Chapter 11
Analyzing the Effect of Advanced Agriculture Development Policy

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Abstract This chapter broadens the scope of current theoretical studies, divides rural agriculture into two sectors—advanced and traditional—and takes into consideration the land factor and the urban informal sector. Under the assumption that wages in the advanced agricultural sector are higher than in the traditional agricultural sector, this chapter analyzes the effect of policies to promote advanced agricultural development with the comparative static method. The main conclusions of this chapter are wage subsidization of the advanced agricultural sector, in addition to having the same economic impact as interest subsidies on the advanced agricultural sector, could also increase the land employment in the advanced agricultural sector, and reduce that in the traditional agricultural sector. Therefore, the effect of wage subsidizing policies is stronger than that of interest subsidies, while land rent subsidies for the advanced agricultural sector have the same economic effect as wage subsidies.

Keywords Advanced agriculture • Traditional agriculture • Transfer of labor

JEL Code J60 • I30 • R10

1 Introduction

When studying economic development and transfer of labor, the urban economy is often divided into two sectors, namely, the formal and the informal ones. Since the 1990s, using the Harris-Todaro model (Harris and Todaro 1970) to study the transfer of rural labor to the urban formal and informal sectors has been a hot topic, on which Grinols (1991), Gupta (1993), Chandra and Khan (1993), Din (1996), and Yabuuchi and Beladi (2001) all have published papers.

In recent years, there have been studies that further divide the rural labor market into the advanced and the traditional agricultural sectors. This is because many

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emerging economies like India, China, and Brazil are making great effort under the market principle to introduce advanced agricultural equipment and technology to develop their agricultural industry, resulting in higher yields compared to traditional agricultural methods.

The existing literature considering advanced agriculture and the transfer of labor adopts two main research methods: one divides the economy into three sectors, namely, the urban sector, the advanced agricultural sector, and the traditional agricultural sector, and studies the economic effect of policies on promoting the development of the advanced agricultural sector assuming the transfer of rural labor. The other divides the economy into four sectors. The urban sector is divided into formal and informal, while the rural sector is divided into advanced agricultural and traditional agricultural, and studies the economic effects of government policies that promote the development of the advanced agricultural sector.

The literature using the three-sector model includes Chaudhuri (2006, 2007), Li and Shen (2012), and so on. Chaudhuri (2006) analyzes the rationality and importance of reforming the labor market in developing countries with the three-sector general equilibrium model. His research shows that, under certain circumstances, liberalization of the labor market can lead to an increase in the rural wage ratio, a decrease in the ratio of return on the land capital, a decrease in the urban wage, and an increase in social welfare. Chaudhuri (2007) analyzes the reasons developing countries attract external capital and the rise of unemployment during the reform process. He discovers that increased foreign capital can improve social welfare and reduce the urban unemployment rate.

Li and Shen (2012), on the other hand, study the economic effect of government development policies to introduce urban private capital to the advanced agricultural sector. Their main conclusion is that interest subsidizing policies could reduce the transfer of rural labor to urban areas, but such policies could also promote the transfer of rural labor to the advanced agricultural sector. Wage subsidizing policies could lead to an increase of the urban unemployment rate and a decrease of the laborers in the traditional agricultural sector.

The four-sector research examines past divisions in the urban economy to study the relationship between the employment situation of rural laborers upon entering cities and the development of advanced agriculture. Among the literature using the four-sector model, Gupta (1997a) analyzes the impact of the changes of product price markets in a less-developed, small, but open economy on formal and informal capital. His study finds that subsidizing the product prices in the advanced agricultural sector could be conducive to economic development. Gupta (1997b) uses the four-sector general equilibrium model to prove the invalidity of the Brecher-Alejandro (1977) proposition under the premise of introducing external capital and the existence of the costs of transfer and human resources training.

Though the above research, whether adopting the three-sector or four-sector model, show different advantages, they also have limitations. First, the research does not explicitly count the land factor as part of the production function, whereas land is an important factor in both the advanced and traditional agricultural sectors. Second, Gupta (1997a, b) and Chaudhuri (2006, 2007) made the same assumption that the wages in the advanced and traditional agricultural sectors are the same,

which defies the purpose of advancement in agricultural production and fails to account for the theoretical motivation of the transfer of labor from the traditional agricultural sector to the advanced one. Generally, the main incentive for labor transfer is wage level—homogenous labor in the lower wage sector will transfer to the higher one. If the wage in the advanced agricultural sector equals that of the traditional one, it is difficult to guarantee sufficient labor force for the advanced sector. This assumption is also out of synch with the reality of the development of the advanced agricultural sector in developing countries. For example, in China, wages in the advanced agricultural sector are obviously higher than in the traditional one.[1] On the other hand, though Li and Shen's (2012) study took into consideration the wage difference between the two agricultural sectors, their model neglects the employment situation of rural laborers after entering the cities and the rural land factor, which cannot be disregarded in the real economy.

Under more general conditions, in order to clarify the policy effect of promoting advanced agricultural development, this chapter assumes different wage levels in the advanced and traditional agricultural sectors, takes into consideration the land factor of the urban informal sector, and analyzes the effect of policies to promote advanced agricultural development with the comparative static method:

1. Subsidizing capital interest for the advanced agricultural sector
2. Subsidizing wages for the advanced agricultural sector
3. Subsidizing land rent for the advanced agricultural sector
4. Change of labor and capital endowment in the economy

This chapter broadens the scope of current theoretical studies and finds that wage subsidization for the advanced agricultural sector, in addition to the same economic impact as the interest subsidies on the advanced agricultural sector, could also increase land employment in the advanced agricultural sector and reduce that in the traditional agricultural sector. Therefore, the effect of wage subsidizing policies is better than that of interest subsidies, but land rent subsidies for the advanced agricultural sector will have the same economic effect as wage subsidies. In the second part of this chapter, we establish a general equilibrium model, in the third part we present a theoretical analysis based on the established model, and in the fourth part we offer a conclusion.

