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GENERAL EQUILIBRIUM EFFECTS OF AN AGRICULTURAL LAND RETIREMENT SCHEME IN A LARGE, OPEN ECONOMY

by

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1. Introduction

Land retirement schemes, in which agricultural land is withdrawn from production in the hope of raising the price of agricultural output, are a common means of assisting the agricultural sector. Analyses of these schemes have often used a closed economy, partial equilibrium framework, the basic idea being that with inelastic demand for agricultural goods total revenue to the agricultural sector will increase as price rises and output falls. However, open economies tend to face more elastic demand functions than do closed economies, a fact which, in today's world of increased trade, throws doubt on the efficacy of land retirement schemes. Furthermore, partial equilibrium models, by their nature, ignore the linkages between the agricultural sector and the rest of the economy. Consequently, they do not allow a full investigation of the effects of policy on the domestic economy as a whole, and in some cases they may give misleading results concerning the effects of policy on the agricultural sector itself.

This paper reexamines land retirement schemes in a large, open economy setting, using general equilibrium analysis. A static, deterministic trade model is employed in which certain factors of production are specific to particular sectors of the economy. The effects of the policy on the country imposing it, and on the rest of the world, are discussed.

2. Assumptions of the Model

Consider a two country world consisting of the home country and the rest of the world. In the mathematical model presented below, variables pertaining to the rest of the world have an asterisk appended to them to distinguish them from variables pertaining to the home country. Both countries consist of two sectors, agriculture and manufacturing. Manufacturing may be interpreted as the rest of the economy other than the agricultural sector. Each sector produces a homogeneous final product using two factors of production, land and labor. In the sections which follow, good 1 represents agricultural commodities, good 2 is manufactures, the first factor is land and the second factor is labor. Both goods are freely traded internationally and both countries are large enough to influence world prices. All consumers, both domestic and foreign, have identical homothetic preferences.

Both economies are assumed to be perfectly competitive with a large number of firms each maximizing profits which are driven to zero in equilibrium. Industry production functions differ between industries, are homogeneous of degree one, have constant elasticities of substitution and are stricly quasi-concave. Both countries produce some of each commodity and, in the initial equilibrium, the home country exports agricultural goods and imports manufactures.

Factors of production are perfectly inelastic in supply and are internationally immobile. The model described in this paper is a short run model in which land represents all fixed resources and labor represents all variable resources. Consequently, labor is assumed to be perfectly mobile between sectors of a country and this leads to a common wage rate in both sectors. However, land is completely immobile so land rentals in the two sectors can differ. For example, should agricultural land rentals exceed those in the manufacturing sector, land cannot be converted from manufacturing to agricultural production so there is no mechanism to bring about equality of land rentals. Industry production functions have the form:

$$Y_1 = Y_1(V_{11}, v_{21})$$

and

$$Y_2 = Y_2(V_{12}, v_{22})$$

where

Y_j is output of good j, j=1,2,

V_{11} is the total quantity of agricultural land available,

V_{12} is the total quantity of land available for manufacturing,

v_{2j} is the quantity of labor used to produce Y_j units of good j, j=1,2.

3. The Model

Profit maximizing behaviour by firms in a perfectly competitive home economy leads to equality between price and average cost in each industry:

(1) $$a_{11}w_{11} + a_{21}w_2 = p$$

(2) $$a_{12}w_{12} + a_{22}w_2 = 1$$

where

w_{11} is the return to land in agriculture,

w_{12} is the return to land in manufacturing,

w_2 is the return to labor (equalized across sectors),

$a_{ij} = a_{ij}(w_{1j}, w_2)$ is the amount of input i used to produce one unit of agricultural goods, $i=1,2$,

$a_{i2} = a_{i2}(w_{12},w_2)$ is the amount of input i used to produce one unit of manufactured goods, $i=1,2$,

p is the price of agricultural goods, relative to the price of manufactured goods.

The conditions for factor market equilibrium in the home country are:

(3) $a_{11}Y_1 = V_{11}$

(4) $a_{12}Y_2 = V_{12}$

(5) $a_{21}Y_1 + a_{22}Y_2 = V_2$

where

$Y_j = Y_j(p,V_{11},V_{12},V_2)$ is the output of good j in the home country, $j=1,2$,

V_{11} is the home country's initial endowment of agricultural land,

V_{12} is the home country's initial endowment of land in the manufacturing sector,

V_2 is the home country's initial endowment of labor.

