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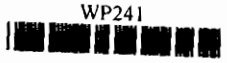
Working Paper



INDIAN INSTITUTE OF MANAGEMENT AHMEDABAD

DISTRIBUTIVE BIAS OF NEW FOODGRAIN TECHNOLOGIES AND FLOW OF CREDIT

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W P No. 241
Sep.1978

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I Introduction

There is ample evidence to show that the gains of new foodgrain technologies in developing countries have been unevenly distributed among different socio-economic classes such as big and small farmers, and landless labourers.[1/] In particular, as foodgrain production increased, although the absolute share of all socio-economic classes might have increased, the relative share of farmers increased while that of landless labourers has decreased. As a follow up of this finding there are some indepth studies on the impact of such inequitable distribution upon the supply of wage goods and employment.[2/]

1/ See Mellor John W., The New Economics of Growth : A strategy for India and the Developing World, Cornell University Press, Ithaca, 1976; Rao C.H.H. Technological Change and Distribution of Gains in Indian Agriculture, The Macmillan Company of India Ltd., Delhi, 1975; Ranade C G ''Distribution of Benefits from New Agricultural Technologies - A Study at Farm Level'' Unpublished Ph.D. Thesis, Cornell University, 1976; and Srivastava Uma K and Earl O Heady, ''Technological Change and Relative Factor Shares in Indian Agriculture'', American Journal of Agricultural Economics August, 1973.

2/ See Mellor op.cit: and Kelley, A.C., J.G., Williamson and R.J. Cheetam, Dualistic Economic Development, The University of Chicago Press, Chicago, 1972.

However its impact upon inter-sectoral flow of credit has not received much attention. Indeed, the work on inter-sectoral flow of resources in India has focused mainly on the time-series of either aggregate terms of trade [3] or the flow of consumer and producer goods between agriculture and non-agricultural sectors without relating them to income distribution. [4]

The purpose of this paper is to formulate a model for foodgrain and non-foodgrain sectors that relates biased technological change with the intersectoral net flow of credit. The basic framework is drawn from a dualistic model formulated by Lele and Mellor.[5] Their model, however, ignores capital formation in the foodgrain sector and considers an exgenously given capital stock in the non-foodgrain sector. The model in this paper explicitly

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3/ Thamarajakshi R ''Intersectoral Terms of Trade and Marketable Surplus of Agricultural Produce, 1951-52 to 1965-66,''' Economic and Political Weekly'', 23 June 1969.

4/ See Mundle S, ''Intersectoral Resource Flow in Post-Colonial India'' Indian Economic Review, Vol.XII (New Series), No.2 October, 1977 pp.151-167, Asian Development Bank : Asian Agricultural Survey, 1976, Rural Asia, Challenge and Opportunity, Manila, 1977

5/ See Lele Uma J and John W Mellor, ''Technological Change Distributive Bias and Labour Transfer in a Two Sector Economy,'' Occasional Paper No.43, Department of Agricultural Economics, Cornell University (Revised) February, 1977

incorporates capital formation in the foodgrain sector by allocating capital stock between two sectors through competitive interest rate. The distributive bias of new technologies is identified with changes in the relative shares of landlords who own land and capital and of landless labourers who are not fully employed.

It is assumed that at the beginning of crop season landlords take credit and invest it fully in the capital input used in foodgrain production. This credit is taken from the non-foodgrain sector at the market rate of interest. Landlords save fixed proportion of income from land and capital at the end of crop year. Labourers spent all of their income on consumption. The difference between landlords savings and the value of capital stock in foodgrain production plus the corresponding rate of interest at the end of crop season on the amount of credit taken is the net transfer of credit between foodgrain and non-foodgrain sector.

Then the paper shows that given significant differences in the price and income elasticities of demand for foodgrains by labourers and owners of land and capital, the net flow of credit and the competitive rate of interest are sensitive to changes in relative output shares.

And, at the same time the capital-labour ratio in the non-foodgrain sector and the terms of trade change in order to maintain equilibrium between two sectors.

The analytical framework is presented in Section II. Section III deals with sensitivity analysis and implications of biased technological change.

Analytical Framework

The production function for foodgrains, assumed to have constant returns to scale and diminishing marginal rates of substitution, is as follows :

$$(1) \quad A = F(Z, K_A, l_A)$$

where A is foodgrains output, Z is fixed area under foodgrains and K_A and l_A are respectively the amounts of capital stock and labour in production.