2 Model

In this chapter, we assume a four-sector closed economy. The four sectors are the urban formal sector, the urban informal sector, the advanced agricultural sector, and the traditional agricultural sector. Among them, the advanced agricultural sector is

[1]Please refer to Zheng et al. (2009), analysis on the target and model of modern high-efficiency agricultural development.

a newly established one. The urban formal sector uses two factors of production: labor and capital. The urban informal sector only uses one factor: labor. The advanced agricultural sector uses three factors: labor, capital, and land. And the traditional agricultural sector uses labor and land. The labor of the traditional agricultural sector moves to the urban formal sector, the urban informal sector, and the advanced agricultural sector. Capital flows freely between the urban formal and advanced agricultural sectors. Land flows freely between the traditional and advanced agricultural sectors. The production functions of each of the said sectors are:

$$Y_1 = F^1(L_1, K_1) \tag{11.1}$$

$$Y_2 = F^2(L_2) \tag{11.2}$$

$$Y_3 = g(K_3)F^3(L_3, T_3) \tag{11.3}$$

$$Y_4 = F^4(L_4, T_4) \tag{11.4}$$

$Y_i (i = 1, 2, 3, 4)$ indicates the output of the urban formal sector, the urban informal sector, the advanced agricultural sector, and the traditional agricultural sector, respectively. $L_i, (i = 1, 2, 3, 4)$ indicates the quantity of labor of each sector. K_1 and K_3 indicate the capital investment in the urban formal sector and the advanced agricultural sector, respectively. T_3 and T_4 indicate the land investment in the modern and traditional agricultural sectors, respectively. $g = g(K_3)$ can be deemed as the scale effect function of the investment in the advanced agricultural sector. We assume that when $K_3 = 0$, $g(0) = 1$, which means, when lacking capital investment, the advanced agricultural sector will retrograde to the traditional agricultural sector. In addition, we also assume that $g(K_3) > 1$, $g'(K_3) > 0$, $g''(K_3) < 0$, and $\forall K_3 > 0$. The production functions Y_1, Y_2, Y_3, and Y_4 are strictly quasi concave, among which Y_1, Y_2, and Y_4 are first-order homogeneous and Y_3 satisfies the feature of increasing return to scale.

We also assume that the transfer of labor from the traditional to the advanced agricultural sector is not limitless. In the early establishment of the advanced agricultural sector, the quantity of labor transferred from the traditional agricultural sector is bound by the capital of the advanced agricultural sector. The relationship between its employed labor and capital is as follows:

$$L_3 = \begin{cases} f(K_3), f'(K_3) > 0, f''(K_3) < 0, K_3 < K_3^* \\ f(K_3^*), \quad f'(K_3^*) = 0, K_3 = K_3^* \\ f(K_3), f'(K_3) \leq 0, f''(K_3) > 0, K_3 > K_3^* \end{cases} \tag{11.5}$$

It should be noted that the first half of Eq. (11.5) describes the development period of advanced agriculture, on which this chapter is focusing.

Using L, K, and T to indicate the endowment of labor, capital, and land in the entire economy, which are all exogenous, we have the following equations under the condition of full employment:

$$L_1 + L_2 + L_3 + L_4 = L. \tag{11.6}$$

$$K_1 + K_3 = K \tag{11.7}$$

$$T_3 + T_4 = T \tag{11.8}$$

$\bar{w_1}$, w_2, w_3, and w_4 indicate the wages in the urban formal sector, the urban informal sector, the advanced agricultural sector, and the traditional agricultural sector, respectively. r and τ indicate the return of capital and land, respectively. To maximize the profit of each sector, we have the following equations:

$$p_1 F_L^1 = \overline{w_1} \tag{11.9}$$

$$p_2 F_L^2 = w_2 \tag{11.10}$$

$$p_3 g F_L^3 = w_3 \tag{11.11}$$

$$F_L^4 = w_4 \tag{11.12}$$

$$p_1 F_K^1 = r \tag{11.13}$$

$$p_3 g' F^3 = r \tag{11.14}$$

$$p_3 g F_T^3 = \tau \tag{11.15}$$

$$F_T^4 = \tau \tag{11.16}$$

In the above, $F_L^i = \partial F^i / \partial L_i$ $(i = 1, 2, 3, 4)$; $F_K^i = \partial F^i / \partial K_i$ $(i = 1, 3)$; $F_T^i = \partial F^i / \partial T_i (i = 3, 4)$; because of labor unions and ubiquitous local protectionism, the wage in the urban formal sector shows a downward rigidity, so $\bar{w_1}$ is an exogenous variable; p_1, p_2, and p_3 refer to the product price in the urban formal sector, the urban informal sector, and the advanced agricultural sector, in terms of the product price in the traditional agricultural sector.

We assume that labor moves from the traditional agricultural sector to the advanced agricultural sector, the urban formal and informal sectors. Thus, according to Harris-Todaro model, when the transfer of labor reaches equilibrium, the labor wage of the rural traditional agricultural sector should be equal to the expected wage of the other three sectors:

$$\frac{L_1\overline{w_1} + L_2w_2 + L_3w_3}{L_1 + L_2 + L_3} = w_4 \tag{11.17}$$

To transform Eq. (11.17), we get

$$L_1\overline{w_1} + L_2w_2 + L_3w_3 = w_4(L - L_4) \tag{11.17'}$$

The presumption of the above equation is the wage in the urban formal sector and the advanced agricultural sector is higher than the wage in the traditional one, so labor in the traditional sector would transfer to the advanced agricultural sector and the urban formal sector. However, it is easy to observe that $w_4 > w_2$, and one possible explanation for the transfer of traditional sector labor to the urban informal sector with lower wages is that migrant workers "temporarily" transfer to the urban informal sector to wait for job opportunities and higher wages in the urban formal sector. Up to now we have established the model. From Eqs. (11.1), (11.2), (11.3), (11.4), (11.5), (11.6), (11.7), (11.8), (11.9), (11.10), (11.11), (11.12), (11.13), (11.14), (11.15), (11.16), and (11.17), there are altogether 17 endogenous variables, which are Y_1, Y_2, Y_3, Y_4, L_1, L_2, L_3, L_4, K_1, K_3, T_3, T_4, w_2, w_3, w_4, r, and τ, and seven exogenous variables, L, K, T, $\bar{w}_1$, p_1, p_2, and p_3.

3 Economic Analysis

This section focuses on the economic effect of interest, wage, and land subsidies on the advanced agricultural economy. We will also discuss the effect of increasing the endowment of factors on the economy.