In the home country, aggregate demand functions of the form:

$$X_j = X_j[p,I(p,V_{11},V_{12},V_2)], \quad j=1,2,$$

are generated from maximizing an aggregate utility function, $U(X_1,X_2)$, subject to a budget constraint $I = w_{11}V_{11} + w_{12}V_{12} + w_2V_2 = pY_1 + Y_2$. Similarly, aggregate demand functions in the rest of the world are:

$$X_j^* = X_j^*[p,I^*(p,V_{11}^*,V_{12}^*,V_2^*)], \quad j=1,2.$$

All consumers have identical, homothetic preferences so, at given prices, consumption of each good constitutes a constant proportion of income, whatever its level, both at home and abroad:

(6a) $X_1 = (m_1/p)I$ and $X_2 = m_2 I$

(6b) $X_1^* = (m_1/p)I^*$ and $X_2^* = m_2 I^*$

where

$X_j = X_j(p, V_{11}, V_{12}, V_2)$ is consumption of good j in the home country, j=1,2,

$X_j^* = X_j(p, V_{11}^*, V_{12}^*, V_2^*)$ is consumption of good j in the rest of the world, j=1,2,

$m_1 = p\delta X_1/\delta I$ is the marginal propensity to consume good 1, both at home and abroad,

$m_2 = \delta X_2/\delta I$ is the marginal propensity to consume good 2, both at home and abroad, $m_1 + m_2 = 1$,

I is GNP in the home country measured in units of good 2,

I^* is GNP in the rest of the world in units of good 2.

GNP, national income and GNE are all equal, that is:

(7a) $I = pY_1 + Y_2 = w_{11}V_{11} + w_{12}V_{12} + w_2V_2 = pX_1 + X_2$ and

(7b) $I^* = pY_1^* + Y_2^* = w_{11}^*V_{11}^* + w_{12}^*V_{12}^* + w_2^*V_2^* = pX_1^* + X_2^*$

Excess demand functions are found by subtracting production from consumption:

(8a) $Z_j = X_j - Y_j$ and

(8b) $Z_j^* = X_j^* - Y_j^*$

where

$Z_j = Z_j(p, V_{11}, V_{12}, V_2)$ represents home country imports if Z_j is positive, or exports if Z_j is negative, j=1,2,

$Z_j^* = Z_j(p, V_{11}^*, V_{12}^*, V_2^*)$ represents imports by the rest of the world if Z_j^* is positive, or exports by the rest of the world if Z_j^* is negative, j=1,2.

In world equilibrium there is zero excess demand for each good so, for example:

(9) $$Z_1 + Z_1^* = 0$$

If the home country is relatively abundant in agricultural land, then it will export agricultural goods and import manuafactures. This can be seen from equation (6) which implies:

(10) $$X_1/X_2 = X_1^*/X_2^*$$

and from equations (3) and (4) which imply:

(11) $$Y_1/Y_2 = (V_{11}/V_{12})(a_{12}/a_{11})$$ and

(12) $$Y_1^*/Y_2^* = (V_{11}^*/V_{12}^*)(a_{12}/a_{11})$$

If $V_{11}/V_{12} > V_{11}^*/V_{12}^*$ then $Y_1/Y_2 > Y_1^*/Y_2^*$. Together with equation (10) this implies $Z_1 < 0$ and $Z_2 > 0$.

4. The Domestic Effects of an Agricultural Land Retirement Scheme

A land retirement scheme constitutes a reduction in the home country's endowment of agricultural land. Its impact on prices production, employment and social welfare can be assessed by expressing the equations of the model in terms of rates of change (denoted by a "^").

First, the effect of acreage restrictions on world prices is considered.

Proposition 1: A reduction in the quantity of land available to the agricultural sector of the home country raises the world price of agricultural goods relative to manufactured goods.

