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PRICE SUPPORT PROGRAMS IN AN OPEN ECONOMY:

A GENERAL EQUILIBRIUM ANALYSIS

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Price Support Programs in an Open Economy: A General  
Equilibrium Analysis\*

1. INTRODUCTION

The essential features of crop price support programs - deficiency payments to farmers and agricultural acreage reductions - are analysed within the framework of the simple, general equilibrium model of a small, open economy.<sup>1</sup> The analysis is short run in nature in that certain resources are fixed in the sense that they are sectorally immobile while others are assumed to be variable in that they can move freely between sectors in response to changes in factor returns. Section 3 analyses the effect of a deficiency payment scheme alone, while section 4 deals with the ceteris paribus effects of acreage controls.<sup>2</sup> Armed with the insights gained from these two sections, the joint effects of deficiency payments and acreage controls are investigated in section 5. Section 6 summarizes the main results of the analysis. The three policies are found to differ most substantially in terms of the changes they bring about in returns to labor and to owners of fixed resources in both the agricultural sector and the rest of the economy.

2. A SHORT RUN GENERAL EQUILIBRIUM MODEL

Underlying the model are the following assumptions:

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\* I would like to thank Dr. G. Edward Schuh for reading this paper and making many helpful comments and suggestions.

<sup>1</sup> The basic model is known as the "Factor Specific Model" in International Trade Theory. It was developed by Jones (2) and extended by Mayer (3).

<sup>2</sup> Sections 3 and 4 are direct applications of Mayer's model. Section 5, however, involves an extension of Mayer's model.

- (i) The economy consists of two sectors, agriculture and manufacturing, each producing its own homogeneous product. Agricultural commodities are exportable while manufactured goods are importable. Manufacturing should be interpreted as the rest of the economy other than agriculture. Each commodity is produced using a fixed factor of production, which will be called land, and a variable factor of production, which will be called labor.
- (ii) All factors of production are fixed in supply to the economy as a whole and are fully employed. However, in the short run only labor moves freely between the two sectors in response to changes in factor prices. Land cannot be transferred from agriculture to manufacturing, nor vice versa.
- (iii) The output of each sector is produced using a linearly homogeneous, twice differentiable, strictly quasi-concave production function.
- (iv) Perfect competition prevails in both domestic factor markets and world commodity markets. In the absence of a crop price support program, perfect competition also prevails in domestic commodity markets. Hence, commodity prices facing consumers are exogenously determined in world markets. Commodity prices facing producers are either world prices or, if a deficiency payment scheme is in operation, government determined support prices. The country is assumed to be small and so is unable to affect its terms of trade.
- (v) Each sector produces a strictly positive quantity of output.
- (vi) Consumers preferences are assumed to be aggregable into a social utility function.

The model consists of the following equations:

(a) A Production Function for each Sector

$$Y_A = Y_A(L_A, D_A)$$

$$Y_M = Y_M(L_M, D_M)$$

where:

A = agriculture,

M = manufacturing,

Y = output,

L = labor, and

D = land.

(b) Full Employment Conditions

$$L_A + L_M = \bar{L}$$

$$D_A = \bar{D}_A$$

$$D_M = \bar{D}_M$$

where  $\bar{L}$ ,  $\bar{D}_A$  and  $\bar{D}_M$  are the economy's endowments of labor and of land in agriculture and land in manufacturing, respectively. Note that factor supplies are perfectly price inelastic.

(c) Factor Demand Equations

Perfect competition implies that factor prices equal the value of their marginal products:

$$w = p \cdot \partial Y_A / \partial L_A$$

$$w = \partial Y_M / \partial L_M$$

$$r_A = p \cdot \partial Y_A / \partial D_A$$

$$r_M = \partial Y_M / \partial D_M$$

where:

$w$  = the wage rate in both agriculture and manufacturing,  
 $r_A$  = the rental on land in agriculture,  
 $r_M$  = the rental on land in manufacturing,  
 $p = P_A/P_M$  = the price received by producers of agricultural goods relative to manufactured goods.

Note that the immobility of land implies that land rentals can differ between sectors in the short term. However, labor is perfectly mobile so wage rates are equalized across sectors:

$$p \cdot \frac{\partial Y_A}{\partial L_A} = \frac{\partial Y_M}{\partial L_M}$$

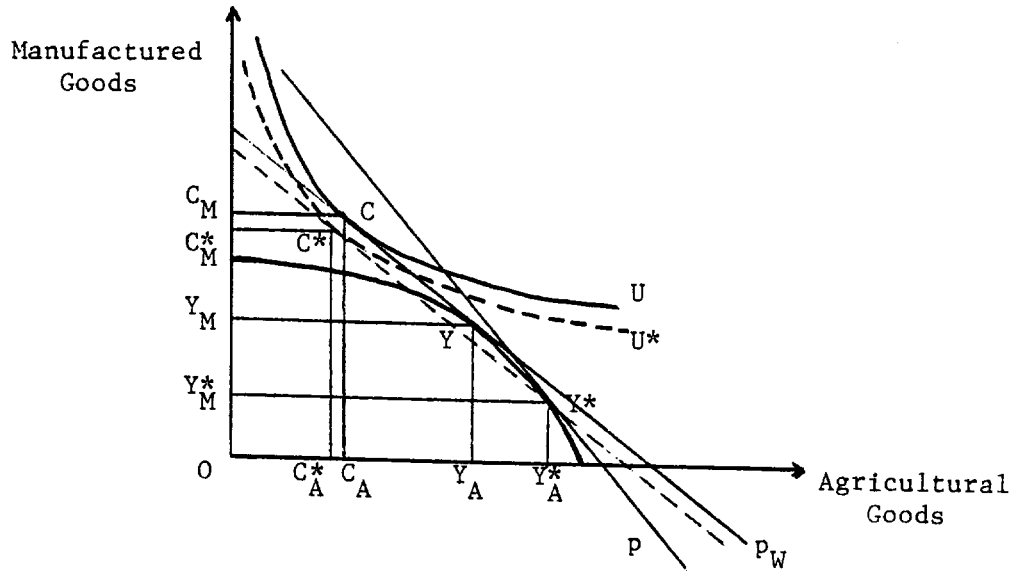
The effect of the deficiency payment scheme, *ceteris paribus*, is to raise the price received by producers of agricultural goods relative to manufactured goods (that is,  $dp > 0$ ), whereas the price paid by consumers of agricultural goods relative to manufactured goods remains unchanged at the world price ratio,  $p_w$ . Acreage controls amount to a reduction in the quantity of land available to the agricultural sector (that is,  $d\bar{D}_A < 0$ ).

