change of production structure. Without considering the role played by the intermediate sector, we cannot explain the phenomenon: with the large-scale outflow of rural labor and extremely low capital elasticity, how small-scale agriculture utilizes increasing intermediate inputs to sustain high agricultural output. In practice, expansion of the APS sector is viewed as an effective approach to speed up the utilization of non-agricultural inputs. And subsidy policies of agricultural producer service sector are useful tools to develop this sector. Therefore, it is necessary to investigate the distributional impact of such subsidy policies.

The remaining parts of this paper are organized as follows. The model that incorporates the APS sector is constructed in Section 3. In Section 4, we analyze the model in the short run. In Section 5, we investigate the impacts of subsidy policies on wage inequality in the long run. Concluding remarks are provided in Section 6.

2. Literature review

This research is related to two strands of the literature. The first strand documents subsidy policy and wage inequality. The growing wage gap in China and other developing nations has drawn a lot of attention from various angles. Scholars in development economics have already used trade and international factor mobility to explain this phenomenon (Beladi et al., 2008; Li & Xu, 2016). The relevance of domestic variables in explaining wage inequality is highlighted in recent theoretical work, which also proposes various mechanisms (Pi & Zhang, 2016; Wang, 2019; Zhang, 2022a). Here, we examine studies on wage disparity with an emphasis on agricultural subsidy policies implemented by developing countries. Dong and Li (2019) consider agricultural dualism and explicitly incorporate modern agriculture into a three-sector general-equilibrium model to analyze the effects of several modern-agricultural factor price subsidy policies on the wage inequality between skilled and unskilled labor. Dong and Li (2019) arrive at that capital mobility is one factor to affect the impacts. By using the survey data of the China Family Panel Studies (CFPS), Zhang (2022b) construct a difference-in-difference (DID) model and to examine the impact of agricultural subsidies on the income of rural households. Zhang (2022b) obtain two possible mechanisms that explain the impact of subsidies on income: transfer effect and productivity effect, and conclude that improvement of income only can be confirmed in the low-income rural households. Nevertheless, to the best of our knowledge, the impact of subsidy policies of APS on wage inequality is largely ignored by the existing literature. Small-scale agriculture receives intermediate inputs from the APS sector. Services, in the meantime, impact labor employment in agricultural sector, which results in a redistribution of production factors among sectors. Considering subsidy of APS leads to development and expansion of APS sector that affects labor allocation simultaneously, it is necessary to analyze how subsidy of APS impact the wage inequality between skilled and unskilled labor.

This research contributes to the other strand of the literature that studies agricultural modernization or agricultural productivity in developing countries. Recently, scholars have paid attention to small-scale agriculture and incorporated the APS sector as an intermediate sector in small-scale agriculture. The angle that is most closely related to this paper is Li and Fu (2022) and Li and Fu (2023). Li and Fu (2022) incorporate APS sector into a three-sector general equilibrium model to study the effects of remittance rate of migrant workers' income on environmental pollution. Under the settings of Li and Fu (2022), all remittances are used to purchase APS's products that complement labor in agricultural production. Thus, when purchasing more services, agricultural sector will enlarge its employment. Li and Fu (2023) put the APS sector and agricultural pollution into a framework and investigate the effects of government price subsidy, interest subsidy, and wage subsidy to APS on agricultural pollution and other economic indicators by constructing a three-sector general equilibrium model. However, the impact of subsidy policies of APS on wage inequality has largely ignored by existing literature.

In order to fill the current research gap and address issues mentioned above, this paper focuses on the effects of factor price subsidy policies of the APS sector, which aim to promote the APS sector, on the income inequality between skilled and unskilled labor. The main conclusions are wage subsidy policy on unskilled labor narrows down wage gap both in the short and long run. Interest subsidy policy reduces wage inequality, while wage subsidy policy on skilled labor expands it in the short term. In the long run, the results of interest and skilled labor wage subsidy depend on the elasticity of substitution among varieties in the APS sector. When the elasticity of substitution among varieties is

relatively small, subsiding skilled labor narrows down the wage inequality; however, the elasticity of substitution among varieties is relatively large, subsiding skilled labor expands the wage inequality. Such results are different from existing conclusions that consider the impacts of manufacturing producer service on wage inequality and give new insights into relevant research.

3. The model

Before establishing the theoretical model, we first define APS sector. According to Li and Fu (2022), APS sector is the provision of productive services and intermediate inputs for agriculture with the goal of integrating modern production factors such as scientific information technology, capital equipment, and skill into agricultural production. Under the dual economy concept, rural regions lag behind urban regions, hence Li and Fu (2022) assume the APS sector is located in the urban region. The issue of how rural agriculture uses services from the urban sector arises because service creation and consumption occur simultaneously. Concerning this issue, Wang and Li (2022) provide detailed illustration and here we follow this approach. Wang and Li (2022) use one example from a book, titling Typical Cases of National Agricultural Socialization Services (2020). In the first case, the company created a "Platform-Subsidiaries-Township Service Center-Service Advisor" four-tiered service network. The Platform offers the entire company technical solutions, input supplies, and training assistance. The platform's inputs and technical solutions are used by subsidiaries, which are based in counties or districts and offer services in their respective counties. The company serves customers locally through Township Service Centers. The "peripheral nerve" of the company for implementing the service is Service Advisor. The Platform offers the Service Advisor training on contract interpretation, agricultural technology, operational processes, and other topics. On behalf of the business, the Service Advisor signs the service agreement with the client.