Proof: Using equations (8) and (9) we see that in world equilibrium:

$$X_1[p,I(p,V_{11},V_{12},V_2)] - Y_1(p,V_{11},V_{12},V_2) + X_1^*[p,I^*(p,V_{11}^*,V_{12}^*,V_2^*)] - Y_1^*(p,V_{11}^*,V_{12}^*,V_2^*) = 0$$

Differentiating totally and setting $dV_{12} = dV_2 = dV_{11}^* = dV_{12}^* = dV_2^* = 0$ leads to:

$$\left(\frac{\partial X_1}{\partial p} + \frac{\partial X_1}{\partial I}\frac{\partial I}{\partial p}\right)dp + \frac{m_1}{p}\left[p\frac{\partial Y_1}{\partial V_{11}} + \frac{\partial Y_2}{\partial V_{11}}\right]dV_{11} - \frac{\partial Y_1}{\partial p}dp - \frac{\partial Y_1}{\partial V_{11}}dV_{11} + \left(\frac{\partial X_1^*}{\partial p} + \frac{\partial X_1^*}{\partial I^*}\frac{\partial I^*}{\partial p}\right)dp - \frac{\partial Y_1^*}{\partial p}dp = 0$$

which simplifies, using equations (6) and (7), to:

(13) $$\left(s_{11} - \frac{m_1}{p}Z_1 - t_{11} + s_{11}^* - \frac{m_1}{p}Z_1^* - t_{11}^*\right)dp = \left[(1 - m_1)\frac{\partial Y_1}{\partial V_{11}} - \frac{m_1}{p}\frac{\partial Y_2}{\partial V_{11}}\right]dV_{11}$$

where

$s_{11} = \frac{\partial X_1}{\partial p} + \frac{\partial X_1}{\partial I}X_1 < 0$ and $s_{11}^* = \frac{\partial X_1^*}{\partial p} + \frac{\partial X_1^*}{\partial I^*}X_1^* < 0$ are the own price Slutsky substitution terms in the home and foreign countries respectively, and

$t_{11} = \frac{\partial Y_1}{\partial p} > 0$ and $t_{11}^* = \frac{\partial Y_1^*}{\partial p} > 0$.

But (3) and (4) imply $\partial Y_1/\partial V_{11} = 1/a_{11}$, $\partial Y_2/\partial V_{11} = 0$ and in world equilibrium $Z_1 = -Z_1^*$, so equation (13) can be written:

(14) $$\hat{p}/\hat{V}_{11} = \frac{Y_1(1 - m_1)}{p(s_{11} + s_{11}^* - t_{11} - t_{11}^*)} < 0$$

Since Y_1, p, t_{11}, $t_{11}^* > 0$; s_{11}, $s_{11}^* < 0$ and $0 < m_1 < 1$, the effect of a reduction in the endowment of agricultural land is to increase the world price of agricultural goods relative to manufactured goods. Equation (14) also shows that the less price responsive are domestic and foreign demands and supplies, the larger the initial volume of agricultural production, and the smaller the marginal propensity to consume agricultural goods, the more responsive is the world price ratio to acreage reductions.

Next the effect of a land retirement scheme on factor prices is examined.

Proposition 2: A reduction in the quantity of land available to the agricultural sector of the home country increases both nominal and real land rentals in the agricultural sector and reduces real wage rates in the economy as a whole. The effects on nominal wage rates and on land rentals in the manufacturing sector depend upon the extent to which prices are responsive to acreage reductions.

Proof: Cost minimizing firms face given factor prices, w_{11}, w_{12} and w_2, and choose factor-output ratios such that:

(15) $\theta_{11}\hat{a}_{11} + \theta_{21}\hat{a}_{21} = 0$

(16) $\theta_{12}\hat{a}_{12} + \theta_{22}\hat{a}_{22} = 0$

Hence, the profit maximizing conditions (1) and (2) can be written as:

(17) $\theta_{11}\hat{w}_{11} + \theta_{21}\hat{w}_{2} = \hat{p}$

(18) $\theta_{12}\hat{w}_{12} + \theta_{22}\hat{w}_{2} = 0$

where

θ_{ij} is the share of factor i in the output of good j, that is, $\theta_{11} = w_{11}a_{11}/p$, $\theta_{21} = w_{2}a_{21}/p$, $\theta_{12} = w_{12}a_{12}$, $\theta_{22} = w_{2}a_{22}$ and $\theta_{11} + \theta_{21} = \theta_{12} + \theta_{22} = 1$.