### 3. SHORT RUN RESPONSES TO DEFICIENCY PAYMENTS

The effects of the deficiency payments scheme on domestic production and consumption are shown in Figure 1 below.

With no deficiency payment scheme production takes place at  $Y$  where the production possibility frontier is tangential to the world price line,  $p_w$ . Consumption occurs at point  $C$  where the world price line through  $Y$  touches the highest social indifference curve,  $U$ . Exports of agricultural goods equal to  $Y_A - C_A$  are exchanged at world prices for  $C_M - Y_M$  imports of manufactured goods.

Figure 1



The deficiency payment scheme increases the price ratio facing agricultural producers from  $p_w$  to  $p$  and consequently production changes to  $Y^*$  with more agricultural goods and fewer manufactures being produced. Consumers, however, continue to pay world prices  $p_w$ , so, under the assumption of balanced trade, consumption changes to  $C^*$  where the world price line through  $Y^*$  touches the highest social indifference curve,  $U^*$ . Clearly, consumers are worse off under the deficiency payment scheme. Exports of agricultural goods increase to  $Y_A^* - C_A^*$  and imports of manufactures increase to  $C_M^* - Y_M^*$ .

These, and other, results will now be derived algebraically.

Result 1: A deficiency payment scheme attracts labor into agriculture from manufacturing.

Given  $p \cdot \frac{\partial Y_A}{\partial L_A} = \frac{\partial Y_M}{\partial L_M}$  total differentiation implies:

$$\frac{\partial Y_A}{\partial L_A} \cdot dp + p \cdot \frac{\partial^2 Y_A}{\partial L_A^2} \cdot dL_A = \frac{\partial^2 Y_M}{\partial L_M^2} \cdot dL_M \quad (1)$$

But  $L_A + L_M = \bar{L}$  so

$$dL_M = -dL_A \quad (2)$$

Substituting (2) into (1) and rearranging gives:

$$dL_A = \frac{-\partial Y_{A/\partial L_A}}{p \cdot \partial^2 Y_{A/\partial L_A^2} + \partial^2 Y_{M/\partial L_M^2}} \cdot dp \quad (3)$$

Hence<sup>3</sup>,  $dp > 0$  implies  $dL_A > 0$  and  $dL_M < 0$ , that is, employment of labor rises in the agricultural sector but falls in the manufacturing sector as a result of an increase in the relative price of agricultural goods.

Result 2: A deficiency payment scheme increases nominal wage rates.

Total differentiation of  $w = p \cdot \partial Y_{A/\partial L_A}$  gives:

$$dw = dp \cdot \partial Y_{A/\partial L_A} + p \cdot \partial^2 Y_{A/\partial L_A^2} \cdot dL_A$$

Substituting  $dL_A$  from equation (3) and rearranging gives:

$$dw = \frac{\partial Y_{A/\partial L_A} \cdot \partial^2 Y_{M/\partial L_M^2}}{p \cdot \partial^2 Y_{A/\partial L_A^2} + \partial^2 Y_{M/\partial L_M^2}} \cdot dp$$

$$\therefore \frac{dw}{w} = \frac{\partial^2 Y_{M/\partial L_M^2}}{p \cdot \partial^2 Y_{A/\partial L_A^2} + \partial^2 Y_{M/\partial L_M^2}} \cdot \frac{dp}{p} \quad (4)$$

Hence,  $dp > 0$  implies  $dw > 0$  but  $0 < \frac{dw}{w} < \frac{dp}{p}$ , that is, nominal wage rates rise in response to an increase in relative prices, but by a smaller percentage than relative prices themselves.

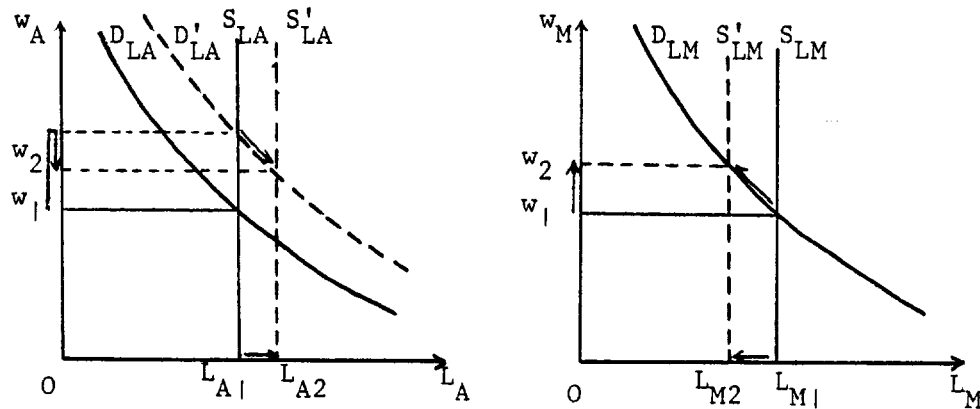
<sup>3</sup> In interpreting results, keep in mind that  $\partial Y_{A/\partial L_A} > 0$ ,  $\partial Y_{M/\partial L_M} > 0$ ,

$\partial^2 Y_{A/\partial L_A^2} < 0$ ,  $\partial^2 Y_{M/\partial L_M^2} < 0$ .