Consider a small open developing economy that composes of three sectors: two sectors in the urban area and one agriculture sector (sector A) in the rural region. One urban sector is a manufacturing sector (sector M), and the other is the APS sector. APS sector is an upstream sector in the sense that it supplies varieties of differentiated intermediate inputs to the agricultural sector. These goods include, for instance, agricultural machinery services, agricultural technical services, supply service of agricultural means of production that embody the manufacturing technologies. The sector M uses skilled labor S_M, unskilled labor L_M and capital K_M to produce an importable good Y_M. The output of agricultural (Y_A) is generated through the use of unskilled labor L_A and a set of n of differentiated goods of APS sector sold within a market structure characterized by monopolistic competition.

Agricultural goods Y_A are produced under perfect competition with constant returns to scale technology. We use the Cobb-Douglas type production function to describe the relationship for simplification

$$Y_A = \zeta L_A^{1-\alpha} X^{a}, \quad X = \left(\sum_0^n x_i^{\frac{\sigma-1}{\sigma}} \right)^{\sigma/(\sigma-1)}$$

where α is a parameter in the range of (0, 1), ζ is a parameter measuring the agricultural productivity, and we choose the unit measurement and set $\zeta = [(1-\alpha)^{1-\alpha}\ \alpha^{\alpha}]^{-1}$ X is the index of differentiated intermediate inputs and X is assumed to be of the CES type. x_i denotes the amount of each service output, n is the number of varieties in the APS sector, $\sigma > 1$ a parameter and represents the elasticity of substitution among varieties. Commodity Y_A is chosen as the numeraire. From the production function, the price equals to the unit cost for the agricultural good,

$$1 = w^{1-\alpha} P^{\alpha} \tag{1}$$

where w is a flexible wage rate of unskilled labor in the rural region, $p = \left(\sum_0^n p_i^{1-\sigma} \right)^{1/(1-\sigma)}$ is the price index of intermediate inputs X, p_i is the price of variety i. Given X, the agricultural sector generates the demand for each variety $x_i = p_i^{-\sigma} P^{\sigma} X$.

Production in the manufacturing sector takes place under constant returns to scale technology as follows: $Y_M = F^M$ (S_M, L_M, K_M) and F^M is linearly homogeneous and strictly concave. Given the assumption of perfectly competitive markets, the price-unit cost equality condition relating to the manufacturing sector is given by

$$p_M = a_{SM} w_S + a_{LM} \overline{w} + a_{KM} r \tag{2}$$

where p_M is the relative price of commodity Y_M. w_S is the flexible wage rate of skilled labor. However, due to the minimum wage law and other reasons, the wages of unskilled labor in the manufacturing sector is given as $\overline{w}$. r indicates the interest rate. a_{iM} ($i = S, K, L$) denotes the amount of factor i used to produce one unit of good M.

APS sector. Each variety is produced by a monopolistically competitive firm by utilizing capital, skilled labor and unskilled labor. Capital and skilled labor are assumed to enter as fixed inputs, and the fixed cost of each firm is $r^{\psi} w_S^{1-\psi}$. Meanwhile, firms employ unskilled labor in rural area and do farm work in the rural region [Here we assume the APS sector employs rural unskilled labor to conduct marginal production. The reason is firms need local unskilled labor to do the terminal service, like harvest, carrying, sow seeds etc. In addition, unskilled labor also is willing to accept the work in order to know the working environment of APS sector or establish linkages with firms]. Thus, the unskilled labor is the variable input, with the unskilled labor demand by each firm given by mx_i, where m denotes the unit unskilled labor requirement. Total cost faced by each service firm is $TC_i = r^{\psi} w_S^{1-\psi} + mx_i w$. The presence of internal economies of scale implies that each firm specializes in the production of a single variety. Given the demand function and the cost function of each variety, a firm sets the price to maximize its profit, which yields

$$p_i = \left(\sigma / (\sigma - 1)\right) mw \tag{3}$$

Equation (3) states that each service firm sets its price at a mark-up above its marginal cost, mw. The mark up rate $\sigma/(\sigma-1)$ is negatively related to σ. As the parameter increases, the intermediate inputs become less differentiated from each other, reducing the price markup. When the parameter declines, each variety becomes more differentiated, allowing each firm to have more leeway in manipulating its demand. Here, the pricing rule is independent of the variety index i. Since p, ψ, m and w are the same for all firms, each firm would also produce the same equilibrium level of output, and set $x_i = x_j = x$, $p_i = p_j = p$. Further, in equilibrium, we have $P = pn^{1/(1-\sigma)}$, and $X = xn^{\sigma/(\sigma-1)}$. Because of $\sigma > 1$, expansion of the number of varieties, n, reduces the price index P and raises X, even if each firm keeps its price and output constant. As the value of σ goes to infinite, the influence of n on P and X disappears. The reason is that, X becomes the simple sum of the quantities of services and varieties become perfect substitutes for each other. On the other hand, as the value of σ declines towards 1, the importance of diversity becomes more significant.

