

Original Research Article

Imperfect factor mobility, agricultural producer service and agricultural development in developing economy

Abstract:

Agriculture in developing countries operates on small-scale land that hinders the utilization of modern inputs. Agricultural producer service sector that acts as an intermediate sector facilitates this process. We build three-sector general equilibrium models to delineate two-layer vertical production structure: parts of manufacturing goods are utilized by the service sector, the outputs of which are intermediate inputs that could substitute labor in agriculture. Results show that a raise in capital mobility expands agricultural sector and promotes agricultural productivity, while an increase in labor mobility cuts down output of agricultural sector and its productivity.

Keywords: agricultural producer service, Imperfect factor mobility, agricultural development

1. Introduction

Growth in agriculture productivity is central to development in developing countries. However, traditional agricultural systems can not generate high labor productivity in agriculture; opportunities for rapid productivity growth become available only through advancement in science-based technology. Modern intermediate inputs in agriculture, which refer to those factors that are provided outside the agricultural sector, are vital in agricultural productivity and rural development.

In one influential work, Restuccia et. al. (2008) argue that certain distortions in factor markets may severely dampen the incentives of farmers for adopting modern inputs. They examine two kinds of barriers to the use of intermediate inputs. The first are direct barriers in poor countries that are reflected in the cost of modern inputs. The second are indirect barriers associated with labor market distortions. Obstacles to migration reduce labor flows from the agricultural to non-agricultural sector, and when combined with institutionally protected urban wages, often suppress agricultural wages to very low levels (e.g., Rosenzweig, 1988). This distortion encourages farmers to substitute cheap labor for other inputs, and therefore is an indirect barrier to

intermediate input use. They suggest that removing barriers to adopting modern inputs in agriculture could substantially raise agricultural in poor countries.

Restuccia et. al. (2008) considers this issue in the context of large-scale agriculture, where modern inputs could be used by traditional agriculture directly after a simple transformation. However, China and many other emerging nations primarily practice small-scale agriculture (Sarah et al., 2016). Modern intermediate inputs are difficult for small-scale farmers to use directly. On the one hand, farmers are unable to afford to buy comparatively costly modern inputs, such farm equipment. However, their small-scale activities also prevent them from taking advantage of economies of scale. In order to indirectly use intermediate inputs, small-scale agriculture needs an intermediate sector. Purchasing services from the agricultural producer service sector and outsourcing certain stages of agricultural production are considered practical ways to expedite the use of non-agricultural inputs (Yang, 2013; Zhang et al., 2017; Belton et al., 2021). This sector is called “New Agricultural Service Providers” in China.

Since financial development in rural area lags behind the urban region and the agricultural producer service sector needs much more capital to production, policymaker makes effort to promote the mobility of capital between urban and rural. Meanwhile, labor transfer between rural and urban faces less restrict from policy, and more and more labor employs in the urban region to obtain higher wage. Question arises. When the developing economy face the improvement of factor mobility, how this change affects rural development. We try to bridge this gap and analyze the impacts of an increase in factor (e.g. capital and labor) mobility on rural development with the exist of agricultural producer services.

2.Model

Consider a small open economy with two traded goods(manufacturing Y and agriculture Z) and one intermediate input X (varieties of agricultural producer services(APS)). Good Y is produced in the urban region, while good Z and input X are produced in the rural area. Y is produced by using of labor and capital, while Z is produced by labor and input X .The production functions are

$$Y = L_Y^\alpha K_Y^{1-\alpha}$$

$$Z = L_Z^\beta X^{1-\beta}$$

where two functions satisfy neoclassical properties (i.e., strict quasi-concavity and linear homogeneity). The employment of labor in $Y (Z)$ is $L_Y (L_Z)$, while the use of capital(input) in $Y (Z)$ sector is $K_Y (X)$.

Use x_i to express the output of firm i in APS sector, n is the number of firms in that market,

$$X = \left[\sum_{i=1}^n x_i^\delta \right]^{\frac{1}{\delta}}$$

where δ is a parameter to be interpreted shortly and $0 < \delta < 1$.