The story behind equations (3) and (4) is as follows. An increase in the relative price of agricultural goods, *ceteris paribus*, increases the demand for agricultural labor and thereby increases nominal wage rates in the agricultural sector. Labor is attracted out of manufacturing into agriculture and as it does so the marginal physical product (MPP) of labor in manufacturing rises and the MPP of labor in agriculture falls until eventually wage rates are equalized across sectors at a new, higher, nominal level. This process is illustrated in Figure 2 below. The rise in nominal wage rates proves to be smaller than the rise in relative prices facing producers hence real labor costs to agricultural producers fall and to manufacturers rise. However, relative prices facing consumers are unchanged so real wages received by consumers rise.

Figure 2



Result 3: A deficiency payment scheme increases nominal and real returns to agricultural land.

Given  $r_A = p \cdot \frac{\partial Y_A}{\partial D_A}$ , total differentiation implies:

$$dr_A = \frac{\partial Y_A}{\partial D_A} \cdot dp + p \cdot \frac{\partial^2 Y_A}{\partial L_A \partial D_A} \cdot dL_A$$

$$\text{But}^4 \frac{\partial^2 Y_i / \partial L_i \partial D_i}{D_i} = - \frac{L_i}{D_i} \frac{\partial^2 Y_i / \partial L_i^2}{L_i} = - \frac{D_i}{L_i} \frac{\partial^2 Y_i / \partial D_i^2}{L_i} = \frac{\partial^2 Y_i / \partial D_i \partial L_i}{L_i} \quad (5)$$

$i = A, M$

$$\text{so } dr_A = \frac{\partial Y_A}{\partial D_A} \cdot dp - \frac{pL_A}{D_A} \cdot \frac{\partial^2 Y_A}{\partial L_A^2} \cdot dL_A$$

Substituting  $dL_A$  from equation (3) into the above equation and rearranging gives:

$$dr_A = \frac{\partial Y_A}{\partial D_A} \cdot dp + \frac{pL_A}{D_A} \cdot \frac{\partial^2 Y_A}{\partial L_A^2} \cdot \frac{\partial Y_A / \partial L_A \cdot dp}{p \frac{\partial^2 Y_A}{\partial L_A^2} + \frac{\partial^2 Y_M}{\partial L_M^2}}$$

$$\frac{dr_A}{r_A} = \left\{ 1 + \frac{w \cdot p / r_A \cdot L_A / D_A \cdot \frac{\partial^2 Y_A}{\partial L_A^2}}{p \frac{\partial^2 Y_A}{\partial L_A^2} + \frac{\partial^2 Y_M}{\partial L_M^2}} \right\} \frac{dp}{p} \quad (6)$$

Hence,  $dp > 0$  implies  $dr_A > 0$  and  $0 < \frac{dp}{p} < \frac{dr_A}{r_A}$ , that is, land rentals in agriculture rise by a larger percentage than relative prices received by producers. Since relative prices facing consumers do not change, land rentals in agriculture rise in both nominal and real terms as a result of an increase in the relative price of agricultural goods.

**Result 4:** A deficiency payment scheme reduces returns to manufacturing land.

Given  $r_M = \frac{\partial Y_M}{\partial D_M}$  total differentiation implies

$$dr_M = \frac{\partial^2 Y_M}{\partial L_M \partial D_M} \cdot dL_M \text{ and by equation (5)}$$

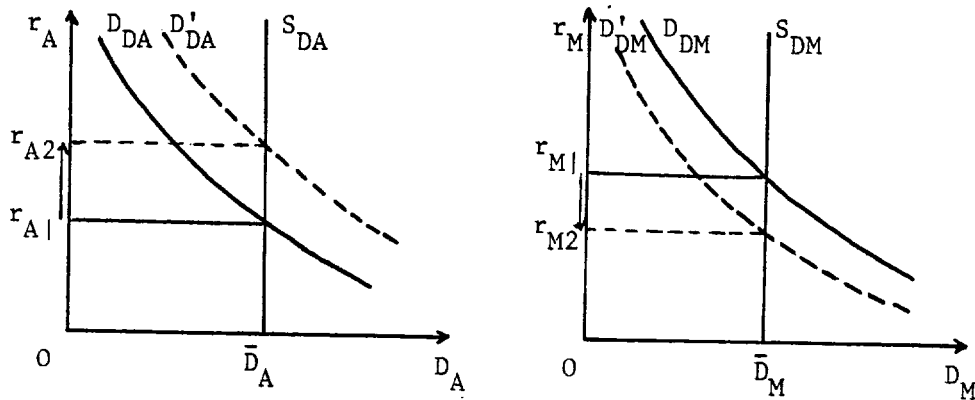
$$dr_M = - \frac{L_M}{D_M} \cdot \frac{\partial^2 Y_M}{\partial L_M^2} \cdot dL_M$$

<sup>4</sup> See Mayer (3), p. 961.

Hence,  $dL_M < 0$  implies  $dr_M < 0$ , that is returns to land in manufacturing fall as a result of an increase in the relative price of agricultural goods.

The increased level of labor employed in agriculture increases the demand for agricultural land (since the MPP schedule of land is increased) and thereby leads to a rise in agricultural land rentals in both nominal and real terms. The reduced level of labor employed in manufacturing decreases the demand for land in the manufacturing sector and thereby leads to a fall in land rentals in that sector (see Figure 3). Notice that owners of both resources used in the agricultural sector benefit from the price increase, whereas owners of land in the manufacturing sector are worse off.

Figure 3



Result 5: Deficiency payments increase agricultural output but reduce manufacturing output.