By using Eq. (1), APS goods market-clearing condition can be demonstrated by

$$\alpha Y_A p^{-1} = nx \tag{4}$$

The left hand of Eq. (4) is the derived demand for APS outputs, and the right is the supply.

Generally, developing countries lack skilled labor, and assume that skilled labor is fully employed. However, unemployment of unskilled labor exists in the urban region due to the downward rigid wage rate. Define L_U as the unemployment of unskilled labor in the urban region and define λ as the unemployment rate, and $\lambda = L_U / (a_{LM} Y_M)$. Thus, the allocation mechanism which based on the Harris-Todaro type can be shown as follows:

$$\overline{w} = (1 + \lambda) w \tag{5}$$

The market-clearing conditions of the skilled labor, unskilled labor and capital could be shown as follows:

$$(1 - \psi) r^{\psi} w_S^{-\psi} n + a_{SM} Y_M = S \tag{6}$$

$$(1 - \alpha) w^{-1} Y_A + nxm + (1+\lambda) a_{LM} Y_M = L \tag{7}$$

$$\psi r^{\psi-1} w_S^{1-\psi} n + a_{KM} Y_M = K \tag{8}$$

where S, L and K represent the endowment of skilled labor, unskilled labor and capital, respectively. From the fixed cost of each firm, the first term in Eq. (6) (8) is the demand for skilled labor (capital) in the APS sector. The first and the second terms on the left-hand side of Eq. (7) are demand for unskilled labor in the agricultural sector and APS sectors, respectively, whereas the third term is unskilled labor in urban region.

Short-run equilibrium involves a situation where the number of firms, n, is exogenous and hence the zero-profit condition does not hold. The short-run equilibrium is characterized by Eqs. (1) to (8) with eight endogenous variables: λ, w, p, w_S, r, Y_A, x, Y_M. In the short term, this model is decomposable. From (1) and (3), we could solve w and p. From (5), we obtain λ. From (2), (6) and (8), we arrive at r, w_S and Y_M. x and Y_A are derived by equation (4) and (7).

The long-run equilibrium is characterized by free entry and exit of firms, which means total revenue px equals total cost TC and the zero-profit of all firms in this sector. Using equation (3), the zero-profit condition occurs

$$\frac{mxw}{\sigma - 1} = r^{\psi} w_S^{1-\psi} \tag{9}$$

Eq. (9) determines the number of firms (i.e., n). Accordingly, the long-run equilibrium involves nine equations ((1) to (9)) and nine endogenous variables: λ, w, p, w_S, r, Y_A, x, Y_M, n. For long-term general equilibrium model, this is an indecomposable system. According to the solution in the short-term, we could each endogenous variable as a function of n, and using (9), we get the whole endogenous variables.

From Eqs. (5) and (7), it is not hard to verify that the average wage rate of unskilled labor is w. In accordance with the definition of the skilled-unskilled wage inequality in Beladi et al., (2008) and Li and Xu (2016), we use the wage of skilled labor and the average wage of unskilled labor, as well as their relative change to investigate the effects of subsidy policy of unskilled labor (v_L), skilled labor (v_S) and interest rate (v_K) in the APS sector on skilled-unskilled wage gap in the short and long run.

4. Analysis of the model in the short run

In this section, we focus on the effects of subsidy policy of unskilled labor (v_L), skilled labor (v_S) and interest rate (v_K) in the APS sector on wage inequality and unemployment in the short run. Conducting the subsidy policies reduces firms' cost, so the real costs for those three factors are: $w(1-v_L)$, $w_S(1-v_S)$ and $r(1-v_K)$. Differentiating Eq. (1) to (8), and considering the initial value of the subsidy rate is zero. The impact of an increase in wage subsidy policy related to unskilled labor in the APS sector as follows:

$$\hat{w}_S - \hat{w} = -\alpha v_L \hat{v}_L$$

Subsidizing unskilled labor does not affect skilled wages, while it increases the wages of unskilled labor and narrows down the wage inequality. After the unskilled wages are subsidized, each firm in APS sector reduces its marginal cost and increases its demand for unskilled labor. Meanwhile, from (3), subsidizing unskilled labor reduces the price of services, and agricultural sector augments its demand for service and raises its demand for unskilled labor correspondingly. Therefore, an increase in unskilled wage subsidy raises the demand for unskilled labor from the APS sector and agricultural sector, raising unskilled wage rate. A change in the unskilled wage subsidy does not affect manufacturing production. Thus, this policy does not influence skilled wage and unskilled labor employment. Nevertheless, since the rural region raises the demand for unskilled labor, replenished unskilled labor comes from urban unemployment and the unemployment rate decreases.

We use proposition 1 to illustrate the above result.

Proposition 1 The wage subsidy policy on unskilled labor reduces wage inequality as well as unemployment rate.