Substituting equations (3) and (4) into equation (5) gives:

$$a_{21}V_{11}/a_{11} + a_{22}V_{12}/a_{12} = V_2$$

which is totally differentiated to produce:

$$\frac{a_{21}V_{11}}{a_{11}V_2}(\hat{a}_{21} - \hat{a}_{11} + \hat{V}_{11}) + \frac{a_{22}V_{12}}{a_{12}V_2}(\hat{a}_{22} - \hat{a}_{12} + \hat{V}_{12}) = \hat{V}_2$$

Since $a_{21}/a_{11} = v_{21}/V_{11}$ and $a_{22}/a_{12} = v_{22}/V_{12}$, the above equation can be written:

$$(19) \quad \lambda_{21}(\hat{a}_{21} - \hat{a}_{11}) + \lambda_{22}(\hat{a}_{22} - \hat{a}_{12}) = \hat{V}_2 - \lambda_{21}\hat{V}_{11} - \lambda_{22}\hat{V}_{12}$$

where

λ_{ij} is the proportion of factor i used in the production of good j, that is, $\lambda_{21} = v_{21}/V_2$, $\lambda_{22} = v_{22}/V_2$ and $\lambda_{21} + \lambda_{22} = 1$

The elasticities of substitution for the two sectors are defined as:

$$(20) \quad \sigma_1 = (\hat{a}_{11} - \hat{a}_{21})/(\hat{w}_2 - \hat{w}_{11}) > 0 \quad \text{and}$$

$$(21) \quad \sigma_2 = (\hat{a}_{12} - \hat{a}_{22})/(\hat{w}_2 - \hat{w}_{12}) > 0$$

Substituting equations (20) and (21) into equation (19) and setting $\hat{V}_{12} = \hat{V}_2 = 0$ gives:

$$(22) \quad \lambda_{21}\sigma_1\hat{w}_{11} + \lambda_{22}\sigma_2\hat{w}_{12} - (\lambda_{21}\sigma_1 + \lambda_{22}\sigma_2)\hat{w}_2 = -\lambda_{21}\hat{V}_{11}$$

Solving equations (17), (18) and (22) simultaneously for $\hat{w}_{11}$, $\hat{w}_{12}$ and $\hat{w}_2$ we find:

$$(23) \quad \hat{w}_{11}/\hat{V}_{11} = \frac{(\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2)\hat{p}/\hat{V}_{11} - \lambda_{21}\theta_{21}\theta_{12}}{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11}} < 0$$

$$(24) \quad \hat{w}_{11}/\hat{p} = \frac{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2 - (\lambda_{21}\theta_{21}\theta_{12})\hat{V}_{11}/\hat{p}}{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11}} > 1$$

$$(25) \quad \hat{w}_{12}/\hat{V}_{11} = \frac{-\theta_{22}[(\lambda_{21}\sigma_1\theta_{12})\hat{p}/\hat{V}_{11} + \lambda_{21}\theta_{11}\theta_{12}]}{\theta_{12}(\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11})}$$

$$(26) \quad \hat{w}_{11}/\hat{p} = \frac{-\theta_{22}[\lambda_{21}\sigma_1\theta_{12} + (\lambda_{21}\theta_{11}\theta_{12})\hat{V}_{11}/\hat{p}]}{\theta_{12}(\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11})}$$

$$(27) \quad \hat{w}_2/\hat{V}_{11} = \frac{(\lambda_{21}\sigma_1\theta_{12})\hat{p}/\hat{V}_{11} + \lambda_{21}\theta_{11}\theta_{12}}{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11}}$$

$$(28) \quad \hat{w}_2/\hat{p} = \frac{\lambda_{21}\sigma_1\theta_{12} + (\lambda_{21}\theta_{11}\theta_{12})\hat{V}_{11}/\hat{p}}{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11}} < 1$$

Equations (23), (24) and (28) reveal that a reduction in the amount of agricultural land available for production increases both nominal and real land rentals in the agricultural sector and reduces real wage rates in the economy as a whole. The effects on nominal wage rates and on land rentals in the manufacturing sector depend upon the responsiveness of relative prices to acreage reductions [see equations (25) to (27)]. If price is sufficiently responsive to reduced acreage (namely, if $-\hat{p}/\hat{V}_{11} > \theta_{11}/\sigma_1$)[1] then nominal wage rates will rise and nominal land rentals in the manufacturing sector will fall. Otherwise (that is, if $\theta_{11}/\sigma_1 > -\hat{p}/\hat{V}_{11} > 0$) nominal wage rates will fall and nominal land rentals in the manufacturing sector will rise. If price is even more unresponsive to acreage reductions [namely, if $0 < -\hat{p}/\hat{V}_{11} < \theta_{11}\theta_{22}\lambda_{21}/(\lambda_{21}\sigma_1+\lambda_{22}\sigma_2\theta_{11})$] then real land rentals in the manufacturing sector will rise as a result of a land retirement scheme[2].