Given  $Y_A = Y_A(L_A, \bar{D}_A)$ ,  $dY_A = \partial Y_A / \partial L_A \cdot dL_A$  so  $dL_A > 0$  implies  $dY_A > 0$ . Similarly,  $Y_M = Y_M(L_M, \bar{D}_M)$  so  $dY_M = \partial Y_M / \partial L_M \cdot dL_M$ . Hence,  $dL_M < 0$  implies  $dY_M < 0$ . That is, agricultural output rises and manufacturing output falls as labor migrates from the manufacturing sector into the agricultural sector in

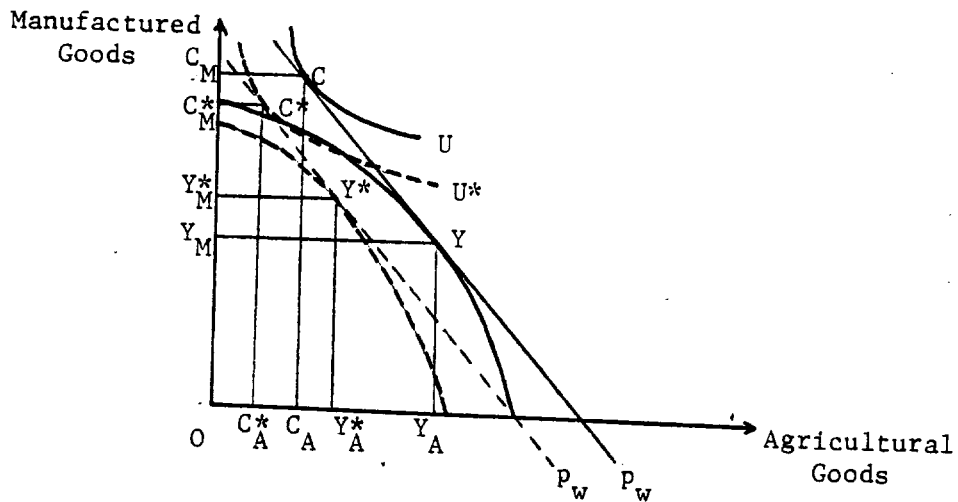
response to the temporary wage rate difference in the two sectors. This was shown in Figure 1.

In the long run all resources are mobile, so land rentals will be equalized across sectors as land is diverted from the manufacturing sector into agriculture. According to the Stolper-Samuelson Theorem, the increase in the relative price of agricultural goods will lead to an increase in the return to the resource which is used relatively intensively in the production of agricultural goods (presumably land) and to a reduction in the return to the resource which is used relatively intensively in the production of manufactures (presumably labor).

4. SHORT RUN RESONSES TO ACREAGE CONTROLS

The effects of acreage controls on production and consumption are shown in Figure 4 below..

Figure 4



Before acreage reductions are imposed, production occurs at point Y and consumption at point C, where the (world) price line,  $p = p_w$ , is tangential

to the production possibility frontier, and the highest social indifference curve, respectively.  $Y_A - C_A$  of agricultural goods are exported and  $C_M - Y_M$  of manufactures are imported.

When acreage controls are imposed in the agricultural sector, the production possibility frontier shifts inward, and, with world prices unchanged, production takes place at point  $Y^*$  and consumption at point  $C^*$ . Note that social welfare is reduced from  $U$  to  $U^*$ , imports fall to  $C_M^* - Y_M^*$  and exports fall to  $Y_A^* - C_A^*$ .

We now turn to an algebraic derivation of these, and other, results.

Result 6: Acreage controls lead to a migration of labor out of agriculture into manufacturing.

Given  $p \cdot \partial Y_{A/\partial L_A} = \partial Y_{M/\partial L_M}$ , total differentiation implies:

$$p(\partial^2 Y_{A/\partial L_A^2} \cdot dL_A + \partial^2 Y_{A/\partial D_A \partial L_A} \cdot dD_A) = \partial^2 Y_{M/\partial L_M^2} \cdot dL_M$$

Substituting equations (2) and (5) into the above equation and rearranging gives:

$$dL_A = \frac{p \cdot L_{A/D_A} \cdot \partial^2 Y_{A/\partial L_A^2}}{p \cdot \partial^2 Y_{A/\partial L_A^2} + \partial^2 Y_{M/\partial L_M^2}} \cdot dD_A \quad (7)$$

Hence,  $dD_A < 0$  implies  $dL_A < 0$  and  $dL_M > 0$ , that is, labor migrates from agriculture into manufacturing as a result of acreage controls in the agricultural sector.

Note that in a small, open economy, acreage controls do not affect prices. This is a very different result from that which occurs in a closed economy. A large, open economy can raise price by restricting output via

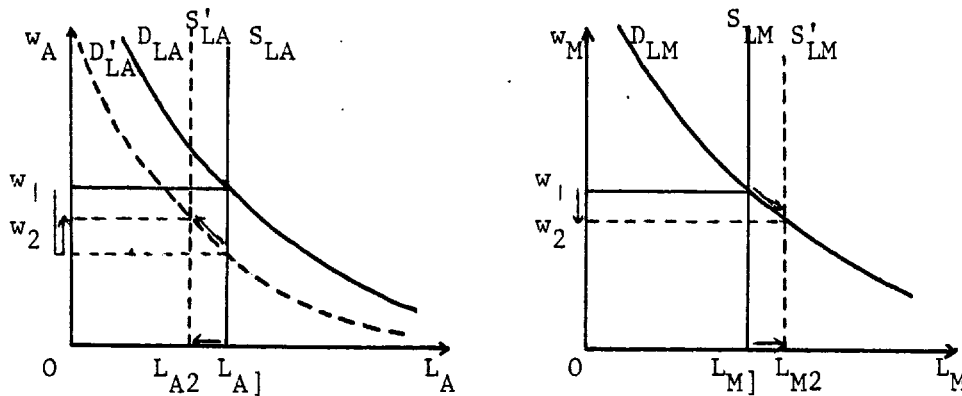
acreage controls but since demand from the rest of the world is more elastic than domestic demand, its ability to do so is less than that of a closed economy.