Next considering the wage subsidy policy related to skilled labor and capital in the APS sector.

$$\hat{w}_S - w = v_S \frac{(1-\psi)\lambda_{SM}\lambda_{KX} + \psi\lambda_{SX}\lambda_{KM}}{A_1\lambda_{SM} - A_2\lambda_{KM}} v_S$$

and

$$\hat{w}_S - w = -v_K \frac{(1-\psi)\lambda_{SM}\lambda_{KX} + \psi\lambda_{SX}\lambda_{KM}}{A_1\lambda_{SM} - A_2\lambda_{KM}} v_K$$

where λ_{ij} ($i = K, S, L$; $j = M, A, X$) is the allocative share of factor i in the jth sector (e.g. $\lambda_{SX} = (1-\psi)r^{\psi} w_S^{-\psi} n / S$). θ_{iM} ($i = S, K$) is the distributive share of factor i in manufacturing sector.

$$A_1 = (1-\psi)\lambda_{KX}(1+\theta_{SM}/\theta_{KM}) + \lambda_{KM}(S_{KS} - S_{KK}\theta_{SM}/\theta_{KM}) > 0,$$

$$A_2 = \lambda_{SM}(S_{SS} - S_{SK}\theta_{SM}/\theta_{KM}) - \psi\lambda_{SX}(1+\theta_{SM}/\theta_{KM}) < 0.$$

S_{ij} ($i, j = S, L, K$) is the partial elasticity of substitution between factors i and j in the manufacturing sector, $S_{ij} > 0 (i \neq j)$ and $S_{ii} < 0$.

The wage subsidy policy on skilled labor enlarges the skilled-unskilled wage gap. After the skilled wage is subsidized, the demand for skilled labor in APS sector increases, which leads to a higher nominal wage to attract more skilled labor, and in turn, skilled labor is released from sector M to APS sector. A decrease in skilled labor lowers the marginal return of capital r in sector M. Meanwhile, the inflow of skilled labor substitutes capital in the fixed cost, which also contributes the decline of r. Here, the movement of skilled labor does not mean the same mobility direction of capital and unskilled labor. If capital plays a more significant role in manufacturing production, that is the elasticity S_{SK} is relatively large, outflow of skilled labor has less effect on manufacturing production and reduction of interest rate expands this sector instead. Expansion of manufacturing raises the demand for unskilled labor by attracting unskilled labor from rural area and contracts sector A and APS sector, which raises the expected wage rate (probability of employment multiplies $\overline{w}$). According to Eq. (5), the migration disappears until the expected wage rate equals the agricultural wage rate. At the equilibrium, unskilled labor wage in the agriculture remains constant. If skilled labor plays a more significant role in the manufacturing production, that is the elasticity S_{KS} is relatively large, we could obtain the opposite results on output of three sectors. In two cases, wage subsidy policy on skilled labor does not affect w. As a result, the skilled-unskilled wage gap becomes larger.

Compared with the impacts of wage subsidy policy of skilled labor on skilled wage, interest rate subsidy policy exerts an exact opposite effect on it due to the fixed number of varieties. And this policy has no impact on unskilled wage rate, which is similar with that of wage subsidy policy of skilled labor. Therefore, interest rate subsidy policy narrows down wage inequality.

To sum up, we obtain the following proposition 2.

Proposition 2 The wage subsidy policy on skilled labor expands wage inequality , while interest subsidy policy reduces it. Meanwhile, both policies do not affect unemployment rate.

5. Analysis of the model in the long run

In this section, we consider the number of firms in the APS sector is an endogenous variable and investigate the effects of subsidy policies of in the APS sector on wage inequality and the specialization level of this sector in the long run. Differentiating Eqs. (1) to (9) can yield the following matrix equation:

$$\begin{pmatrix} 0 & -1 & 0 & 1 & 1+\dfrac{\alpha}{\sigma-1} \\ (1+\lambda)\lambda_{LM}(S_{LS}-S_{LK}\theta_{SM}/\theta_{KM}) & \lambda_{LA} & (1+\lambda)\lambda_{LM} & \lambda_{LX} & \lambda_{LX}-\dfrac{\alpha[\lambda_{LA}+(1+\lambda)\lambda_{LM}]}{\sigma-1} \\ A_1 & 0 & \lambda_{KM} & 0 & \lambda_{KX} \\ A_2 & 0 & \lambda_{SM} & 0 & \lambda_{SX} \\ \psi\theta_{SM}/\theta_{KM}-(1-\psi) & 0 & 0 & 1 & \dfrac{\alpha}{\sigma-1} \end{pmatrix} \begin{pmatrix} \hat{w}_S \\ \hat{Y}_A \\ \hat{Y}_M \\ \hat{x} \\ \hat{n} \end{pmatrix}$$

$$= \begin{pmatrix} 1-\alpha \\ \alpha[\lambda_{LA}+(1+\lambda)\lambda_{LM}] \\ 0 \\ 0 \\ 1-\alpha \end{pmatrix} v_L\hat{v}_L + \begin{pmatrix} 0 \\ 0 \\ (1-\psi)\lambda_{KX} \\ -\psi\lambda_{SX} \\ -(1-\psi) \end{pmatrix} v_S\hat{v}_S + \begin{pmatrix} 0 \\ 0 \\ -(1-\psi)\lambda_{KX} \\ \psi\lambda_{SX} \\ -\psi \end{pmatrix} v_K\hat{v}_K \tag{10}$$