Although agricultural land rentals rise in both real and nominal terms as a result of a land retirement scheme, total payments to land in the agricultural sector, I_{11}, may rise or fall as land is withdrawn from production. Given:

$$\hat{I}_{11} = \hat{w}_{11} + \hat{V}_{11}$$

and substituting equation (23) for $\hat{w}_{11}/\hat{V}_{11}$, we obtain:

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1. $\sigma_1/\theta_{11} = (\hat{a}_{11} - \hat{a}_{21})/(\hat{w}_2 - \hat{p}) > 0$ is defined as the own price elasticity of demand for labor in the agricultural sector.

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2. In the small country case $\hat{p}/\hat{V}_{11} = 0$ so wage rates fall and returns to land rise in both sectors.

(29) $$\hat{I}_{11}/\hat{V}_{11} = \frac{(\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2)\hat{p}/\hat{V}_{11}}{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11}} + \frac{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11} - \lambda_{21}\theta_{21}\theta_{12}}{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11}}$$

If $-\hat{p}/\hat{V}_{11} > \dfrac{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2\theta_{11} - \lambda_{21}\theta_{21}\theta_{12}}{\lambda_{21}\sigma_1\theta_{12} + \lambda_{22}\sigma_2}$

then the price rise is sufficient to compensate for the reduction in acreage and total returns to land in the agricultural sector will rise, otherwise total returns to agricultural land will fall.

We now examine the effect of a land retirement scheme on output and employment.

Proposition 3: A reduction in the quantity of land available to the agricultural sector of the home country reduces agricultural output less than proportionately. Output of the manufacturing sector may rise or fall.

Proof: The change in the output of agricultural goods is given by:

$$dY_1/dV_{11} = \delta Y_1/\delta V_{11} + (\delta Y_1/\delta p)(dp/dV_{11})$$

or $$\hat{Y}_1/\hat{V}_{11} = (V_{11}/Y_1)(\delta Y_1/\delta V_{11}) + (pt_{11}/Y_1)(\hat{p}/\hat{V}_{11})$$

Substituting $\delta Y_1/\delta V_{11} = 1/a_{11}$ from equation (3) and $\hat{p}/\hat{V}_{11}$ from equation (14):

(30) $$\hat{Y}_1/\hat{V}_{11} = \frac{s_{11} + s_{11}^{*} - m_1 t_{11} - t_{11}^{*}}{s_{11} + s_{11}^{*} - t_{11} - t_{11}^{*}}$$

Hence $0 < \hat{Y}_1/\hat{V}_{11} < 1$, that is, the total effect of a reduction in agricultural land is to reduce agricultural output, but by a smaller percentage than that by which acreage declines.

The change in the output of manufactured goods is given by:

$$dY_2/dV_{11} = \delta Y_2/\delta V_{11} + (\delta Y_2/\delta p)(dp/dV_{11})$$

or $\hat{Y}_2/\hat{V}_{11} = (V_{11}/Y_2)(\Delta Y_2/\Delta V_{11}) + (pt_{21}/Y_2)(\hat{p}/\hat{V}_{11})$

where $t_{21} = \Delta Y_2/\Delta p$. Substituting $\Delta Y_2/\Delta V_{11} = 0$ from equation (4) and $\hat{p}/\hat{V}_{11}$ from equation (14):

$$(31) \qquad \hat{Y}_2/\hat{V}_{11} = \frac{Y_1(1 - m_1)t_{21}}{Y_2(s_{11} + s_{11}^* - t_{11} - t_{11}^*)}$$

Hence, $t_{21}<0$ implies $\hat{Y}_2/\hat{V}_{11}>0$ and $t_{21}>0$ implies $\hat{Y}_2/\hat{V}_{11}<0$. That is, if agricultural and manufacturing goods are substitutes (complements), manufacturing output falls (rises). If all resources were mobile, production would be efficient and $pt_{11} + t_{21}$ would equal zero. Under these circumstances $t_{21} = -pt_{11} < 0$ and output of manufactured goods would fall. However, when land is immobile the production point lies in the interior of the production possibility set, $pt_{11} + t_{21}$ is not necessarily zero and output of manufactured goods need not necessarily fall.