Result 7: Acreage controls lead to wage reductions.

Given  $w = \partial Y_M / \partial L_M$ ,  $dw = \partial^2 Y_M / \partial L_M^2 \cdot dL_M$  so  $dL_M > 0$  implies  $dw < 0$ , that is, wage rates fall as a result of acreage controls in the agricultural sector.

Figure 5 depicts the results given by the above equations. A reduction in the amount of land employed in the agricultural sector, ceteris paribus, reduces the demand for labor in that sector (since the MPP schedule of labor in agriculture shifts to the left) and thereby depresses wage rates in the agricultural sector. Labor migrates from agriculture into manufacturing and as it does so the MPP of labor in agriculture rises and the MPP of labor in manufacturing falls until eventually wage rates are equalized across sectors again but at a lower level than before the acreage controls were imposed.

Figure 5



Result 8: Acreage controls increase returns to land in the agricultural sector.

Given  $r_A = p \cdot \partial Y_A / \partial D_A$ , total differentiation implies:

$$dr_A = p \left\{ \partial^2 Y_A / \partial L_A \partial D_A \cdot dL_A + \partial^2 Y_A / \partial D_A^2 \cdot dD_A \right\}$$

Using equation (5) to simplify the above expression, we obtain:

$$dr_A = p \left\{ -D_A / L_A \cdot \partial^2 Y_A / \partial D_A^2 \cdot dL_A + \partial^2 Y_A / \partial D_A^2 \cdot dD_A \right\} \quad (8)$$

Substitution of equation (7) into equation (8) and some rearranging gives:

$$dr_A = \frac{p \cdot \partial^2 Y_A / \partial D_A^2 \cdot \partial^2 Y_M / \partial L_M^2 \cdot dD_A}{p \cdot \partial^2 Y_A / \partial L_A^2 + \partial^2 Y_M / \partial L_M^2}$$

Hence,  $dD_A < 0$  implies  $dr_A > 0$ , that is, land rentals in the agricultural sector rise in response to acreage controls in that sector.

Result 9: Acreage controls increase returns to land in the manufacturing sector.

Given  $r_M = \partial Y_M / \partial D_M$  total differentiation gives:

$$dr_M = \partial^2 Y_M / \partial L_M \partial D_M \cdot dL_M \text{ which, by equation (5), implies:}$$

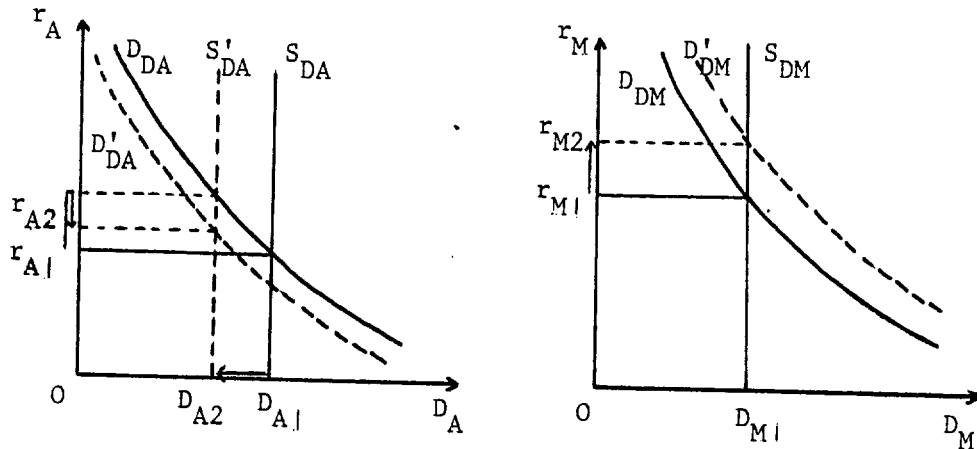
$$dr_M = -L_M / D_M \cdot \partial^2 Y_M / \partial L_M^2 \cdot dL_M$$

Hence,  $dL_M > 0$  implies  $dr_M > 0$ , that is, land rentals in the manufacturing sector rise in response to acreage controls in the agricultural sector.

The results given by the above equations are depicted in Figure 6. Initially agricultural land rentals rise as agricultural land is withdrawn from production, but as labor moves from the agricultural sector into the manufacturing sector, demand for land in agriculture falls, but not sufficiently to offset the initial price rise. Demand for land in manufac-

turing rises with the increased supply of labor and this causes land rentals in manufacturing to rise. Notice that land owners in both sectors benefit from the acreage controls in the agricultural sector, in that returns to land increase. However, ignoring direct payments for the retirement of land, total total factor payments to land in agriculture change from  $r_{A1} \cdot D_{A1}$  to  $r_{A2} \cdot D_{A2}$ , which may not necessarily be an increase, while total factor returns to land in manufacturing unambiguously increase from  $r_{M1} \cdot D_{M1}$  to  $r_{M2} \cdot D_{M1}$ .

Figure 6



Result 10: Acreage controls reduce agricultural output and increase output of manufactured goods.

$$\text{Given } Y_A = Y_A(L_A, D_A)$$

$$dY_A = \partial Y_A / \partial L_A \cdot dL_A + \partial Y_A / \partial D_A \cdot dD_A$$

Hence,  $dL_A < 0$  and  $dD_A < 0$  implies  $dY_A < 0$ , that is, agricultural output falls when land is withdrawn from production in the agricultural sector.