3.1 The Economic Effect of Interest Subsidies on the Advanced Agricultural Sector

If the government subsidizes the interest of loans for the advanced agricultural sector with the rate of s_1, Eq. (11.14) can be rewritten as:

$$p_2g'(K_2)F^2 = r(1 - s_1) \tag{11.14'}$$

Then, the total differential of (11.5), (11.6), (11.7), (11.8), (11.9), (11.10), (11.11), (11.12), (11.13), (11.14′), (11.15), (11.16), and (11.17′) is:

$$\begin{bmatrix} F^1_{LL} & 0 & 0 & -F^1_{LK} & 0 & 0 & 0 \\ 0 & 0 & 0 & p_3\left(g'F^3_L + gF^3_{LL}f'\right) & p_3gF^3_{LT} & -1 & 0 \\ 0 & 0 & F^4_{LL} & 0 & -F^4_{LT} & 0 & -1 \\ p_1F^1_{KL} & 0 & 0 & -\left[p_1F^1_{KK} + p_3\left(g''F^3 + g'F^3_Lf'\right)\right] & -p_3g'F^3_T & 0 & 0 \\ 0 & 0 & -F^4_{TL} & p_3\left(g'F^3_T + gF^3_{TL}f'\right) & p_3gF^3_{TT} + F^4_{TT} & 0 & 0 \\ 1 & 1 & 1 & f' & 0 & 0 & 0 \\ \overline{w_1} & w_2 + L_2p_2F^2_{LL} & w_4 & w_3f' & 0 & L_3 & -(L - L_4) \end{bmatrix}$$

$$\times \begin{bmatrix} dL_1 \\ dL_2 \\ dL_4 \\ dK_3 \\ dT_3 \\ dw_3 \\ dw_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ rds_1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

The coefficient matrix (11.18) is:

$$\begin{aligned} \Delta_1 = \; & p_3F^1_{LL}\left(g''F^3 + g'F^3_Lf'\right)\left[w_2 + L_2p_2F^2_{LL} - w_4 + F^4_{LL}(L - L_4)\right]\left(p_3gF^3_{TT} + F^4_{TT}\right) \\ & -p_1F^4_{TL}F^1_{KL}F^1_{LK}p_3gF^3_{LT}(L - L_4) - p_3g'F^3_TF^4_{TL}F^1_{LK}\left(w_2 + L_2p_2F^2_{LL} - \overline{w_1}\right) \\ & -p^2_3g'F^1_{LL}F^3_T\left(g'F^3_T + gF^3_{TL}f'\right)\left[w_2 + L_2p_2F^2_{LL} - w_4 + F^4_{LL}(L - L_4)\right] \\ & +p_3g'F^3_TF^1_{LL}F^4_{LT}\left[w_3f' - \left(w_2 + L_2p_2F^2_{LL}\right)f' + p_3L_3\left(g'F^3_L + gF^3_{LL}f'\right)\right] \\ & -F^4_{TL}F^4_{LT}(L - L_4)p_3F^1_{LL}\left(g''F^3 + g'F^3_Lf'\right) \end{aligned}$$

Since the sign of Δ_1 cannot be directly determined, we will use dynamic adjustment to decide its sign. The process detail is explained in Appendix A. After the dynamic adjustment, we get $\Delta_1 > 0$.

Before solving Eq. (11.18), we will prove the following two lemmas.

Lemma 11.1 When $f' > 0$, the assumed economy in this chapter satisfies the inequality $p_3\left(g''F^3 + g'f'F^3_L\right) < 0$.

Proof The total differential of Eq. (11.14) is:

$$p_3g''F^3(L_3)dK_3 + p_3g'F^3_L(L_3)f'dK_3 = dr.$$

Therefore,

$$p_3g''F^3(L_3) + p_3g'F^3_L(L_3)f' = dr/dK_3.$$

With increasing inflow of capital to the advanced agricultural sector, its interest rate should fall. So we have $dr/dK_3 < 0$, and $f' > 0$, which means $p_3\left(g''F^3 + g'f'F^3_L\right) < 0$. End of proof.

Lemma 11.2 In the assumed economy in this chapter, when $f' > 0$, $g'F^3_L + gF^3_{LL}f' > 0$.

Table 11.1 The calculation result of Eq. (11.18) (please refer to Appendix B for details of the calculation procedure)

	dL_1	dL_2	dL_3	dL_4	dK_1	dK_3	dT_3	dT_4	dr	dw_2	dw_3	dw_4	$d\tau$
ds_1	−	/	+	/	−	+	/	/	0	/	/	/	/

Note: "−" means that the ratio of the items in the above horizontal column to ds_1 is negative, "+" means the ratio is positive, and "/" means the sign cannot be decided

Proof The total differential of Eq. (11.11) can be written as the following equation:

$$p_3\left(g'F_L^3 + gF_{LL}^3 f'\right)dK_3 = dw_3.$$

It should be noted that $dw_3/dK_3 > 0$ (this is because, with the increase of urban capital flowing to the advanced agricultural sector, rural labor will become more condensed, and rising wage is the main force increasing labor condensation), it could be inferred that $g'F_L^3 + gF_{LL}^3 f' > 0$. End of proof.

Using the Cramer rule to solve Eq. (11.18) and Lemma 11.2, we can get Table 11.1 as follows:

Proposition 11.1 The interest subsidies for the advanced agricultural sector will not affect the interest rate but will have the following economic impacts:

1. Reducing the labor and capital employment in the urban formal sector
2. Increasing the labor and capital employment in the advanced agricultural sector

The essence of subsidizing capital interest for the advanced agricultural sector is to make the capital using interest of advanced sector smaller than urban formal sector and then reduce the capital using cost of advanced sector. Using a two-sector (urban sector and rural sector) Harris-Todaro framework, Khan and Naqvi (1983) and Chao and Yu (1992) analyze the economic impacts of reduction in the capital differential, respectively; their main researches are the impacts of change in the capital differential on social welfare, but Proposition 11.1 in this chapter considers more impacts.

Subsidizing capital interest for the advanced agricultural sector will cause more capital from the urban formal sector to flow to the advanced agricultural sector, and thus the capital utilization environment of the advanced agricultural sector will improve, as will the working environment. In the early period of establishing the advanced agricultural sector, the improvement of the working environment will attract more rural labor to transfer to the advanced agricultural sector and less to the urban formal environment, which is indicated by Proposition 11.1. It is worth noting that Proposition 11.1 in this chapter is different from the three-sector model which considers unemployment in Li and Shen (2012). Proposition 11.1 cannot determine whether interest subsidies for the advanced agricultural sector will reduce labor employment in the traditional sector or not, but Li and Shen (2012) unambiguously conclude that they will. This difference can be explained by

Table 11.2 The calculation result of Eq. (11.19) (please refer to Appendix B for the details of the calculation process)

	dL_1	dL_2	dL_3	dL_4	dK_1	dK_3	dT_3	dT_4	dr	dw_2	dw_3	dw_4	$d\tau$
ds_2	−	/	+	/	−	+	+	−	0	/	/	/	/

Note: The meaning of above signs is the same as in Table 11.1

this four-sector model: the interest subsidies for the advanced agricultural sector will reduce employment in the urban formal sector, which lowers the expectation of transferring to the urban formal sector for the labors in the urban informal sector. As a result, labor transferring to the urban sector declines. Therefore, if the increased labor transfer to the advanced agricultural sector is smaller than the decrease in those to the urban sector, employment in the traditional agricultural sector will rise.