Denote the determinant of the coefficient matrix of eq. (10) as Δ,

$$\Delta = \left(\frac{\alpha}{\sigma-1}-1\right)(A_1\lambda_{SM}-A_2\lambda_{KM})+(1+\lambda)\lambda_{LM}(A_1-A_2)-$$

$$\left\{(1+\lambda)\lambda_{LM}\left(S_{LS}-S_{LK}\theta_{SM}/\theta_{KM}\right)-(\lambda_{LA}+\lambda_{LX})[\psi\theta_{SM}/\theta_{KM}-(1-\psi)]\right\}(\lambda_{KM}-\lambda_{SM})$$

The sign of Δ is ambiguous. According to Appendix, Δ should be negative in order to ensure the local stability of the economic system.

5.1 *Impact of subsiding unskilled labor*

Solving Eq. (10) with regards to $\hat{v}_L$,

$$\frac{\hat{w}_S-w}{\hat{v}_L}=\frac{v_L(\alpha-\lambda_{LX})[\lambda_{SM}\lambda_{KX}-\lambda_{SX}\lambda_{KM}+\alpha(A_1\lambda_{SM}-A_2\lambda_{KM})/(\sigma-1)]}{\Delta}$$

The result depends the relation between α and λ_{LX}, we assume the importance of X in the agricultural production is larger than allocative share of unskilled labor in the APS sector, that is $\alpha > \lambda_{LX}$. Then $\left(\hat{w}_S-w\right)/v_L<0$.

Proposition 3 Subsiding unskilled labor narrows down the wage inequality.

Subsiding unskilled labor reduces the marginal cost of the APS sector, which cuts down its equilibrium price and raises the demand for x. Meanwhile, the subsidy policy makes existing firms earn profits and attracts new firms to enter this sector, expanding the X. Thus, the APS sector and sector A increase their demand for unskilled labor, raising its wage rate. Regarding the sector M, the entrance of new firms draws the outflow of skilled labor and capital from this sector and contracts output. Because the amount of capital corresponding to unit skilled labor in the fixed cost of APS sector is higher than that in the sector M, the demand for skilled labor falls in sector M that, in turn, leads to a decrease in the skilled wage rate.

Even though subsiding unskilled labor reduces the skilled-unskilled wage inequality in the short and long run, the mechanism between two results is different. In the short run, subsiding unskilled labor narrows down wage inequality by raising demand for unskilled labor alone. Nevertheless, in the long run, the same policy also attracts new entrance of firms and exerts an effect on the movement of skilled labor and capital between sector M and APS sector, cutting down the demand for skilled labor.

5.2 *Impact of subsiding skilled labor and capital*

In section 3, we obtain the exact opposite impacts of subsiding skilled labor and capital due to the fixed number of varieties; however, in the long run, because of the free entry and exit of firms, the results are different. Solving Eq. (10) with regards to $\hat{v}_S$ and $\hat{v}_K$ on $\hat{n}$, we first use Lemma 1 to illustrate the impact of subsiding skilled labor and capital on the number of varieties.

Lemma 1 Subsiding skilled labor raises the number of varieties, while the impact of subsiding capital on the number of varieties is ambiguous.

As we know from Eq. (9), if the left side of this equation, mainly determined by firm's output x, is larger than the fixed cost, the number of varieties increases. We first consider the impacts of subsiding policy on the fixed cost. Subsiding one factor reduces the real cost for utilizing this factor, and stimulates subsidized sector to use this factor more extensively and contributes to rising demand for this factor and factor reward; however, the wage rate of skilled labor and interest rate of capital varies inversely in the manufacturing sector and APS sector, thus, subsiding one factor not always reduces the fixed cost. Under the assumption that the APS sector is more capital intensive than skilled-labor intensive in its fixed input, a change in interest rate has more weight on determining the fixed cost. And an increase in interest rate which also means a reduction of skilled wage rate raises the fixed cost, and vice versa.

Subsiding skilled labor, on the one hand, cuts down the real cost of skilled labor and contributes to raising skilled wage rate and reducing the fixed cost; on the other hand, reduction of interest rate substitutes more unskilled labor than the substitution between skilled labor and unskilled labor in the sector M. Thus, sector M releases unskilled labor and promotes each firm's output. Therefore, when subsiding skilled labor, the left side of Eq. (9) raises and right side of Eq. (9) reduces, and attracting new firms to entry.

However, subsiding capital drops the real cost of interest rate and raises the demand for capital and interest rate, which brings an indeterminate impact on each firm's fixed cost. Meanwhile, sector M faces a higher interest rate and uses capital to substitute more unskilled labor, contributing to contracting each firm's output. Thus, the impact of subsiding capital on the number of varieties is ambiguous.

