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 a three-sector general equilibrium model to investigate the relationship between imperfect factor mobility and agricultural development by incorporating agricultural producer service sector. 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

Developing economy face one permanent characteristic: dual economy structure. A dual economy refers to a structural economic framework characterized by the coexistence of two distinct sectors with different levels of development and productivity. This duality manifests as a stark contrast between a modern and industrially advanced urban alongside a traditional and backwards rural or agricultural sector. Thus, raising agricultural productivity and realizing agricultural modernization is viewed as an efficient way to end this duality.

Meanwhile, ineffective allocation of resources contributes to the low productivity of agriculture. 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 and raising agricultural productivity. Scholars use the term imperfect factor mobility to describe this issue (Casas,1984). Imperfect factor mobility characterizes the restrictions and challenges associated with the movement of production factors such as labor and capital, within a given economic systems. These resources face impediments that hinder their smooth and efficient allocation across different sectors or regions. These barriers can be rooted in various factors, including

institutional regulations, geographic constraints, and structural limitations. Recognizing and addressing these imperfections in factor mobility is essential for formulating targeted policies that can unleash the latent potential of these economies, ultimately contributing to sustainable development and economic advancement.

In addition to the aspect of imperfect factor mobility, small-scale agriculture prevails in developing countries, which also results in low agricultural productivity and hinders rural development (Sarah et al., 2016). Therefore, small-scale agriculture encounters difficulties to utilize modern advanced intermediate inputs directly. To overcome these challenges, the outsourcing of various stages of agricultural production and the procurement of services from the agricultural producer service sector are considered effective strategies to expedite the integration of non-agricultural inputs (Yang et al., 2013; Zhang et al., 2017; Belton et al., 2021).

The purpose of this study is to investigate the impacts of imperfect factor mobility on rural development with the existence of agricultural modernization in small-scale agriculture developing economy. Following Li and Fu (2022) and Li and Fu (2023), we view agricultural producer service sector as an intermediate sector to facilitate the introduction of non-agricultural intermediate inputs. 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.Literature Review

This research is closely related to two strands of the literature. The first strand documents imperfect factor mobility and its impact on economic activities. Choi and Yu (2010) analyzed the implications of imperfect mobile capital among sectors in the context of the two-sector general equilibrium model. Results show that under partially mobile capital,labor growth (capital accumulation) may destabilize sectoral capital movement and lower the welfare of a small country if the agricultural rental rate is lower (higher) than the manufacturing rental rate. Agnès and Hippolyte (2021) considered this issue from the perspective of tax competition. The conclusions show that the mobility of one factor affects the taxation of both factors, and that the "race-to-the-bottom" narrative (with burden shifting) applies essentially to capital-exporting countries. Erhan et al.(2022) formulated a multi-sector dynamic model featuring capital and labour adjustment costs and explore how different

investment frictions affect the patterns of responses of labor markets to tariff cuts. Results indicate that capital adjustment can create long-run responses of real wages that are larger than the short-run responses. Nevertheless, the impact generated byimperfect factor mobility in the presence of agricultural producer service sector on the rural development in developing countries is largely ignored. When investigating the relationship between factor mobility and rural development, scholars leave agricultural producer service aside and neglect to discuss this aspect. In reality, along with factor mobility, the factor rewards will change corresponding and further affect intermediate inputs in agriculture, exerting a neglectable impact on rural development. Thus, it is necessary to analyze howimperfect factor mobility in the presence of agricultural producer service sector influences the rural development.

This research contributes to the literature focusing on rural development or agricultural production in developing countries. A widely held consensus among scholars is that sustainable advancements in the productivity of traditional agriculture hinge on the integration of technology developed in urban sectors. While prior studies addressing the introduction of intermediate inputs in traditional agriculture predominantly examined large-scale farming, assuming direct utilization after a straightforward transformation (Yang and Zhu, 2013; Donovan, 2021), recent scholarship has increasingly turned its attention to small-scale agriculture. Notably, researchers such as Li and Fu (2022) have incorporated the agricultural producer service sector into a three-sector general equilibrium model to examine the impact of the remittance rate of migrant workers' income on environmental pollution. Furthermore, Li and Fu (2023) explored the effects of government subsidies (price, interest, and wage) to the agricultural producer service on agricultural pollution and other economic indicators, employing a comprehensive three-sector general equilibrium model. Within the frameworks proposed by Li and Fu (2022) and Li and Fu (2023), it becomes evident that intermediate inputs, agricultural producer services, and unskilled labor are complementary components influencing agricultural dynamics. However, the above-mentioned papers neglect to consider the aspect of imperfect factor mobility.