The APS sector uses labor and capital for production. Capital is assumed to enter as a fixed input, with the given capital input requirement of each producer equals to γ . Labor is a variable input, with the labor demand by each service firm given by $L_i = \beta x_i$, where β denotes the unit labor requirement. Total cost faced by each service firm is $TC_i = \gamma r + \beta x_i w$, where w and r , respectively, are wage rate of labor in and price of capital in the rural area. Here, we impose two assumptions about APS. First, assume the market structure within services is one of Chamberlinian monopolistic competition. In this framework, the price elasticity of demand for a single service would be $1/(1-\delta)$. Second, we consider a symmetric way in APS firms, $x_i = x_j = x$. Therefore, $X = n^{1/\delta} x$ and we can rewrite the production function of agricultural sector as follow: $Z = n^{\frac{1-\delta}{\delta}} L_Z^\beta x^{1-\beta}$. From this production function, a rise in the quantity of firms in the APS sector increases the output of agricultural sector, even if the agriculture keeps its inputs the same. Such external economies were captured by $(1-\delta)/\delta$ in the model. In addition, as the value of δ goes to 1, the output of firms in the APS becomes perfect substitutes for each other, only total output of APS matters. On the other hand, as the δ declines towards 0, the importance of firm's number becomes more important.

Use p to denote the price of services, and the equality of marginal cost to marginal revenue implied that

$$\delta p = \beta w (1)$$

Concerning two final goods and taking Z as numeraire, in equilibrium, we have

$$A\bar{w}^\alpha r_Y^{1-\alpha} = q \quad (2)$$

and

$$Bw^\beta p^{1-\beta} n^{\frac{(1-\beta)(1-\delta)}{\delta}} = 1 \quad (3)$$

where q is the relative price of good Y . \bar{w} is the wage rate of labor in the manufacturing sector, which is downward rigid due to the protection of labor unions. r_Y is the interest rates of capital in the urban sector. $A = 1/[\alpha^\alpha (1-\alpha)^{1-\alpha}] > 0$ and $B = 1/[\beta^\beta (1-\beta)^{1-\beta}] > 0$ are parameters. The productivity of agricultural sector is linked to the quantity of varieties of APS. An increase in the quantity of varieties reduces the unit cost of agricultural production. The labor of demand for two sectors are $L_Y = \alpha q A \bar{w}^{\alpha-1} r_Y^{1-\alpha} Y$ and $L_Z = \beta B w^{\beta-1} p^{1-\beta} n^{\frac{(1-\beta)(1-\delta)}{\delta}} Z$. Capital demand in urban sector is $K_Y = (1-\alpha) A q \bar{w}^\alpha r_Y^{-\alpha} Y$.

Assume labor and capital market are characterized by the existence of some inertia. The equilibrium condition of labor market is specified using Gilbert and Oladi (2009) setting, hence:

$$w + \rho = \frac{L_Y}{L_Y + L_U} \bar{w} \quad (4)$$

where ρ is the cost of migration, L_U is unemployment in the urban sector, and $L_Y/(L_Y + L_U)$ is the probability of employment in the urban region. Decrease of ρ means the increase of labor mobility. As for the capital market, we follow Casas(1984) and stipulate the mobility function of capital as:

$$K_Y/(n\gamma) = k(r_Y/r)^\varepsilon \quad (5)$$

where ε is the elasticity of capital mobility, which is assumed to be constant. $\varepsilon = 0$ means capital is completely immobile, and $\varepsilon = \infty$ indicates capital is perfect mobility. The right-hand side of (8) measures the impact of intersectoral rent differential on the mobility of capital. Regarding the rent differentials of urban and rural regions, we assume the rural rent is larger than that of urban¹.

The market clearing condition for services is

$$(1-\beta) B w^\beta p^{1-\beta} n^{\frac{(1-\beta)(1-\delta)}{\delta}} Z = nx \quad (6)$$

¹ Some discussion on intersectoral rent differentials refers to Choi and Yu(2010).

Factor markets clearing conditions are:

$$L_Y + L_Z + nx\beta + L_U = L \quad (7)$$

and

$$K_Y + n\gamma = K \quad (8)$$

where L and K denote the economy's endowment of labor and capital, respectively.

In the long run, zero profit of service condition

$$px(1-\delta) = r\gamma \quad (9)$$

So far, the theoretical model has been established. Nine endogenous variables, w , r_Y , r , n , p , Y , Z , L_U and x , are determined by equation (1)–(9), ε and ρ are policy variables. Other variables are exogenous. To set the following analysis, it is necessary to conduct the ensuing comparative static analysis.