Next, we consider the impacts of subsiding policies on skilled and unskilled wage rate and wage inequality. Solving Eq. (10) with regards to $\hat{v}_S$ on $\hat{w}_S$,

$$\frac{\hat{w}_S}{v_S\hat{v}_S}=\left\{\begin{array}{l}(1+\lambda)\lambda_{LM}[(1-\psi)\lambda_{KX}+\psi\lambda_{SX}]+(\lambda_{SM}-\lambda_{KM})(1-\psi)\lambda_{LX}\\ -[(1-\psi)\lambda_{KX}\lambda_{SM}+\psi\lambda_{SX}\lambda_{KM}]\left(1-\dfrac{\alpha}{\sigma-1}\right)\end{array}\right\}\Big/\Delta$$

and

$$\frac{\hat{w}}{v_S\hat{v}_S}=\frac{\alpha}{\sigma-1}\frac{n}{v_Sv_S}>0$$

From the previous discussion, we impose $\sigma > 1 + \alpha$ and the sign of $\hat{w}_S/v_S$ is indeterminate. Different from the short term, subsiding skilled labor has two opposite effects on the skilled wage rate in the long run: factor demand effect and resource allocation effect. The factor demand effect, which exists both in the short and long term, raises the demand for skilled labor and consequently increases its wage. However, the resource allocation effect occurs only in the long run, which adds complexity to determine the impact. From Lemma 1, subsiding skilled labor expands the number of varieties in the APS sector, which contributes to the outflow of skilled labor and capital from sector M. Due to the difference of factor intensities, an outflow of two factors brings down skilled wage rate. When σ is small enough, which means varieties are more differentiated and adding n plays a significant role, the latter effect dominates the change of skilled labor wage, and subsiding skilled labor lowers skilled labor wage. When σ is relatively large, adding varieties has an insignificant role and resource allocation effect is relatively small, the former effect dominates the variation of skilled wage rate.

In the short run, subsiding skilled labor has no impact on unskilled labor wage. However, in the long run, subsiding skilled labor affects unskilled wage rate through its impact on n. The impact of subsiding skilled labor on unskilled labor wage is determined by two factors: its impact on the number of varieties and σ. Expanding varieties has external economies on agricultural production and augments the marginal productivity of unskilled labor, which raises unskilled wage rate. Meanwhile, the parameter σ determines the magnitude of external economies. When σ is small enough, expanding varieties has a large effect on external economies and raises unskilled labor wage in a large extent. When σ is relatively large, an increase in n has little effect on unskilled wage rate.

From the above discussion, we use proposition 4 to summarize the impact of subsiding skilled labor on wage inequality.

Proposition 4 Subsiding skilled labor narrows down the wage inequality if σ is relatively small; however, when σ is large enough, subsiding skilled labor expands the wage inequality.

When σ is relatively small, the resource allocation effect lowers skilled wage rate and adding the number of varieties has a large positive effect on unskilled wage rate, thus, subsiding skilled labor narrows down the wage inequality. However, if σ is large enough, the impact of subsiding skilled labor on skilled wage rate dominates by factor demand effect and skilled wage rate rises. In this situation, the expansion of varieties has little effect on unskilled wage, and unskilled wage almost keeps constant as a result of subsiding skilled labor. Therefore, subsiding skilled labor expands wage inequality when σ is large enough.

Next, we investigate the effect of interest rate subsidy on skilled labor wage. Solving Eq. (10),

$$\frac{\hat{w}_S}{v_K \hat{v}_K} = \left\{ \begin{array}{l} \left(1-\frac{\alpha}{\sigma-1}\right)[(1-\psi)\lambda_{KX}\lambda_{SM} + \psi\lambda_{SX}\lambda_{KM}] \\ +\psi(\lambda_{LX}+\lambda_{LA})(\lambda_{SM}-\lambda_{KM}) - (1+\lambda)\lambda_{LM}[(1-\psi)\lambda_{KX} + \psi\lambda_{SX}] \end{array} \right\} \Big/ \Delta < 0$$

Different with the effect of subsiding skilled labor, interest rate subsidy decreases skilled wage rate unambiguously. Interest rate subsidy also brings factor demand effect and resource allocation effect; however, two effects exert the same impact on skilled wage rate. Factor demand effect: interest rate subsidy raises the demand for capital and the interest rate and decreases the skilled wage rate. Resource allocation effect: interest rate subsidy promotes capital and skilled labor move from sector M into APS sector, which also brings down skilled wage rate.

Now we turn to analyzes the impact of interest rate subsidy on wage inequality. From Lemma 1, the interest rate subsidy has an ambiguous effect on the number of varieties. Thus, its impact on unskilled wage also ambiguous. However, we know when σ is large enough, due to little external economies, interest rate subsidy does not affect the unskilled wage rate, irrespective of the variation of n. Moreover, interest rate subsidy decreases skilled wage rate in this situation. We use proposition 5 to summarize the impact of interest rate subsidy on wage inequality.

Proposition 5 Interest rate subsidy decreases wage inequality when σ is large enough.