3.2 *The Economic Effect of Wage Subsidies for the Advanced Agricultural Sector*

If the government subsidizes the wages of the advanced agricultural sector at the rate of s_2, then Eq. (11.11) becomes:

$$p_3 g F_L^3 = w_3(1 - s_2) \tag{11.11'}$$

The total differential of (11.5), (11.6), (11.7), (11.8), (11.9), (11.10), (11.11′), (11.12), (11.13), (11.14), (11.15), (11.16), and (11.17′) is:

$$\begin{bmatrix} F_{LL}^1 & 0 & 0 & -F_{LK}^1 & 0 & 0 & 0 \\ 0 & 0 & 0 & p_3\left(g'F_L^3 + gF_{LL}^3 f'\right) & p_3 g F_{LT}^3 & -1 & 0 \\ 0 & 0 & F_{LL}^4 & 0 & -F_{LT}^4 & 0 & -1 \\ p_1 F_{KL}^1 & 0 & 0 & -\left[p_1 F_{KK}^1 + p_3\left(g'' F^3 + g' F_L^3 f'\right)\right] & -p_3 g' F_T^3 & 0 & 0 \\ 0 & 0 & -F_{TL}^4 & p_3\left(g'F_T^3 + gF_{TL}^3 f'\right) & p_3 g F_{TT}^3 + F_{TT}^4 & 0 & 0 \\ 1 & 1 & 1 & f' & 0 & 0 & 0 \\ \overline{w_1} & w_2 + L_2 p_2 F_{LL}^2 & w_4 & w_3 f' & 0 & L_3 & -(L - L_4) \end{bmatrix} \times \begin{bmatrix} dL_1 \\ dL_2 \\ dL_4 \\ dK_3 \\ dT_3 \\ dw_3 \\ dw_4 \end{bmatrix} = \begin{bmatrix} 0 \\ -w_3 ds_2 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \tag{11.19}$$

It could be calculated that the value of the coefficient matrix (11.19) is Δ_1.

Using the Cramer rule to solve Eq. (11.19) and Lemma 11.1, we can get Table 11.2 as follows:

To summarize, we obtain Proposition 11.2:

Proposition 11.2 In addition to having the same economic effect as Proposition 11.1, wage subsidies for the advanced agricultural sector will also increase the land use of the advanced agricultural sector and reduce that of the traditional agricultural sector.

There are some researches considering wage subsidies to rural sector in the existing theoretical literatures which consider labor transfer, most of them build a two-sector (manufacturing sector and rural sector) or three-sector (manufacturing sector, informal sector, and rural sector) model and don't set apart the rural sector. For example, in the two-sector researches, Corden and Findlay (1975) draw a conclusion that in the absence of capital mobility, a wage subsidy in agriculture leaves output of manufactures unchanged, while capital mobility will bring about some fall in output of manufactures. McCool (1982) concludes that a subsidy to agricultural wages does not affect wages in the manufacturing sector neither does it affect the gross return to capital or the capital intensity in either sector. In the three-sector models, the economic impacts of wage subsidy on the agriculture mostly relate to labor employment and social welfare. Gupta (1993) concludes that a wage subsidy to the rural sector increases the level of unemployment when the informal sector produces non-trade intermediate goods. Under the assumption that capital in the urban formal sector is internationally mobile and rural capital is specific, Din (1996) concludes that a rural wage subsidy raises the rural output and the return to capital specific to rural sector, depresses the outputs of both urban region, and leaves national welfare unchanged. Under the general informal sector condition, Yabuuchi and Beladi (2001) get that wage subsidies to the rural sector, improve national welfare, and decrease the level of unemployment. Though Proposition 11.2 in this chapter has some differences with the above researches, because this chapter divides the rural sector into two parts, so Proposition 11.2 in this chapter is more accurate and applicable than the existing researches.

Using the advanced agricultural sector as an example, the wage subsidies for the advanced agricultural sector would have no effect on employment and capital level in this sector in Li and Shen (2012). However, this chapter shows that wage subsidies could increase the labor and capital employment. The reason for the distinction is that wage subsidies in the three-sector model would not affect capital employment in the advanced agricultural sector, but will increase capital employment in this sector under the four-sector model that this chapter applies. Further, increase in capital employment would lead to increase in labor employment and thus would affect the entire economy.

Compared to interest rate subsidizing policies, wage subsidies for the advanced agricultural sector decrease the cost of labor employment and have a more direct impact of increasing labor employment in this sector. Under the condition that the production technology level does not change in the short run, the production scale

Table 11.3 The calculation result of Eq. (11.20) (please refer to Appendix B for the details of the calculation procedure)

	dL_1	dL_2	dL_3	dL_4	dK_1	dK_3	dT_3	dT_4	dr	dw_2	dw_3	dw_4	$d\tau$
ds_3	−	/	+	/	−	+	+	−	0	/	/	/	/

Note: The meaning of above signs is the same as in Table 11.1

of this sector must increase, as does land employment. However, the source of land is only the traditional agricultural sector, which is indicated by Proposition 11.2.

3.3 *The Economic Impact of Land Subsidies for the Advanced Agricultural Sector*

If the government subsidizes land for the advanced agricultural sector with the rate of s_3, then Eq. (11.15) becomes:

$$p_3 g F_T^3 = \tau(1 - s_3) \tag{11.15'}$$

The total differential of (11.5), (11.6), (11.7), (11.8), (11.9), (11.10), (11.11), (11.12), (11.13), (11.14), (11.15′), (11.16), and (11.17′) is:

$$\begin{bmatrix} F_{LL}^1 & 0 & 0 & -F_{LK}^1 & 0 & 0 & 0 \\ 0 & 0 & 0 & p_3\left(g'F_L^3 + gF_{LL}^3 f'\right) & p_3 g F_{LT}^3 & -1 & 0 \\ 0 & 0 & F_{LL}^4 & 0 & -F_{LT}^4 & 0 & -1 \\ p_1 F_{KL}^1 & 0 & 0 & -\left[p_1 F_{KK}^1 + p_3\left(g'' F^3 + g' F_{LF}^3 f'\right)\right] & -p_3 g' F_T^3 & 0 & 0 \\ 0 & 0 & -F_{TL}^4 & p_3\left(g'F_T^3 + gF_{TL}^3 f'\right) & p_3 g F_{TT}^3 + F_{TT}^4 & 0 & 0 \\ 1 & 1 & 1 & f' & 0 & 0 & 0 \\ \overline{w_1} & w_2 + L_2 p_2 F_{LL}^2 & w_4 & w_3 f' & 0 & L_3 & -(L - L_4) \end{bmatrix} \times \begin{bmatrix} dL_1 \\ dL_2 \\ dL_4 \\ dK_3 \\ dT_3 \\ dw_3 \\ dw_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ -\tau ds_3 \\ 0 \\ 0 \end{bmatrix} \tag{11.20}$$

Apparently, the value of the coefficient matrix (11.20) is Δ_1.