3. Comparative static analysis

The impacts of an increase in capital and labor mobility on the quantity of varieties, agricultural output and productivity, unemployment can be conducted by differentiating equilibrium conditions (1)–(9) with respect to ε and ρ . The impacts of a raise in capital and labor mobility on the quantity and output of varieties, agricultural output is as follow:

$$\hat{n} = \frac{1}{\Delta} \left[-\varepsilon(\lambda_{LZ} + \lambda_{LX}) \log \frac{r_Y}{r} \hat{\varepsilon} + \frac{\lambda_{LU}\lambda_{\rho}^e}{\lambda} \hat{\rho} \right] \quad (10)$$

$$\hat{x} = \frac{1}{\Delta} \left\{ \varepsilon \left[\lambda_{LZ} + \lambda_{LX} - \frac{(\lambda_{LY} + \lambda_{LU})\lambda_{KX}}{\lambda_{KY}} - \frac{\lambda_{LU}\lambda_w^e}{\lambda} \frac{(1-\beta)(1-\delta)}{\delta} \right] \log \frac{r_Y}{r} \hat{\varepsilon} - \frac{\lambda_{LU}\lambda_{\rho}^e}{\lambda} \left[\varepsilon \frac{(1-\beta)(1-\delta)}{\delta} - \frac{1}{\lambda_{KY}} \right] \hat{\rho} \right\} \quad (11)$$

$$\hat{Z} = \frac{1}{\Delta} \left[-\varepsilon \left[\lambda_{KX} \frac{\lambda_{LY} + \lambda_{LU}}{\lambda_{KY}} + \left(\lambda_{LX} + \lambda_{LZ} + \frac{\lambda_{LU}\lambda_w^e}{\lambda} \right) \frac{(1-\beta)(1-\delta)}{\delta} \right] \log \frac{r_Y}{r} \hat{\varepsilon} + \frac{\lambda_{LU}\lambda_{\rho}^e}{\lambda} \left(\varepsilon + \frac{1}{\lambda_{KY}} \right) \hat{\rho} \right] \quad (12)$$

$$\Delta = \frac{\lambda_{LZ} + \lambda_{LX}}{\lambda_{KY}} + \varepsilon \left[\lambda_{LZ} + \lambda_{LX} - \frac{(\lambda_{LY} + \lambda_{LU})\lambda_{KX}}{\lambda_{KY}} - \left(\lambda_{LZ} + \lambda_{LX} + \frac{\lambda_{LU}\lambda_w^e}{\lambda} \right) \frac{(1-\beta)(1-\delta)}{\delta} \right] \quad (13)$$

where λ_{ij} ($i=L,K; j=X,Y,Z$) is the allocated share of factor i in the j th sector. λ is

unemployment rate in the urban region. $\lambda_{\rho}^e = \rho/(\rho + w)$ and $\lambda_w^e = w/(\rho + w)$. The

sign of Δ is ambiguous. Under the case that capital is completely immobile, $\Delta > 0$.

By making use of dynamic stability condition, we obtain $\Delta > 0$ as long as the

equilibrium is stable. In addition, to make the ensuing discussion tractable, we assume

that per capita capital in urban region is larger than that of the rural region. Under this assumption, $\lambda_{KY}/(\lambda_{LY} + \lambda_{LU}) > \lambda_{KX}/(\lambda_{LZ} + \lambda_{LX})$.

3.1 Capital Mobility and Agricultural Productivity

From (10) and (11), we obtain $\hat{n}/\hat{\varepsilon} > 0$ and the sign of $\hat{x}/\hat{\varepsilon}$ is ambiguous. Suppose that δ^* is the solution of $\hat{x}/\hat{\varepsilon} = 0$. If $\delta > \delta^*$, then $\hat{x}/\hat{\varepsilon} < 0$; and if $\delta < \delta^*$, then $\hat{x}/\hat{\varepsilon} > 0$. We summarized results by Lemma 1

Lemma 1 *A raise in capital mobility increases varieties in APS sector; however, its impact on a single service output depends on the size of external economies. If the size is relatively large (small), an increase in capital mobility expands (contracts) a single service output.*

A raise in capital mobility increases the capital available and reduces the interest rate in the rural area. With the decreased interest rate, the APS sector faces a lower fix cost, which grows varieties in this sector. A larger quantity of capital and varieties raises the marginal product of labor in the APS and agricultural sector, and attract labor move out of urban region. Its impact on a single service output is related to the magnitude of external economies. If the size of external economies is relatively large, an increase in varieties has a relatively large impact on agricultural output and raises the (derived) demand of APS correspondingly. At this case, a raise in capital mobility contributes to the expansion of a single service output. In contrast, if the size is relatively small, a growth of varieties has relatively little influence on the agricultural output and (derived) demand of APS accordingly. With the growth of quantity in the APS sector, a raise in capital mobility reduces a single service output.