Similarly,  $Y_M = Y_M(L_M, D_M)$  so  $dY_M = \partial Y_M / \partial L_M \cdot dL_M$ . Hence,  $dL_M > 0$  implies  $dY_M > 0$ , that is, manufacturing output rises as a result of acreage controls in the agricultural sector since acreage controls lead to a movement of labor out of agriculture and into the manufacturing sector. These results were depicted in Figure 4.

In the long run, according to the Rybczynski Theorem, a reduction in the supply of land to the economy as a whole, *ceteris paribus*, will decrease the output of the land intensive good (that is, agriculture) and increase the output of the labor intensive good (that is, manufactures). This is in line with the results of our short run analysis. However, an implication of the Factor Price Equalization Theorem is that, in an open economy, factor endowments have no effect on factor returns, so in the long run land rentals and wage rates will be equalized across sectors at their original long run equilibrium levels.

##### 5. SHORT RUN RESPONSES TO DEFICIENCY PAYMENTS AND ACREAGE CONTROLS

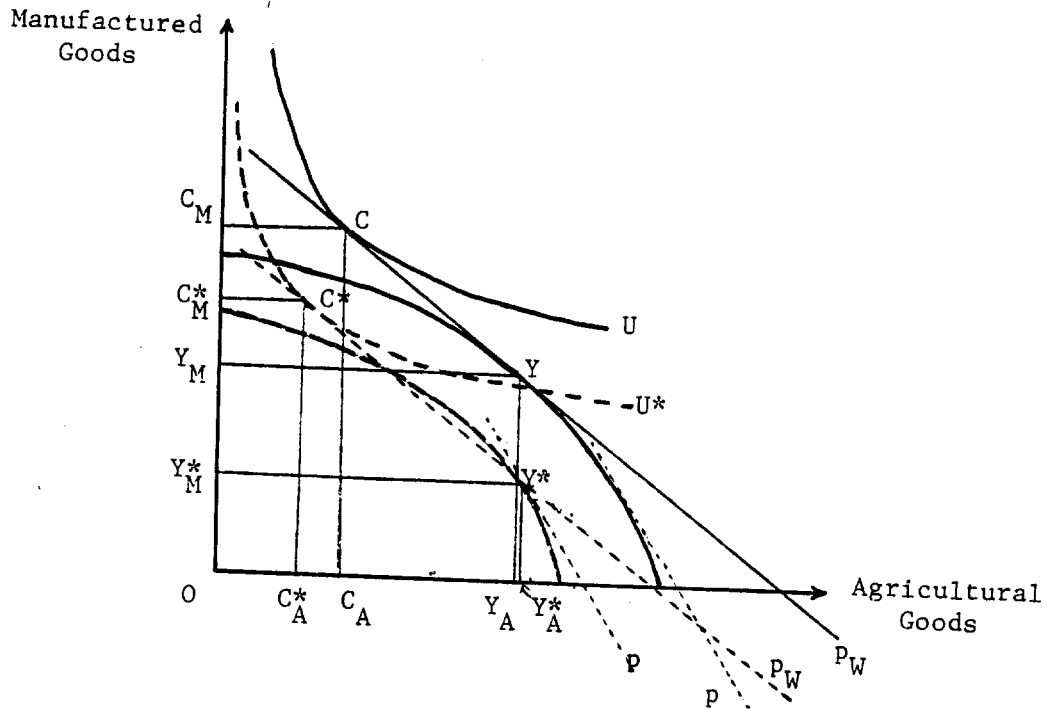
The effects of deficiency payments and acreage controls in agriculture on production and consumption are shown in Figure 7.

With no deficiency payment scheme and no acreage controls production occurs at point Y, consumption at point C, and social utility is U.

The deficiency payment scheme increases the price ratio facing producers from  $p_w$  to  $p$  while consumers continue to pay  $p_w$ . Acreage reductions in the agricultural sector shrink the production possibility frontier.

The new production point is Y\*, consumption occurs at C\* and social welfare is reduced to U\*. This fall in social welfare exceeds that which occurs under a deficiency payment scheme alone or under acreage controls

Figure 7



alone. Although consumption of both goods falls under this combined policy, changes in production levels, imports and exports cannot be predicted a priori. These results are confirmed in the algebraic treatment which follows.

Result 11: The direction of labor movements between the agricultural and manufacturing sectors depends upon the relative magnitudes of price and acreage changes and upon the elasticity of demand for labor in the agricultural sector.

Given  $p \cdot \frac{\partial Y_A}{\partial L_A} = \frac{\partial Y_M}{\partial L_M}$ , total differentiation gives:

$$\frac{\partial Y_A}{\partial L_A} \cdot dp + p \left\{ \frac{\partial^2 Y_A}{\partial L_A^2} \cdot dL_A + \frac{\partial^2 Y_A}{\partial D_A \partial L_A} \cdot dD_A \right\} = \frac{\partial^2 Y_M}{\partial L_M^2} \cdot dL_M$$

Substituting equations (2) and (5) into the above equation we obtain, after some rearranging of terms:

$$dL_A = \frac{p \cdot L_A/D_A \cdot \partial^2 Y_A/\partial L_A^2 \cdot dD_A - \partial Y_A/\partial L_A \cdot dp}{p \cdot \partial^2 Y_A/\partial L_A^2 + \partial^2 Y_M/\partial L_M^2} \quad (9)$$

With  $dD_A < 0$  and  $dp > 0$  the sign of  $dL_A$  could be either positive or negative, so we cannot predict a priori whether labor will move out of agriculture into manufacturing, or vice versa, in response to a program of deficiency payments combined with acreage controls. However, closer examination of equation (9) reveals that:

$$\frac{L_A}{\partial Y_A/\partial L_A} \cdot \frac{\partial(\partial Y_A/\partial L_A)}{\partial L_A} \cdot \frac{dD_A}{D_A} \leq \frac{dp}{p} \text{ implies } dL_A \geq 0$$

$$\text{or } \frac{dD_A}{D_A} \leq \frac{dp}{p} \cdot e \text{ implies } dL_A \geq 0 \quad (10)$$

where  $e$  is the price elasticity of demand for labor in the agricultural sector.