Using the Cramer rule to solve Eq. (11.20) and according to the Lemmas 11.1 and 11.2, we get Table 11.3 as follows:

To summarize, we obtain Proposition 11.3:

Proposition 11.3 The economic effect of both land subsidies and wage subsidies in the advanced agricultural sectors is the same.

Land subsidies for the advanced agricultural sector will reduce the cost of land use in this sector and thus increase the land use. It should be noted that, compared to interest and wage subsidies, land subsidies for the advanced agricultural sector would have a more direct impact on increasing land use in this sector. Assuming that the production technology level does not change in the short run, the production scale of this sector must increase, as will the employment of labor and capital. The source of labor is the laborers who would have moved to the urban formal sector; the source of capital is from the urban formal sector. This is indicated by Proposition 11.3. Besides, except this chapter, the existing four-sector models (such as Gupta (1997a), and Beladi et al. (2010)) don't take into account the land factor, so our conclusion regarding land subsidies for the advanced agricultural sector is new.

3.4 The Impact of Changes in Labor and Capital Endowment on the Economy

When the labor endowment increases, the total differential of (11.5), (11.6), (11.7), (11.8), (11.9), (11.10), (11.11), (11.12), (11.13), (11.14), (11.15), (11.16), and (11.17′) is the following Eq. (11.21):

$$\begin{bmatrix} F_{LL}^1 & 0 & 0 & -F_{LK}^1 & 0 & 0 & 0 \\ 0 & 0 & 0 & p_3\left(g'F_L^3 + gF_{LL}^3 f'\right) & p_3 g F_{LT}^3 & -1 & 0 \\ 0 & 0 & F_{LL}^4 & 0 & -F_{LT}^4 & 0 & -1 \\ p_1 F_{KL}^1 & 0 & 0 & -\left[p_1 F_{KK}^1 + p_3\left(g''F^3 + g'F_L^3 f'\right)\right] & -p_3 g' F_T^3 & 0 & 0 \\ 0 & 0 & -F_{TL}^4 & p_3\left(g'F_T^3 + gF_{TL}^3 f'\right) & p_3 g F_{TT}^3 + F_{TT}^4 & 0 & 0 \\ 1 & 1 & 1 & f' & 0 & 0 & 0 \\ \overline{w_1} & w_2 + L_2 p_2 F_{LL}^2 & w_4 & w_3 f' & 0 & L_3 & -(L - L_4) \end{bmatrix} \times \begin{bmatrix} dL_1 \\ dL_2 \\ dL_4 \\ dK_3 \\ dT_3 \\ dw_3 \\ dw_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ dL \\ w_4 dL \end{bmatrix} \tag{11.21}$$

Apparently, the value of the coefficient matrix (11.21) is Δ_1.

When the capital endowment increases, the total differential of (11.5), (11.6), (11.7), (11.8), (11.9), (11.10), (11.11), (11.12), (11.13), (11.14), (11.15), (11.16), and (11.17′) is (11.22):

$$\begin{bmatrix} F_{LL}^1 & 0 & 0 & -F_{LK}^1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & p_3\left(g'F_L^3 + gF_{LL}^3 f'\right) & p_3 gF_{LT}^3 & -1 & 0 \\ 0 & 0 & F_{LL}^4 & 0 & 0 & -F_{LT}^4 & 0 & -1 \\ p_1 F_{KL}^1 & 0 & 0 & p_1 F_{KK}^1 & -p_3\left(g'' F^3 + g' F_L^3 f'\right) & -p_3 g' F_T^3 & 0 & 0 \\ 0 & 0 & -F_{TL}^4 & 0 & p_3\left(g' F_T^3 + gF_{TL}^3 f'\right) & p_3 gF_{TT}^3 + F_{TT}^4 & 0 & 0 \\ 1 & 1 & 1 & 0 & f' & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ \overline{w_1} & w_2 + L_2 p_2 F_{LL}^2 & w_4 & 0 & w_3 f' & 0 & L_3 & -(L - L_4) \end{bmatrix} \times \begin{bmatrix} dL_1 \\ dL_2 \\ dL_4 \\ dK_1 \\ dK_3 \\ dT_3 \\ dw_3 \\ dw_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ dK \\ 0 \end{bmatrix} \tag{11.22}$$

We assume that the value of the coefficient matrix (11.22) is Δ_2, and then we can calculate that $\Delta_2 = -\Delta_1$.

Using the Cramer rule and according to Lemmas 11.1 and 11.2, we get the following Table 11.4:

To summarize, we obtain Propositions 11.4 and 11.5.

Proposition 11.4 The increase of labor endowment does not affect interest, but it has the following economic impacts:

1. Increase the labor and capital employment of the urban formal sector
2. Decrease the labor, capital, and land employment of the advanced agricultural sector
3. Increase the land employment of the traditional agricultural sector

Proposition 11.5 The increase of capital endowment does not affect interest, but it has the following economic impact:

1. The employment of labor, capital, and land in the advanced agricultural sector increases, and its wage increases.

Table 11.4 The result of the change of capital and labor endowment (please refer to Appendix C for the detailed calculation)

	dL_1	dL_2	dL_3	dL_4	dK_1	dK_3	dT_3	dT_4	dr	dw_2	dw_3	dw_4	$d\tau$
dL	+	/	−	/	+	−	−	+	0	/	/	/	/
dK	/	/	+	−	/	+	+	−	0	/	+	/	/

Note: The meaning of above signs is the same as in Table 11.1

2. The employment of labor and land of the traditional agricultural sector decreases.

The analysis of economic impacts of changes in factor endowment on the rural sector is a classic theme in the existing labor transferring researches. These researches always take the rural sector as a whole and focus on the impacts of factor endowment changes on labor employment and social welfare, among which Beladi and Naqvi (1988) is a typical one. Beladi and Naqvi (1988) take land factor into account in their model and conclude that increase in capital endowment will reduce urban unemployment rate and increase in labor endowment aggravates urban unemployment. On the other hand, Yabuuchi (1998) finds the relationship between capital endowment and labor employment through the analysis of unemployment rate; he concludes that with certain condition, increase in capital endowment leads to a fall in urban unemployment. Because this chapter segments the rural sector, so we could discuss the impacts of endowment changes on the economy more explicitly, in especial we could separately analyze the impacts on the two rural sectors. From Propositions 11.4 and 11.5, the impacts of endowment changes on the two rural sectors are different, so the different impacts can't be summarized through a one-rural-sector model; furthermore, this difference didn't get reflected in the previous researches.