The change of capital mobility further affects agricultural output and productivity through the APS sector. From (12), we get its impact on agricultural output and summarize it in **Proposition 1**.

Proposition 1 *A raise in capital mobility expands agricultural sector and promotes agricultural productivity.*

A raise in capital mobility promotes capital as well as labor transfer from urban to rural area, and grows the number of APS available. From results, the intermediate

input X also increases as a result of a larger mobility of capital. Therefore, a larger movement of capital raises the inputs of agriculture and its output. Meanwhile, expansion of agriculture also raises the demand for labor and intermediate input, which leads to an increase in wage rate and price of intermediate input. Under the setting, changes of two factor reward are same. If no external economies, agricultural productivity keeps the same. However, a raise in capital mobility grows the number of APS available and amplifies such external economies. Thus, a raise in capital mobility promotes agricultural productivity through the expansion of external economies.

3.2 Labor Mobility and Agricultural Productivity

Raising labor mobility means a decrease in migration cost, namely, a reduction of ρ . From (10) and (11), we obtain $\hat{n}/\hat{\rho} > 0$ and the sign of $\hat{x}/\hat{\rho}$ is ambiguous. Suppose that δ^{**} is the solution of $\hat{x}/\hat{\rho} = 0$. If $\delta > \delta^{**}$, then $\hat{x}/\hat{\rho} > 0$; and if $\delta < \delta^{**}$, then $\hat{x}/\hat{\rho} < 0$. We summarized results by Lemma 2

Lemma 2 *A raise in labor mobility decreases varieties in APS sector; its impact on a single service output depends on the size of external economies. If the size is relatively large (small), an increase in capital mobility expands (contracts) a single service output.*

A raise in labor mobility means a drop of migration cost and promotes labor mobility between rural and urban region. Manufacturing sector raises the demand for labor and capital. Due to the rigid wage in the manufacturing sector, not all migrants can employ by this sector and urban unemployment raises. In the rural area, agricultural sector employs less labor and correspondingly reduces its demands for APS. Thus, the rewards of two inputs reduces. Facing a lower demand and output price, the number of firms decreases. Its impact on a single service output depends on the change of wage rate. When the external economies are small, a drop of varieties affects the marginal product of labor insignificantly, and the reduction of wage rate mainly decided by a decline of demand. Thus, a single service firm responses in the same way and reduces its output. If the external economies are relatively large, a reduction of varieties decreases wage in a large scale. Under this case, a single service faces a much lower variable cost, which encourages it to expand the output.

The impact of an increase in labor mobility on agricultural output can be obtained from (12) and summarize it in **Proposition 2**.

Proposition 2 *An increase in labor mobility cuts down output of agricultural sector and its productivity.*

An increase in labor mobility transfers labor from rural to urban and reduces the employment in the agricultural sector. From the Lemma 2, an increase in labor mobility reduces the number of varieties in the APS sector, but the impact on the total output, nx , is ambiguous. However, the contribution of APS on agricultural sector also includes the external economies, X . After incorporating the external economies, the agricultural sector faces a less X in production and its output reduces. As the discussion in the Proposition 1, the agricultural productivity decided by the number of APS. An increase in labor mobility decreases the number of APS and reduces its productivity correspondingly.

4. Concluding remarks

Enhancing traditional agricultural productivity heavily depends on introducing modern non-agricultural inputs. However, due to small-scale operation, smallholders face numerous difficulties in utilizing modern inputs directly. The study highlights agricultural producer service sector that acts as an intermediate sector in facilitating the use of non-agricultural inputs. We build a two-layer vertical production structure in three-sector general equilibrium models to delineate this process: parts of manufacturing goods are utilized by the service sector, the outputs of which are intermediate inputs that could substitute labor in agricultural production. Under this framework, we explore the impact of factor mobility (capital and labor) on rural development. Results show that a raise in capital mobility expands agricultural sector and promotes agricultural productivity, while an increase in labor mobility cuts down output of agricultural sector and its productivity.

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