Note that in the short run, we obtain $\hat{w}_S / v_S + w_S / v_K = 0$. Since subsidizing skilled labor and capital has no impact on unskilled labor, conducting the two subsidies in same magnitude does not affect wage inequality. However, in the long run, if $v_S = v_K$, we have

$$\hat{w}_S / v_S + w_S / v_K = -v_K (\lambda_{LX} + \lambda_{LA})(\lambda_{KM} - \lambda_{SM}) / \Delta < 0$$

and

$$\hat{w} / \hat{v}_S + \hat{w} / \hat{v}_K = \alpha v_K (\lambda_{LX} + \lambda_{LA})(A_2 \lambda_{KM} - A_1 \lambda_{SM}) / [(\sigma - 1)\Delta] > 0,$$

and implementation of two subsidy policies simultaneously reduces wage inequality. Implementation of both these policies at the same time expands the number of varieties and raises unskilled wage rate. Meanwhile, the resource allocation effect dominates the change of wage rate of skilled labor, driving its wage downwards.

6. Concluding remark

This paper concentrates on the effects of factor price subsidy policies of the APS sector on the income inequality between skilled and unskilled labor. Compared with the impacts of manufacturing producer service on wage inequality from existing literature, we obtain different results and give new insights into relevant research. Distinct conclusions are derived from the differences between manufacturing and APS. Note that, there is more to investigating APS than academic needs. The economic reality of developing countries also requires to conduct the research. Predictably, in the next period of time, developing countries, not only China, like Vietnam, India and other emerging economies, the promotion of APS is their chief economic task for rural development.

Therefore, the conclusions of this paper can provide references for these countries to formulate corresponding economic policies concerning wage inequality. For instance, when considering subsidy of skilled labor in the long term, conclusions show that the elasticity of substitution among varieties plays a significant role in determining the impacts of subsidy policies on wage inequality. Therefore, when implementing this subsidy policy, governors should consider the magnitude of the elasticity of substitution among varieties and take effective measures to keep differentiations among varieties and reduce homogeneity of services.

Acknowledgments

The author acknowledges the valuable suggestions from the peer reviewers. Fangfang Cheng is supported by the Undergraduate Research Innovation Fund of Anhui University of Finance and Economics (Project No. ACJJXYZD2316) and College Students' Innovative Entrepreneurial Training Plan Program of Anhui University of Finance and Economics (No. S202310378582). Dianshuang Wang is supported by the Ministry of Education Humanities and Social Science Project of China (Grant No. 22YJC790121).

Conflict of interest

The authors declare no competing financial interest.

References

Beladi, H., Chaudhuri, S., & Yabuuchi, S. (2008). Can international factor mobility reduce wage inequality in a dual economy. *Review of International Economics, 16*(3), 893-903. https://doi.org/10.1111/1467-9396.00359

Belton, B., Win, M. T., Zhang, X., & Filipski, M. (2021). The rapid rise of agricultural mechanization in Myanmar. *Food Policy, 101*, 102095. https://doi.org/10.1016/j.foodpol.2021.102095

Dong, Z., & Li, X. (2019). Rural dual economics, subsidy policy and the income inequality between skilled and unskilled workers. *Asia-Pacific Journal of Accounting & Economics, 26*(5), 609-621. https://doi.org/10.1080/16081625.2017.1363656

Donovan, K. (2021). The equilibrium impact of agricultural risk on intermediate inputs and aggregate productivity. *Review of Economic Studies, 88*(5), 2275-2307. https://doi.org/10.1093/restud/rdaa084

Li, X., & Fu, H. (2022). Migrant remittance, agricultural producer services, and environmental pollution. *Asia-Pacific Journal of Accounting & Economics, 29*(5), 1267-1282. https://doi.org/10.1080/16081625.2020.1808797

Li, X., & Fu, H. (2023). Agricultural producer service subsidies and agricultural pollution: an approach based on endogenous agricultural pollution. *Review of Development Economics, 27*(2), 1177-1198. https://doi.org/10.1111/rode.12983

Li, X., & Xu, Y. (2016). Unemployment, wage inequality and international factor movement in the presence of agricultural dualism. *Review of Development Economics, 20*(2), 415-425. https://doi.org/10.1111/rode.12235

Pi, J., & Zhang, P. (2016). Hukou system reforms and skilled-unskilled wage inequality in China. *China Economic Review, 41*, 90-103. https://doi.org/10.1016/j.chieco.2016.08.009

Pi, J., & Zhou,Y. (2013). Institutional quality and skilled-unskilled wage inequality. *Economic Modelling, 35*, 356-363.