The increase of labor endowment means the increase of labor supply; when we consider the four-sector model which contains advanced agricultural sector, Proposition 11.4 tells us the increase of labor supply will raise the labor employment of the urban formal sector. The decrease in the labor employment of the advanced sector is, on the other hand, due to the decrease of capital employment in the advanced sector, and hence the decrease of land employment, the reduced land employment in the advanced agricultural sector, then returns to the traditional agricultural sector. In the three-sector model of Li and Shen (2012), the increase in labor endowment is absorbed by unemployment in the urban sector. The increase of capital endowment mainly affects the formal sector and the advanced agricultural sector, both of which use capital. With the increased use of capital by the advanced agricultural sector, its employment increases. The source of labor is the traditional agricultural sector, which then results in decreased employment in this sector. On the other hand, the reason the advanced sector is able to attract labor is because of its rising wages, which are indicated by Proposition 11.5. But in the three-sector model, the increase of capital endowment has no effect on capital, labor employment, and wages in the advanced agricultural sector.

4 Conclusion

This chapter establishes a four-sector model and analyzes the economic effect of the policies to promote the development of the advanced agriculture. The main content of this chapter includes the development policies commonly involved in

mainstream economic analyses and their effect on economic development. We determined from our analysis that interest, wage, and land rent subsidization policies have a similar effect on labor and capital employment. This provides a good policy environment for the development of the advanced agricultural sector and broadens the scope of policy choices. According to Propositions 11.1 and 11.2, compared to interest subsidies for the advanced agricultural sector, wage and land subsidies would have a stronger effect on the development of advanced agricultural sector and should be the first choice for policymakers. In addition, in this chapter, we also compared some of our conclusions with those of three-sector and four-sector models. Generally, when the unemployment problem is significant in the economy, the conclusions based on a three-sector model considering unemployment rate should be adopted, but when the urban informal sector is growing and taking a larger part of the economy, the conclusions of this chapter should be considered. However, we would also like to explain that, in our established model, there are still some undecided items which need to be determined under some specific conditions. Furthermore, wage and rent subsidization policies have a more direct impact on land employment than interest subsidization policies. With respect to economic development, we determined that increasing capital endowment in the economy increases wages in the advanced agricultural sector. These conclusions will provide guidance to policymakers in their all-important task of rural development.

Appendices

Appendix A

The dynamic adjustment procedure:

$$\dot{L}_1 = d_1\left(p_1 F_L^1 - \overline{w_1}\right) \tag{11.A1}$$

$$\dot{L}_2 = d_2\left(p_2 F_L^2 - w_2\right) \tag{11.A2}$$

$$\dot{L}_3 = d_3\left(p_3 g F_L^2 - w_3\right) \tag{11.A3}$$

$$\dot{L}_4 = d_4\left(F_L^4 - w_4\right) \tag{11.A4}$$

$$\dot{K}_1 = d_5\left(p_1 F_K^1 - r\right) \tag{11.A5}$$

$$\dot{K}_3 = d_6\left(p_3 g' F^3 - r\right) \tag{11.A6}$$

$$\dot{T}_3 = d_7\left(p_3 g F_T^3 - \tau\right) \tag{11.A7}$$

$$\dot{T}_4 = d_8\left(F_T^4 - \tau\right) \tag{11.A8}$$

$$\dot{w}_2 = d_9(L_1 + L_2 + L_3 + L_4 - L) \tag{11.A9}$$

$$\dot{w}_3 = d_{10}(L_3 - f(K_3)) \tag{11.A10}$$

$$\dot{w}_4 = d_{11}(L_1\overline{w_1} + L_2 w_2 + L_3 w_3 - (L - L_4)w_4) \tag{11.A11}$$

$$\dot{r} = d_{12}(K_1 + K_3 - K) \tag{11.A12}$$

$$\dot{\tau} = d_{13}(T_3 + T_4 - T) \tag{11.A13}$$

The total differential of (11.A1), (11.A2), (11.A3), (11.A4), (11.A5), (11.A6), (11.A7), (11.A8), (11.A9), (11.A10), (11.A11), (11.A12), and (11.A13) can be written as the following Jacobian matrix:

$$
\begin{aligned}
|J| &= \begin{bmatrix}
d_1p_1F_{LL}^1 & 0 & 0 & 0 & d_1p_1F_{LK}^1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & d_2p_2F_{LL}^2 & 0 & 0 & 0 & 0 & 0 & 0 & -d_2 & 0 & 0 & 0 & 0 \\
0 & 0 & d_3p_3gF_{LL}^3 & 0 & 0 & d_3p_3g'F_L^3 & d_3p_3gF_{LT}^3 & 0 & 0 & -d_3 & 0 & 0 & 0 \\
0 & 0 & 0 & d_4F_{LL}^4 & 0 & 0 & 0 & d_4F_{LT}^4 & 0 & 0 & -d_4 & 0 & 0 \\
d_5p_1F_{KL}^1 & 0 & 0 & 0 & d_5p_1F_{KK}^1 & 0 & 0 & 0 & 0 & 0 & 0 & -d_5 & 0 \\
0 & 0 & d_6p_3g'F_L^3 & 0 & 0 & d_6p_3g''F^3 & d_6p_3g'F_T^3 & 0 & 0 & 0 & 0 & -d_6 & 0 \\
0 & 0 & d_7p_3gF_{TL}^3 & 0 & 0 & d_7p_3g'F_T^3 & d_7p_3gF_{TT}^3 & 0 & 0 & 0 & 0 & 0 & -d_7 \\
0 & 0 & 0 & d_8F_{TL}^4 & 0 & 0 & 0 & d_8F_{TT}^4 & 0 & 0 & 0 & 0 & -d_8 \\
d_9 & d_9 & d_9 & d_9 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & d_{10} & 0 & 0 & -d_{10}f' & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
d_{11}\overline{w_1} & d_{11}w_2 & d_{11}w_3 & d_{11}w_4 & 0 & 0 & 0 & 0 & d_{11}L_2 & d_{11}L_3 & -d_{11}(L-L_4) & 0 & 0 \\
0 & 0 & 0 & 0 & d_{12} & d_{12} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & d_{13} & d_{13} & 0 & 0 & 0 & 0 & 0
\end{bmatrix} \\
&= -d_1d_2d_3d_4d_5d_6d_7d_8d_9d_{10}d_{11}d_{12}d_{13}p_1\Delta_1
\end{aligned}
$$

Under the condition of a stable system, there must be $|J| < 0$, and thus $\Delta_1 > 0$.