As for employment levels, obviously the quantity of land used by the agricultural sector falls with acreage restrictions and the quantity of land employed in manufacturing remains unchanged. It remains to examine the effect of a land retirement scheme on employment of labor.

Proposition 4: A reduction in the quantity of land available to the agricultural sector of the home country attracts labor into the agricultural sector if the rise in the price of agricultural goods is sufficiently large. Otherwise labor will migrate out of agriculture into the manufacturing sector.

Proof: Equations (25) and (27) show that if price is sufficiently responsive to acreage reductions (that is, if $-\hat{p}/\hat{V}_{11} > \theta_{11}/\sigma_1$) then $\hat{w}_2 > \hat{w}_{12}$. Otherwise, (that is, if $0 < -\hat{p}/\hat{V}_{11} < \theta_{11}/\sigma_1$)

$\hat{w}_2 < \hat{w}_{12}$. From equation (21) we see that $\hat{w}_2 > \hat{w}_{12}$ implies $\hat{a}_{12} > \hat{a}_{22}$ and vice versa. Combining these results:

(32) $\qquad -\hat{p}/\hat{V}_{11} > \theta_{11}/\sigma_1$ implies $\hat{w}_2 > \hat{w}_{12}$ implies $\hat{a}_{12} > \hat{a}_{22}$

and

(33) $\qquad 0 < -\hat{p}/\hat{V}_{11} < \theta_{11}/\sigma_1$ implies $\hat{w}_2 < \hat{w}_{12}$ implies $\hat{a}_{12} < \hat{a}_2$

Now, $\hat{V}_{12} = \hat{a}_{12} + \hat{Y}_2 = 0$ and $\hat{v}_{22} = \hat{a}_{22} + \hat{Y}_2$ so:

(i) $-\hat{p}/\hat{V}_{11} > \theta_{11}/\sigma_1$ implies $\hat{v}_{22} < 0$ and since $\hat{V}_2 = 0$, $\hat{v}_{21} > 0$. That is, when price is relatively responsive to acreage reductions, labor migrates from the manufacturing sector into the agricultural sector (and the output of manufactured goods falls).

(ii) $0 < -\hat{p}/\hat{V}_{11} < \theta_{11}/\sigma_1$ implies $\hat{v}_{22} > 0$ and since $\hat{V}_2 = 0$, $\hat{v}_{21} < 0$. That is, when price is relatively unresponsive to acreage reductions, labor migrates out of the agricultural sector into the manufacturing sector (and the output of manufactured goods rises).

The effect of a land retirement scheme on total revenue of the agricultural sector, R, is now examined.

Proposition 5: A reduction in the quantity of agricultural land in the home country does not necessarily increase total revenue of the agricultural sector.

Proof: $\hat{R}/\hat{V}_{11} = \hat{p}/\hat{V}_{11} + \hat{Y}_1/\hat{V}_{11}$

$$= \hat{p}/\hat{V}_{11} + (V_{11}/Y_1)(\Delta Y_1/\Delta V_{11}) + (pt_{11}/Y_1)(\hat{p}/\hat{V}_{11})$$

(34) $$= (1 + \eta_1)(\hat{p}/\hat{V}_{11}) + 1$$

where

$\eta_1 = (p/Y_1)(\delta Y_1/\delta p)$ is the own price elasticity of supply of agricultural goods.

Hence, $\hat{R}/\hat{V}_{11} < 0$ if $-\hat{p}/\hat{V}_{11} > 1/(1 + \eta_1)$ where $1/(1 + \eta_1) < 1$. That is, total revenue to the agricultural sector will rise only if the price of agricultural goods is sufficiently responsive to acreage reductions. Note however, that the percentage increase in price does not have to exceed the (absolute value of the) percentage change in acreage for total revenue to increase.