The production function for the non-foodgrain sector is Cobb-Douglas linear homogeneous of the first degree as follows

$$(2) \quad Q = K_I^{\alpha} L_I^{1-\alpha}$$

where Q is non-foodgrain output; K_I and L_I are respectively capital and labour inputs; and α is the relative share of capital (constant).

In the foodgrain labour market an equilibrium is reached at a constant wage rate W_A equal to the marginal product of labour. This wage rigidity results into an underemployment equilibrium such that $l_A < L_A$ where L_A is the total foodgrain labour force. Then the relative share of labour S_L and the average income of labourers Y in the foodgrain sector are :

$$(3) \qquad S_L = \frac{l_A W_A}{A} \quad \text{and} \quad Y = \frac{l_A W_A}{L_A} = \frac{S_L A}{rL}$$

where r is the proportion of foodgrain labour force in the exogenously given total labour force L.

In the non-foodgrain sector labourers are fully employed at competitive wage rate (W_I) equalling the marginal productivity of labour and the foodgrain labour migrates to the non-foodgrain sector until per capita income of labourers in the latter (W_I) is equal to a certain of proportion of the per capita labour income in the former sector. Thus,

$$(4) \quad PY = P \frac{S_L A}{rL} = \beta W_I = \beta(1-\alpha)\, k_I^{\alpha}$$

where α is an exogenously given constant of proportionality P is for the terms of trade between two sectors expressed in terms of foodgrains and k_I is the capital labour ratio in the non-foodgrain sector.

An exogenously produced capital stock (K) is allocated between two sectors according to the competitive rate of return (R). Then,

(5) $K = K_A + K_I$ and

(6) $PR = \alpha k_I^{\alpha-1}$

Note that under this assumption the rate of return on capital is equal to the rate of interest. Further more it is assumed that the non-foodgrain sector is more capital intensive than the non-foodgrain sector. Then,

(7) $k_I > k > k_A$

where k and k_A are respectively capital per unit of labour in both sectors together and in the foodgrain sector.

(8) $k = rk_A + (1-r)\, k_I$

Now dividing equation (4) by (6) we get

(9) $$\frac{S_L}{S_K} = \frac{\beta(1-\alpha)}{\alpha} \quad \frac{k_I}{k_A}$$

where $S_K = \frac{\partial A}{\partial K_A} \frac{K_A}{A} = \frac{RK_A}{A}$ is the relative share of capital in the foodgrain output. Since we are assuming constant return to scale, the relative share of land (S_Z) is given by :

(10) $S_Z = 1 - S_K - S_L$

Then the net transfer of credit (NT) from the foodgrain sector

is the difference between savings of landlords and the amount of credit to be paid plus one year's interest on it.

$$(11) \quad NT = s\,(S_Z + S_K)\,A - K_A\,(1+R) = sS_ZA - S_KA\,(1-s) - \frac{S_K}{R}$$

where s is the exogenously given average propensity to save.

Equilibrium in the foodgrain market is attained when the marketed supply of foodgrains to the non-foodgrain sector is equal to its demand for foodgrains. That is,

$$(12) \quad A - C_1 - bS_LA = b\,\frac{W_I}{P}\,L_I + C_2$$

where C_1 and C_2 are the quantities of foodgrains consumed by landlords and capital owners in the non-foodgrain sector respectively. It is assumed that demand for foodgrains by these classes is price and income inelastic. Furthermore, b is the budget share of foodgrains by labourers which is a function of terms of trade and their income such that $\frac{\partial b}{\partial P} < 0$ and $\frac{\partial b}{\partial Y} < 0$. By using equation (4) and substituting $C = C_1 + C_2$, (11) can be rewritten as

$$(13) \quad A - C - bS_LA/r = 0$$

It can be seen that given the values of exogenous variables Z, W_A, L, K, C and s; the endogenous variables can be uniquely determined from the above simultaneous equations.