This paper plans to analyze the impacts of an increase in factor (e.g. capital and labor) mobility on rural development with the exist of agricultural producer services. We build a three-sector general equilibrium model to investigate the relationship between imperfect factor mobility and agricultural development by incorporating

agricultural producer service sector. 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.

3.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

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

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 manufacturingsector, 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 urban[1].

The market clearing condition for services is

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

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.

4.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:

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

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

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

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

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

where λ_{ij} (i=L,K; j=X,Y,Z)is the allocated shareof factor i in the jth 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 regionis larger than that of the rural region. Under this assumption, $\lambda_{KY}/(\lambda_{LY}+\lambda_{LU})>\lambda_{KX}/(\lambda_{LZ}+\lambda_{LX})$.

4.1 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 availableand 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 mobilitycontributes 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 furtheraffects 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.

4.2 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 $\hat{x}/\hat{\varepsilon} < 0$. 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 aresmall, 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.

5.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 three-sector general equilibrium model to investigate the relationship between imperfect factor mobility and agricultural development by incorporating agricultural producer service sector. 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.

Future studies can extend our analysis in the following respects. Firstly, foreign investment is one type of liberalization policy and plays an important role in economic development, we can consider the impact of imperfect factor mobility by incorporating this aspect. Secondly, improvements of factor mobility promote labor migration which further leads to structural transformation. With the existence of the agricultural producer service sector, we can analyze how imperfect factor mobility influences structural transformation in small-scale agriculture. Thirdly, the factor mobility also contributes labor mobility and further impacts on labor rewards and wage inequality. Hence, we should consider this point in future research.

References

Agnès Bénassy-Quéré and Hippolyte d'Albis.,2021. Taxing capital and labor when both factors are imperfectly mobile internationally, https://shs.hal.science/halshs-03134050.

Belton,B., Win,M.T., Zhang,X. and Filipski,M.,2021, The rapid rise of agricultural mechanization in Myanmar, *Food Policy*,101,102095.

Casas FR,1984, Imperfect factor mobility: a generalization and synthesis of two-sector models of international trade. *Canadian Journal of Economics*, 17:747-761.

Choi, Jai-young and Yu, Eden S. H., 2010,Imperfect Capital Mobility: A General Approach to the Two-Sector Harris Todaro Model, *Review of International Economics*,18, 81-94

Donovan, K. ,2021, The equilibrium impact of agricultural risk on intermediate inputs and aggregate productivity, *Review of Economic Studies*, 88, 2275-2307.

Erhan, A., Irene, B., Guido, P., 2022, Patterns of Labour Market Adjustment to Trade Shocks with Imperfect Capital Mobility, *Economic Journal*, 132(646), 2048–2074.

Gilbert, John and Oladi, Reza, 2009. Capital specificity, imperfect labor mobility and growth in developing economies,International Review of Economics & Finance, 18(1), 113-122,

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.

Restuccia, Diego, Dennis Tao Yang, and Xiaodong Zhu. 2008. Agriculture and Aggregate Productivity: A Quantitative Cross-Country Analysis.*Journal of Monetary Economics*, 55(2): 234-250.

Rosenzweig, M., 1988. Labor markets in low-income countries. In: Chenery, H., Srinivasan, T.N. (Eds.), Handbook of Development Economics, vol. 1, Part II. North-Holland, New York, pp. 713-762.

Sarah, L.,Jakob, S.and Terri, R.(2016).The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide, *World Development*, 87,16-29.

Yang, D. and X. Zhu.,2013, Modernization of Agriculture and Long-Term Growth. *Journal of Monetary Economics* 60,367-382.

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, 1245-1251.

Zhang, X., Yang, J., & Thomas, R. ,2017, Mechanization outsourcing clusters and division of labor in Chinese agriculture. *China Economic Review*, 43, 184-195.