Ministry of Agriculture and Rural Affairs of China (2020). Typical Cases of National Agricultural Socialization Services. China Agriculture Press, Beijing.
Restuccia, D., Yang, D. T., & Zhu, X. (2008). Agriculture and aggregate productivity: A quantitative cross-country analysis. *Journal of Monetary Economics, 55*(2), 234-250. https://doi.org/10.1016/j.jmoneco.2007.11.006
Sarah, L., Jakob, S., & Terri, R. (2016). The number, size, and distribution of farms, smallholder farms, and family farms worldwide. *World Development, 87*, 16-29. https://doi.org/10.1016/j.worlddev.2015.10.041
Wang, D. (2019). Manufacturing and agricultural pollution, private mitigation and wage inequality in the presence of pollution externalities. *Agricultural Economics-Czech, 65*, 51-58. https://doi.org/10.17221/79/2018-AGRICECON
Wang, L., Yang, R., & Wu, B. (2020). A study on total factor productivity of agricultural production of rural households in China. *Management World, 12*, 77-90. https://doi.org/10.3390/su12083327
Wang, D., & Li, X. (2022). Capital market distortion, agricultural producer service and wage inequality in the small-scale agriculture. *Annals of Regional Science, 69*, 391-409. https://doi.org/10.1007/s00168-022-01141-x
Whang, U. (2017). Structural sransformation and comparative advantage: Implications for small open economies. *The World Economy, 40*(4),743-763. https://doi.org/10.1111/twec.12398
Yang, D., & Zhu, X. (2013). Modernization of agriculture and long-term growth. *Journal of Monetary Economics, 60*(3), 367-382. https://doi.org/10.1016/j.jmoneco.2013.01.002
Yang, J., Huang, Z., Zhang, X., & Reardon, T. (2013). The rapid rise of cross-regional agricultural mechanization services in China. *American Journal of Agricultural Economics, 95*(3), 1245-1251. https://www.jstor.org/stable/24476906
Zhang, P. (2022a). Can public subsidy on education reduce wage inequality in the presence of automation? *Economic Research-Ekonomska Istraživanja, 35*(1), 6850-6866. https://doi.org/10.1080/1331677X.2022.2053783
Zhang, Z. (2022b). Do agricultural subsidies raise the income of rural households effectively? Evidence from rural China. *Applied Economics Letters*. https://doi.org/10.1080/13504851.2022.2159003
Zhang, X., Yang, J., & Thomas, R. (2017). Mechanization outsourcing clusters and division of labor in Chinese agriculture. *China Economic Review, 43*, 184-195.

Appendix

Determinant of the sign of Δ

Here, we follow the method of Beladi et al. (2008) and Pi and Zhou (2013). Under the general equilibrium model, we construct the dynamic adjustment based on excess demand functions. The adjustment consists of the Marshallian quantity adjustment process and the Walrasian price adjustment process. The adjustment processes of Eqs. (1)-(9) can be specified as follows:

$$\dot{Y}_A = d_1(1 - w^{1-\alpha} P^{\alpha}) \tag{A-1}$$

$$\dot{Y}_M = d_2(p_M - a_{SM} w_S - a_{LM} \overline{w} - a_{KM} r) \tag{A-2}$$

$$\dot{x} = d_3\left(p - \frac{\sigma}{\sigma - 1} mw\right) \tag{A-3}$$

$$\dot{p} = d_4\left(aY_A p^{-1} - nx\right) \tag{A-4}$$

$$\dot{\lambda} = d_5\left[\overline{w} - (1+\lambda) w\right] \tag{A-5}$$

$$\dot{w}_S = d_6\left[(1-\Psi) r^{\Psi} w_S^{-\Psi} n + a_{SM} Y_M - S\right] \tag{A-6}$$

$$\dot{w} = d_7\left[(1-a) w^{-1} Y_A + nxw + (1+\lambda) a_{LM} Y_M - L\right] \tag{A-7}$$

$$\dot{r} = d_8\left[\Psi r^{\Psi-1} w_s^{1-\Psi} n + a_{KM} Y_M - K\right] \tag{A-8}$$

$$\dot{n} = d_9\left(\frac{mxw}{\sigma - 1} - r^{\Psi} w_S^{1-\Psi}\right) \tag{A-9}$$

where "·" denotes differentiation with regard to time, $d_i > 0$ ($i = 1, 2, \ldots, 9$) represents the speed rate of adjustment. After equivalent transformations, the determinant of the Jacobian matrix of equations (A1)-(A9) is

$$J = \frac{pLSK\prod_{i=1}^{9} d_i}{Y_M Y_A \lambda x n w w_S r} \begin{vmatrix} 0 & -1 & 0 & 1 & 1 + \dfrac{\alpha}{\sigma - 1} \\ (1+\lambda)\lambda_{LM}(S_{LS} - S_{LK}\theta_{SM}/\theta_{KM}) & \lambda_{LA} & (1+\lambda)\lambda_{LM} & \lambda_{LX} & \lambda_{LX} - \dfrac{\alpha[\lambda_{LA} + (1+\lambda)\lambda_{LM}]}{\sigma - 1} \\ A_1 & 0 & \lambda_{KM} & 0 & \lambda_{KX} \\ A_2 & 0 & \lambda_{SM} & 0 & \lambda_{SX} \\ \psi\theta_{SM}/\theta_{KM} - (1-\psi) & 0 & 0 & 1 & \dfrac{\alpha}{\sigma - 1} \end{vmatrix}$$

Therefore, it can be shown that

$$J = \frac{pLSK\prod_{i=1}^{9} d_i}{Y_M Y_A \lambda x n w w_S r} \Delta$$

According to the Routh-Hurwitz theorem, a necessary condition for the local stability of the system is that sign J is negative. If the equilibrium is stable, which implies that $J < 0$; therefore, $\Delta < 0$.