Proof:

$$w = p \cdot \partial Y_A/\partial L_A$$

$$\frac{1}{e} = \frac{L_A}{w} \cdot \frac{dw}{dL_A} = \frac{p \cdot \partial(\partial Y_A/\partial L_A)}{\partial L_A} \cdot \frac{L_A}{p \cdot \partial Y_A/\partial L_A} = \frac{\partial(\partial Y_A/\partial L_A)}{\partial L_A} \cdot \frac{L_A}{\partial Y_A/\partial L_A}$$

The more elastic is the demand for labor in agriculture (that is, the larger is  $|e|$ ), the smaller the rise in prices has to be relative to the reduction in acreage, in order to attract labor out of manufacturing into agriculture. If demand for labor in agriculture is elastic (that is,  $|e| > 1$ ) then provided the percentage increase in price exceeds the percentage reduc-

tion in acreage, labor will migrate from manufacturing to agriculture. If, on the other hand, demand for labor in agriculture is inelastic (that is,  $|e| < 1$ ) then provided the percentage increase in price is less than the percentage reduction in acreage, labor will move from agriculture into the manufacturing sector.

We turn now to the effect of deficiency payments and acreage controls on wage rates.

Result 12: Whether nominal wages rise or fall depends upon the relative magnitudes of price and acreage changes and on the elasticity of demand for labor in the agricultural sector.

Given  $w = p \cdot \partial Y_A / \partial L_A$  total differentiation gives:

$$dw = \partial Y_A / \partial L_A \cdot dp + p \{ \partial^2 Y_A / \partial L_A^2 \cdot dL_A + \partial^2 Y_A / \partial D_A \partial L_A \cdot dD_A \}$$

Substituting equations (5) and (9) into this expression and rearranging gives:

$$dw = \frac{\partial^2 Y_M / \partial L_M^2 \{ \partial Y_A / \partial L_A \cdot dp - p \cdot L_{A/D_A} \cdot \partial^2 Y_A / \partial L_A^2 \cdot dD_A \}}{p \cdot \partial^2 Y_A / \partial L_A^2 + \partial^2 Y_M / \partial L_M^2} \quad (11)$$

Since  $dp > 0$  and  $dD_A < 0$ , the sign of  $dw$  could be positive or negative so the change in nominal wage rates resulting from a deficiency payment scheme with acreage controls cannot be predicted a priori. However, we see from equation (11) that

$$\frac{dD_A}{D_A} \lesseqgtr \frac{dp}{p} \cdot e \text{ implies } dw \gtrless 0 \quad (12)$$

where, once again,  $e$  is the price elasticity of demand for labor in the

agricultural sector. The more elastic is the demand for labor in agriculture (that is, the larger is  $|e|$ ), the smaller the price rise has to be relative to the reduction in acreage, in order to increase the nominal wage rate. If demand for labor in agriculture is elastic (that is, if  $|e| > 1$ ), then provided the percentage increase in price exceeds the percentage reduction in acreage, the nominal wage rate will rise. If demand for labor in agriculture is inelastic (that is, if  $|e| < 1$ ), then provided the percentage increase in price is less than the percentage reduction in acreage, the nominal wage rate will fall.

Equation (11) can be rewritten as:

$$\frac{dw}{w} = \frac{\partial^2 Y_M / \partial L_M^2}{p \cdot \partial^2 Y_A / \partial L_A^2 + \partial^2 Y_M / \partial L_M^2} \cdot \frac{dp}{p} - \frac{\partial^2 Y_M / \partial L_M^2 \cdot p \cdot L_{A/w} \cdot \partial^2 Y_A / \partial L_A^2}{p \cdot \partial^2 Y_A / \partial L_A^2 + \partial^2 Y_M / \partial L_M^2} \cdot \frac{dD_A}{D_A} \quad (13)$$

or

$$\frac{dw}{w} = a \cdot \frac{dp}{p} - b \cdot \frac{dD_A}{D_A}$$

where  $0 < a < 1$  and  $b < 0$ . Hence,  $\frac{dp}{p} > 0$  and  $\frac{dD_A}{D_A} < 0$  implies  $\frac{dw}{w} < \frac{dp}{p}$ , that

is, even if nominal wages rise they do so by a smaller percentage than relative prices facing producers. However, relative prices facing consumers are unchanged so real wages received by consumers may rise or fall when a policy of deficiency payments and acreage controls is introduced into the agricultural sector.

Next the effect of the program on returns to land in the two sectors is investigated.

Result 13: A combination of deficiency payments and acreage controls increases returns to land in the agricultural sector in both nominal and real terms.

Total differentiation of  $r_A = p \cdot \partial Y_A / \partial D_A$  gives:

$$dr_A = \partial Y_A / \partial D_A \cdot dp + p \{ \partial^2 Y_A / \partial L_A \partial D_A \cdot dL_A + \partial^2 Y_A / \partial D_A^2 \cdot dD_A \}$$

Substituting equations (5) and (9) into the above expression and simplifying gives:

$$dr_A = \left\{ \partial Y_A / \partial D_A + \frac{p \cdot D_{A/L_A} \cdot \partial^2 Y_A / \partial D_A^2 \cdot \partial Y_A / \partial L_A}{p \cdot \partial^2 Y_A / \partial L_A^2 + \partial^2 Y_M / \partial L_M^2} \right\} dp + \frac{p \cdot \partial^2 Y_A / \partial D_A^2 \cdot \partial^2 Y_M / \partial L_M^2}{p \cdot \partial^2 Y_A / \partial L_A^2 + \partial^2 Y_M / \partial L_M^2} \cdot dD_A \quad (14)$$