III Sensitivity Analysis

Technological change first increases foodgrain production and its effect upon endogenous variables is examined according to its effect upon the relative factor shares. This is done by first differentiating both sides of equations (4), (9) and (13) logarithmically with respect to technology while holding K and L constant. Then we get three equations with variables such as changes in P, r, k_I A, S_L and S_L. These three derived equations are solved by using Cramer's rule for given values of changes in foodgrain output and relative factor shares.[5] Then we get

$$(14)\quad \frac{\dot{DP}}{P} = \alpha\frac{k_I - k_A}{k_A}\left(\frac{A}{A-C} - n\right)\frac{\dot{A}}{A} + \frac{k}{rk_A}\frac{\dot{A}}{A} - n\alpha\left(\frac{k_I}{k_A}\frac{\dot{S}_L}{S_L} - \frac{\dot{S}_K}{S_K}\right)$$

$$(15)\quad \frac{\dot{Dk_I}}{k_I} = \frac{k_I - k_A}{k_A}\left(\frac{A}{A-C} - n + \epsilon\right)\frac{\dot{A}}{A} - (n-\epsilon)\left(\frac{k_I}{k_A}\frac{\dot{S}_L}{S_L} - \frac{\dot{S}_K}{S_K}\right)$$

$$(16)\quad \frac{\dot{Dr}}{r} = \frac{k}{rk_A}\left(\frac{A}{A-C} - n + \epsilon\right)\frac{\dot{A}}{A} - (n-\epsilon)\frac{k}{rk_A}\frac{\dot{S}_L}{S_L} - \alpha\epsilon\left(\frac{\dot{S}_L}{S_L} - \frac{\dot{S}_K}{S_K}\right)$$

where $D = \epsilon\dfrac{k_I - k_A}{k_A} - (n-\epsilon)\dfrac{k}{rk}$; and

n and ϵ are the income and price elasticities of demand for food by labourers, respectively.

Similarly differentiating (4), (9) and (13) logarithmically with respect to t for changes in total capital stock K

5/ for the basic methodology behind this approach, see Samuelson, Paul A. Foundations of Economic Analysis Harvard University Press, New York, 1970, pp.7-20

and holding foodgrain production, relative factor shares and population constant, we get

$$(17)\quad \frac{\dot{DP}}{P} = -\alpha n \frac{K}{K_A}\frac{\dot{K}}{K}\ ;\ \frac{\dot{Dk_I}}{k_I} = -(n-\epsilon)\frac{K}{K_A}\frac{\dot{K}}{K} \text{ and } \frac{\dot{Dr}}{r} = n\frac{K}{K_A}\frac{K}{K_A}$$

On the basis of above four equations, and (6) and (10) the following sensitivity matrix is derived.

Table : Sensitivity Matrix for changes in Factor Shares when foodgrain production increases *

Endogenous variables	Relative share			Increase in total capital
	Increases	Constant	Decreases	
		Labour		
Terms of trade	±	-	-	+
Foodgrain population	±	-	-	-
Capital/laor in nonfoodgrain	±	-	-	+
Interest rate	±	+	+	-
Inflow of credit	±	-	-	+
		Capital		
Terms of trade	-	-	±	+
Foodgrain population	±	-	-	-
Capital/laor in nonfoodgrain	-	-	±	+
Interest rate	+	+	±	-
Inflow of credit	-	-	±	+

* when $0 < n,\ n-\epsilon < 1$; $\epsilon < 0$ and $k_I > k > k_A$

The result for a constant labour and capital shares are reinforced when the share of labour decreases. In these cases, the terms of trade move against agricultural sector and there is a reduction in the net inflow of credit into foodgrain sector as the rate of interest increases. Although the foodgrain population migrates to the non-foodgrain sector capital per unit of labour decreases in the non-foodgrain sector. It can be seen from the equation (12) that this process is supported by increase in marketable surplus from the foodgrain sector.

Although the results related to decrease in the relative share of capital are indeterminate, it can be seen from equations (14) through (16) that if this decrease is less than that in the relative share of labour, again the terms of trade more against foodgrain sector while there is a reduction in the net inflow of credit in the foodgrain sector. At the same time the rate of interest increases further.

Increase in the relative share of labour works in favour of increase in inflow of credit in the foodgrain sector, reduction in the interest rate, increase in equilibrium capital labour ratio in the

terms of trade.

When the foodgrain production is constant and only total capital stock increases, the terms of trade increases in favour of foodgrain sector. At the same time capital labour ratio in the non-foodgrain sector increases while it receives more and more labour force from the foodgrain sector. This process is accompanied by decreasing rate of interest which supports inflow of credit into the foodgrain sector.

Impacts of biased technological change and total capital stock on the net flow of credit could be analyzed simultaneously. However since these two forces have opposite impacts on the flow of credit, the net effect could be analyzed by simulating the model with the use of real world estimates of intersectoral capital-labour ratios, of factor shares, of growth of foodgrain production etc., This aspect is left as an open end by this paper.