Finally we see that the effect of acreage restrictions on social welfare cannot be predicted with certainty.

Proposition 6: A reduction in the quantity of land available to the agricultural sector of the home country has an unpredictable effect on social welfare.

Proof:

(35) $$dU = \frac{\delta U}{\delta X_1}.dX_1 + \frac{\delta U}{\delta X_2}.dX_2$$

where

$$\delta U/\delta X_1 = p.\delta U/\delta X_2$$

$$dX_1 = \left(\frac{\delta X_1}{\delta p} + \frac{\delta X_1}{\delta I}.X_1 - \frac{m_1}{p}.Z_1\right)dp + \frac{m_1}{a_{11}}.dV_{11}$$

$$dX_2 = \left(\frac{\delta X_2}{\delta p} + \frac{\delta X_2}{\delta I}.X_1 - m_2.Z_1\right)dp + \frac{pm_2}{a_{11}}.dV_{11}$$

Substituting these expressions into equation (35) and simplifying using equations (3), (6) and (7) gives:

(36) $$\hat{U}/\hat{V}_{11} = (p/U)(\delta U/\delta X_2)[(Y_1-Z_1)\hat{p}/\hat{V}_{11} + Y_1]$$

Equation (36) shows that if price is sufficiently responsive to acreage restrictions [namely, if $-\hat{p}/\hat{V}_{11} > Y_1/(Y_1-Z_1) > 0.5$] then the improvement in the terms of trade will outweigh the contraction in the production possibility set and social welfare will increase. Otherwise, the effect of a land retirement scheme is to reduce social welfare.

5. The Effects of an Agricultural Land Retirement Scheme on the Rest of the World

All countries face the same prices so the increase in the relative price of agricultural goods, arising from acreage reductions in the agricultural sector of the home country, constitutes a deterioration in the terms of trade of the rest of the world. As a result social welfare of foreign countries falls. The effect on factor prices in foreign countries can be analysed using the standard "Specific Factor model" of international trade: real and nominal returns to land rise in the agricultural sector and fall in the manufacturing sector, while nominal wage rates rise but real wage rates fall. Furthermore, labor moves out of the manufacturing sector into the agricultural sector and consequently manufacturing output falls and agricultural output rises in the rest of the world.

6. Summary of Results

An agricultural land retirement scheme has the effect of increasing the world price of agricultural goods relative to manufactured goods. The more inelastic are domestic and foreign demands and supply functions, and the larger the initial volume of agricultural production and the smaller the marginal propensity to consume agricultural goods, the more responsive is the world price ratio to agricultural acreage reductions.

The combined effect of the initial reduction in the amount of agricultural land available to the home economy and the resulting increase in the relative price of agricultural goods is to increase both nominal and real land rentals in the agricultural sectors of both economies [see equations (23), (24)]. Real and nominal returns to land in the domestic manufacturing sector may rise or fall [see equations (25) and (26)] but land owners in the manufacturing sector of foreign countries experience a fall in both real and nominal land rentals. Wage rates fall in real terms both at home [see equation (28)], and abroad. They may rise or fall in nominal terms at home [see equation (27)], but rise in nominal terms in the rest of the world. Since the problem of low incomes in the agricultural sector is essentially a problem of low labor incomes, we see that a policy of acreage restrictions is of limited benefit in that it lowers real wages.

Acreage restrictions reduce domestic agricultural output but domestic manufacturing output may rise or fall depending upon how responsive relative price is to reduced acreage. If price tends to be responsive to acreage reductions then the nominal wage rate will rise, the nominal return to land in the manufacturing sector will fall, labor will migrate from manufacturing into agriculture and output of the manufacturing sector will fall. If, however, price tends to be unresponsive to acreage reductions then nominal wage rates will fall, returns to land in the manufacturing sector will rise, labor will leave the agricultural sector and will take up employment in the manufacturing sector, the output of which will rise. In the rest of the world, labor moves out of manufacturing and into agriculture and as it does so manufacturing output falls and agricultural output rises.

Theoretically, a large country can improve its social welfare by restricting land usage in the agricultural sector provided the world price is sufficiently responsive to acreage reductions. This contrasts with the case of a small country which cannot influence its terms of trade and so will experience diminished social welfare as a result of a land retirement program.