Hence,  $dp > 0$  and  $dD_A < 0$  implies  $dr_A > 0$ , that is, the nominal rental on land in agriculture rises as a result of deficiency payments and acreage controls. Furthermore, the percentage increase in land rentals is given by:

$$\begin{aligned} \frac{dr_A}{r_A} &= \left\{ 1 + \frac{p \cdot w / r_A \cdot D_{A/L_A} \cdot \partial^2 Y_A / \partial D_A^2}{p \cdot \partial^2 Y_A / \partial L_A^2 + \partial^2 Y_M / \partial L_M^2} \right\} \frac{dp}{p} + \frac{D_{A/r_A} \cdot p \cdot \partial^2 Y_A / \partial D_A^2 \cdot \partial^2 Y_M / \partial L_M^2}{p \cdot \partial^2 Y_A / \partial L_A^2 + \partial^2 Y_M / \partial L_M^2} \frac{dD_A}{D_A} \quad (15) \\ &= c \cdot \frac{dp}{p} + f \cdot \frac{dD_A}{D_A} \end{aligned}$$

where  $c > 1$  and  $f < 0$ . Hence,  $dp/p > 0$  and  $dD_A/D_A < 0$  imply  $dr_A/r_A > dp/p$ , that is, nominal returns to land in agriculture rise more than relative prices facing producers. Relative prices facing consumers remain constant so real returns to land in agriculture rise.

Result 14: Whether returns to land in the manufacturing sector rise or fall depends upon the relative magnitudes of price and acreage changes and upon

the elasticity of demand for labor in the agricultural sector.

Totally differentiating  $r_M = \partial Y_M / \partial D_M$  gives:

$$dr_M = \frac{\partial^2 Y_M}{\partial L_M \partial D_M} \cdot dL_M$$

which simplifies, using equation (5) to:

$$dr_M = -L_M/D_M \cdot \frac{\partial^2 Y_M}{\partial L_M^2} \cdot dL_M \quad (16)$$

Hence,  $dr_M$  is directly related to  $dL_M = -dL_A$  and we have already seen that the sign of the latter depends upon the relative size of  $dp/p$  and  $dD_A/D_A$  (see equation (10)). The more elastic is the demand for labor in agriculture (that is, the larger is  $|e|$ ), the smaller the rise in agricultural prices has to be relative to the reduction in agricultural acreage, in order to attract labor out of manufacturing and into agriculture and thereby result in a decrease in nominal land rentals in the manufacturing sector. If demand for labor in agriculture is elastic (that is, if  $|e| > 1$ ), then provided the percentage increase in price exceeds the percentage reduction in agricultural acreage, nominal land rentals in manufacturing will fall. However, if demand for labor in agriculture is inelastic (that is, if  $|e| < 1$ ), then provided the percentage increase in price is less than the percentage reduction in agricultural acreage, nominal and real land rentals in manufacturing will rise. Notice that the fortunes of land owners in the manufacturing sector move in the opposite direction to those of labor in terms of factor returns.

Result 15: The effect of deficiency payments and acreage controls on the outputs of the two sectors depends upon the relative sizes of price and acreage changes and upon the elasticity of demand for labor in the agri-

cultural sector.

Given  $Y_A = Y_A(L_A, D_A)$  then

$$dY_A = \frac{\partial Y_A}{\partial L_A} \cdot dL_A + \frac{\partial Y_A}{\partial D_A} \cdot dD_A \quad (17)$$

and given  $Y_M = Y_M(L_M, D_M)$  then

$$dY_M = \frac{\partial Y_M}{\partial L_M} \cdot dL_M \quad (18)$$

From equations (17) and (18) we see that changes in the outputs of the two goods depend upon the direction in which labor moves between the two sectors. If the increase in price is sufficiently large to attract labor out of manufacturing and into the agricultural sector then manufacturing output will fall but agricultural output may either rise or fall. But if the movement of labor is from agriculture into the manufacturing sector then agricultural output will fall and manufacturing output will rise.

## 6. SUMMARY OF RESULTS

All three policies examined in this paper reduce social welfare compared with the free market equilibrium, but they differ in terms of the distribution of benefits and costs among the three groups: labor, owners of agricultural land and land owners in the manufacturing sector.

A deficiency payment program in a small, open economy attracts labor out of the manufacturing sector into the agricultural sector and consequently results in increased agricultural output and reduced output in the rest of the economy. Labor and land owners in the agricultural sector experience increased factor returns whereas land owners in the rest of the economy receive lower factor rentals.



A program of acreage reductions in a small, open economy is unable to raise the price of agricultural output, as it does in a closed economy, since prices are formed in the world market and the latter is unresponsive to supply conditions in individual countries. Acreage reductions result in a movement of labor out of the agricultural sector into manufacturing and consequently agricultural output falls but output of manufactured goods rises. Owners of fixed resources in both sectors experience increased factor returns whereas wage rates fall. Since the problem of low incomes in the agricultural sector is essentially a problem of low labor income, acreage reductions are unlikely to alleviate the problem.

When deficiency payments and acreage reductions are simultaneously applied, only owners of agricultural land benefit unambiguously. This is not surprising since they are the one group of factor owners who benefit from both individual programs. Other results depend upon relative changes in deficiency payments and acreage reductions and on the elasticity of demand for labor in the agricultural sector. Empirical evidence suggests that the latter is price inelastic (4) and that in recent years acreage reductions have been relatively large (1). Under these assumptions labor moves out of agriculture into manufacturing and, as a result, agricultural output falls and manufacturing output rises. Labor does not benefit since nominal and real wages fall so the combined policy does not alleviate the problem of low labor incomes in the agricultural sector. However, land owners in the manufacturing sector are better off since nominal and real land rentals rise. This may help to explain the lack of opposition to this type of agricultural price support policy displayed by producers in the rest of the economy.

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