Appendix B

If the government subsidizes loan interest, wage and land rent for the advanced agricultural sector with the rates of s_1, s_2, and s_3, respectively, Eq. (11.14) becomes:

$$p_2g'(K_2)F^2 = r(1 - s_1) \tag{11.14'}$$

Equation (11.11) becomes:

$$p_3gF_L^3 = w_3(1 - s_2) \tag{11.11'}$$

Equation (11.15) becomes:

$$p_3gF_T^3 = \tau(1 - s_3) \tag{11.15'}$$

Then, the total differential of (11.5), (11.6), (11.7), (11.8), (11.9), (11.10), (11.11′), (11.12), (11.13), (11.14′), (11.15′), (11.16), and (11.17′) can be organized as follows:

$$\begin{bmatrix} F^1_{LL} & 0 & 0 & -F^1_{LK} & 0 & 0 & 0 \\ 0 & 0 & 0 & p_3\left(g'F^3_L + gF^3_{LL}f'\right) & p_3gF^3_{LT} & -1 & 0 \\ 0 & 0 & F^4_{LL} & 0 & -F^4_{LT} & 0 & -1 \\ p_1F^1_{KL} & 0 & 0 & -\left[p_1F^1_{KK} + p_3\left(g''F^3 + g'F^3_Lf'\right)\right] & -p_3g'F^3_T & 0 & 0 \\ 0 & 0 & -F^4_{TL} & p_3\left(g'F^3_T + gF^3_{TL}f'\right) & p_3gF^3_{TT} + F^4_{TT} & 0 & 0 \\ 1 & 1 & 1 & f' & 0 & 0 & 0 \\ \overline{w_1} & w_2 + L_2p_2F^2_{LL} & w_4 & w_3f' & 0 & L_3 & -(L - L_4) \end{bmatrix} \times \begin{bmatrix} dL_1 \\ dL_2 \\ dL_4 \\ dK_3 \\ dT_3 \\ dw_3 \\ dw_4 \end{bmatrix} = \begin{bmatrix} 0 \\ -w_3ds_2 \\ 0 \\ rds_1 \\ -\tau ds_3 \\ 0 \\ 0 \end{bmatrix} \tag{11.B1}$$

By dynamic adjustment, we get that the value of the coefficient matrix (11.B1) $\Delta_1 > 0$.

Let $a = F^1_{LL}$, $b = p_1F^1_{KL}$, $c = \overline{w_1}$, $d = w_2 + L_2p_2F^2_{LL}$, $e = F^4_{LL}$, $f = -F^4_{TL} = -F^4_{LT}$, $g = w_4$, $h = -F^1_{LK}$, $j = p_3\left(g'F^3_L + gF^3_{LL}f'\right)$, $k = -\left[p_1F^1_{KK} + p_3\left(g''F^3 + g'F^3_Lf'\right)\right]$, $m = p_3\left(g'F^3_T + gF^3_{TL}f'\right)$, $n = f'$, $p = w_3f'$, $q = p_3gF^3_{LT}$, $s = -p_3g'F^3_T$, $t = p_3gF^3_{TT} + F^4_{TT}$, $u = L_3$, $v = -(L - L_4)$.

Using the Cramer rule to solve (11.B1), we get:

$$dL_1/ds_1 = -F^1_{KL}r\left\{\left(p_3gF^3_{TT} + F^4_{TT}\right)\left[w_2 + L_2p_2F^2_{LL} - w_4\right] + p_3gF^3_{TT}F^4_{LL}(L - L_4) - F^4_{TL}p_3gL_3F^3_{LT}\right\}/\Delta_1 < 0$$

$$dL_2/ds_1(<,=,>)0$$

$$dL_4/ds_1(<,=,>)0$$

$$dK_3/ds_1 = -ar\left(dt - gt + fqu + f^2v - etv\right)/\Delta_1 > 0$$

$$dK_1/ds_1 = -dK_3/ds_1 < 0$$

$$dL_3/ds_1 = f'dK_3/ds_1 > 0$$

$$dT_3/ds_1(<,=,>)0$$

$$dw_3/ds_1(<,=,>)0$$

$$dw_4/ds_1(<,=,>)0$$

$$dr/ds_1 = p_1F^1_{KL}dL_1/ds_1 + p_1F^1_{KK}dK_1/ds_1 = 0$$

$$d\tau/ds_1 = F^4_{TL}dL_4/ds_1 + F^4_{TT}dT_4/ds_1(<,=,>)0$$

$$dL_1/ds_2 = w_3fhsu/\Delta_1 < 0$$

$$dL_2/ds_2 = w_3u(akt - bht - ams - fhs + afns)/\Delta_1(<,=,>)0$$
$$dL_4/ds_2 = w_3u(bht - akt + ams)/\Delta_1(<,=,>)0$$
$$dK_3/ds_2 = -w_3afsu/\Delta_1 > 0$$
$$dK_1/ds_2 = -dK_3/ds_2 < 0$$
$$dL_3/ds_2 = f'dK_3/ds_2 > 0$$
$$dT_3/ds_2 = w_3fu(ak - bh)/\Delta_1 > 0$$
$$dw_3/ds_2(<,=,>)0$$
$$dw_4/ds_2 = -w_3u\left(bf^2h - beht - af^2k + aekt - aems\right)/\Delta_1(<,=,>)0$$
$$dr/ds_2 = p_1F^1_{KL}dL_1/ds_2 + p_1F^1_{KK}dK_1/ds_2 = 0$$
$$d\tau/ds_2 = F^4_{TL}dL_4/ds_2 + F^4_{TT}dT_4/ds_2(<,=,>)0$$
$$dL_1/ds_3 = -\tau hs(g - d + ev)/\Delta_1 < 0$$
$$dL_2/ds_3(<,=,>)0$$
$$dL_4/ds_3(<,=,>)0$$
$$dK_3/ds_3 = as\tau(g - d + ev)/\Delta_1 > 0$$
$$dK_1/ds_3 = -dK_3/ds_3 < 0$$
$$dL_3/ds_3 = f'dK_3/ds_3 > 0$$
$$dT_3/ds_3 = \tau(bh - ak)(g - d + ev)/\Delta_1 > 0$$
$$dw_3/ds_3 = \tau(bhq - akq + ajs)(g - d + ev)/\Delta_1(<,=,>)0$$
$$dw_4/ds_3(<,=,>)0$$
$$dr/ds_3 = p_1F^1_{KL}dL_1/ds_3 + p_1F^1_{KK}dK_1/ds_3 = 0$$
$$d\tau/ds_3 = F^4_{TL}dL_4/ds_3 + F^4_{TT}dT_4/ds_3(<,=,>)0$$

Appendix C

When the labor endowment increases, the total differential of (11.5), (11.6), (11.7), (11.8), (11.9), (11.10), (11.11), (11.12), (11.13), (11.14), (11.15), (11.16), and (11.17′) can be written as the following (11.21):

$$\begin{bmatrix} F_{LL}^1 & 0 & 0 & -F_{LK}^1 & 0 & 0 & 0 \\ 0 & 0 & 0 & p_3\left(g'F_L^3 + gF_{LL}^3 f'\right) & p_3 g F_{LT}^3 & -1 & 0 \\ 0 & 0 & F_{LL}^4 & 0 & -F_{LT}^4 & 0 & -1 \\ p_1 F_{KL}^1 & 0 & 0 & -\left[p_1 F_{KK}^1 + p_3\left(g'' F^3 + g' F_L^3 f'\right)\right] & -p_3 g' F_T^3 & 0 & 0 \\ 0 & 0 & -F_{TL}^4 & p_3\left(g'F_T^3 + gF_{TL}^3 f'\right) & p_3 g F_{TT}^3 + F_{TT}^4 & 0 & 0 \\ 1 & 1 & 1 & f' & 0 & 0 & 0 \\ \overline{w_1} & w_2 + L_2 p_2 F_{LL}^2 & w_4 & w_3 f' & 0 & L_3 & -(L - L_4) \end{bmatrix} \times \begin{bmatrix} dL_1 \\ dL_2 \\ dL_4 \\ dK_3 \\ dT_3 \\ dw_3 \\ dw_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ dL \\ w_4 dL \end{bmatrix} \tag{11.C1}$$

Apparently, the value of the coefficient matrix (11.C1) is Δ_1.

When the capital endowment increases, the total differential of (11.5), (11.6), (11.7), (11.8), (11.9), (11.10), (11.11), (11.12), (11.13), (11.14), (11.15), (11.16), and (11.17′) is (11.22) as follows:

$$\begin{bmatrix} F_{LL}^1 & 0 & 0 & -F_{LK}^1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & p_3\left(g'F_L^3 + gF_{LL}^3 f'\right) & p_3 g F_{LT}^3 & -1 & 0 \\ 0 & 0 & F_{LL}^4 & 0 & 0 & -F_{LT}^4 & 0 & -1 \\ p_1 F_{KL}^1 & 0 & 0 & p_1 F_{KK}^1 & -p_3\left(g'' F^3 + g' F_L^3 f'\right) & -p_3 g' F_T^3 & 0 & 0 \\ 0 & 0 & -F_{TL}^4 & 0 & p_3\left(g'F_T^3 + gF_{TL}^3 f'\right) & p_3 g F_{TT}^3 + F_{TT}^4 & 0 & 0 \\ 1 & 1 & 1 & 0 & f' & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ \overline{w_1} & w_2 + L_2 p_2 F_{LL}^2 & w_4 & 0 & w_3 f' & 0 & L_3 & -(L - L_4) \end{bmatrix} \times \begin{bmatrix} dL_1 \\ dL_2 \\ dL_4 \\ dK_1 \\ dK_3 \\ dT_3 \\ dw_3 \\ dw_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ dK \\ 0 \end{bmatrix} \tag{11.C2}$$

Assume that the value of the matrix (11.C2) is Δ_2, then $\Delta_2 = -\Delta_1$.

Using the Cramer rule to solve (11.C1) and (11.C2), we get:

$$dL_1/dL = fhs(d-g)/\Delta_1 > 0$$

$$dL_2/dL(<,=,>)0$$

$$dL_4/dL = -(d-g)(akt - bht - ams)/\Delta_1(<,=,>)0$$

$$dK_3/dL = -afs(d-g)/\Delta_1 < 0$$

$$dK_1/dL = -dK_3/dL > 0$$
$$dL_3/dL = f'dK_3/dL < 0$$
$$dT_3/dL = -f(bh - ak)(d - g)/\Delta_1 < 0$$
$$dw_3/dL = -f(bhq - akq + ajs)(d - g)/\Delta_1(<, =, >)0$$
$$dw_4/dL = -f(d - g)$$
$$\left(bf^2h - beht - af^2k + aekt - aems\right)/\Delta_1(<, =, >)0$$
$$dr/dL = p_1F^1_{KL}dL_1/dL + p_1F^1_{KK}dK_1/dL = 0$$
$$d\tau/dL = F^4_{TL}dL_4/dL + F^4_{TT}dT_4/dL(<, =, >)0$$
$$dL_1/dK(<, =, >)0$$
$$dL_2/dK(<, =, >)0$$
$$dL_4/dK = -ht(d - c)(z - s)/\Delta_2 < 0$$
$$dK_1/dK(<, =, >)0$$
$$dK_3/dK = (cfhs - dfhs)/\Delta_2 > 0$$
$$dL_3/dK = f'dK_3/dK > 0$$
$$dT_3/dK = (dfhz - cfhz)/\Delta_2 > 0$$
$$dw_3/dK = cfh(js - zq)/\Delta_2 > 0$$
$$dw_4/dK(<, =, >)0$$
$$dr/dK = p_1F^1_{KL}dL_1/dK + p_1F^1_{KK}dK_1/dK = 0$$
$$d\tau/dK = F^4_{TL}dL_4/dK + F^4_{TT}dT_4/dK(<, =, >)0$$

In the above, the letters a, b, c, d, e, f, g, h, j, k, m, n, p, q, s, t, u, and v have the same meaning as in Appendix B. Besides, $y = p_1F^1_{KK}$, $z = -p_3\left(g''F^3 + g'F^3_Lf'\right)$.

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