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ARTICLES

THE TRANSMISSION OF COST INFLATION IN AGRICULTURE WITH SUBSISTENCE PRODUCTION: A CASE STUDY IN NORTHERN INDIA

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Inflationary pressures in industrial raw materials, fuel and power, and manufactured products are in turn transmitted to agriculture in the form of rising costs. When a part of production is retained for home consumption, the transmission of cost inflation to the product side is highly complex. Yet, these mechanisms must be understood for any meaningful design of policies of product price adjustment. Curiously enough, however, the study of marketed surplus response to price changes has not been carried out on the factor side. In this paper, we consequently develop the analysis of marketed surplus response to factor price changes. We then estimate the elasticities of supply response and derived demands for factors for a set of farms in the Delhi Union Territory. These estimates are used to calculate the marketed surplus response to factor price changes and to simulate the impact of inflationary cost pressures on the marketed surplus. We then analyse the required product price adjustments necessary to compensate for the cost in order to reach different consumption and welfare goals.

The main implication of our work is that, when the agricultural sector is still fundamentally oriented at home consumption with a marketed surplus which is consequently only a small fraction of total production—31 per cent for wheat, 22 per cent for rice [Nadkarni(8)]—, inflationary pressures on the cost side become amplified on the product side. Unless productivity changes are sufficiently high, the transmission of cost inflation in agriculture thus acts as an accelerator of inflation. This result, which we derive formally and quantify, is at the hardcore of the structuralist theories of inflation.

II

A MODEL OF MARKETED SURPLUS RESPONSE TO INFLATION

The study of marketed surplus response to product price movements was initiated by Raj Krishna(5) and Behrman(3). It was applied to the study of the marketed surplus of foodgrains in Northern India by Bardhan(2) and by Shah and Pandey(11). In these studies, attention was centred on the response of marketed surplus to product price changes, output level, and land tenure systems. The basic formulation which Bardhan(2) uses, for example, is:

$$M_1 = Q_1\left(\frac{p_1}{p_2}\right) - C_1\left[p_1,\ I = p_1Q_1\left(\frac{p_1}{p_2}\right) + p_2Q_2\left(\frac{p_2}{p_1}\right)\right]$$

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where M_1 = marketed surplus of subsistence crop (foodgrains),
Q_1 = output of foodgrains, C_1 = consumption of foodgrains,
p_1 = price of foodgrains, p_2=price of crops other than foodgrains,
Q_2= output of crops other than foodgrains and I =farmer's total income.

We are interested here in following the impact of inflationary pressures in fertilizer prices, wages, and fixed capital input prices on the marketed surplus of different types of farms. These farms are engaged in the monoculture of wheat and we consequently neglect the role of prices of other crops on wheat production. Our model is consequently:

$$M = Q\left(\frac{r}{p}, \frac{w}{p}, T, F, t\right) - C\left[p, I = pQ\left(\frac{r}{p}, \frac{w}{p}, T, F, t\right) - X\left(\frac{r}{p}, \frac{w}{p}, T, F, t\right) - wL\left(\frac{r}{p}, \frac{w}{p}, T, F, t\right) - fF\right]$$

where p=product price, r=fertilizer price, w=wage rate, f=fixed factor price, X=level of fertilizer use, L=level of labour use, T=fixed level of land use, F=fixed level of capital use, C=consumption of wheat and t=time (or technological change).

The price of fixed factors does not change the level of factor use, but does influence the level of farm income. Since we deal here with owner operators, the imputed values of land rents and interest on own capital do not enter in the determination of income. Taking the total differential of the expression for the marketed surplus with respect to p, r, w, f, T, F, and t and writing it in terms of relative changes, we obtain:

$$\frac{dM}{M} = E^{p}_{M}\frac{dp}{p} + E^{r}_{M}\frac{dr}{r} + E^{w}_{M}\frac{dw}{w} + E^{f}_{M}\frac{df}{f} + E^{T}_{M}\frac{dT}{T} + E^{F}_{M}\frac{dF}{F} + E^{t}_{M}\frac{dt}{t}$$

where $E^{Z}_{M} = \frac{\partial M}{\partial Z}\frac{Z}{M}$, $Z = p, r, w, f, T, F, t.$

These elasticities are in turn equal to :

$$E^{p}_{M} = -\frac{C}{M}E^{p}_{C} - \frac{C}{M}\frac{pQ}{I}E^{I}_{C} - \left(\frac{Q}{M} - \frac{C}{M}\frac{pQ}{I}E^{I}_{C}\right)\left(E^{r/p}_{Q} + E^{w/p}_{Q}\right) - \left(\frac{C}{M}\frac{rX}{I}E^{I}_{C}\right)\left(E^{r/p}_{X} + E^{w/p}_{X}\right) - \left(\frac{C}{M}\frac{wL}{I}E^{I}_{C}\right)\left(E^{r/p}_{L} + E^{w/p}_{L}\right).$$

$$E^{r}_{M} = \frac{C}{M}\frac{rX}{I}E^{I}_{C} + \left(\frac{Q}{M} - \frac{C}{M}\frac{pQ}{I}E^{I}_{C}\right)E^{r/p}_{Q} + \left(\frac{C}{M}\frac{rX}{I}E^{I}_{C}\right)E^{r/p}_{X} + \left(\frac{C}{M}\frac{wL}{I}E^{I}_{C}\right)E^{r/p}_{L}.$$

$$E_M^w = \frac{C}{M}\frac{wL}{I}E_C^I + \left(\frac{Q}{M} - \frac{C}{M}\frac{pQ}{I}E_C^I\right)E_Q^{w/p} + \left(\frac{C}{M}\frac{rX}{I}E_C^I\right)E_X^{w/p} + \left(\frac{C}{M}\frac{wL}{I}E_C^I\right)E_L^{w/p}.$$

$$E_M^f = \frac{C}{M}\frac{fF}{I}E_C^I.$$

$$E_M^T = \left(\frac{Q}{M} - \frac{C}{M}\frac{pQ}{I}E_C^I\right)E_Q^T + \left(\frac{C}{M}\frac{rX}{I}E_C^I\right)E_X^T + \left(\frac{C}{M}\frac{wL}{I}E_C^I\right)E_L^T.$$

$$E_M^F = \frac{C}{M}\frac{fF}{I}E_C^I + \left(\frac{Q}{M} - \frac{C}{M}\frac{pQ}{I}E_C^I\right)E_Q^F + \left(\frac{C}{M}\frac{rX}{I}E_C^I\right)E_X^F + \left(\frac{C}{M}\frac{wL}{I}E_C^I\right)E_L^F.$$

$$E_M^t = \left(\frac{Q}{M} - \frac{C}{M}\frac{pQ}{I}E_C^I\right)E_Q^t + \left(\frac{C}{M}\frac{rX}{I}E_C^I\right)E_X^t + \left(\frac{C}{M}\frac{wL}{I}E_C^I\right)E_L^t.$$

where

$E_C^p = \frac{\partial C}{\partial p}\frac{p}{C}$, $E_C^I = \frac{\partial C}{\partial I}\frac{I}{C}$ are the price and income elasticities of consumption,

$E_Q^{r/p} = \frac{\partial Q}{\partial \frac{r}{p}}\frac{r}{pQ}$, $E_Q^{w/p} = \frac{\partial Q}{\partial \frac{w}{p}}\frac{w}{PQ}$ are the elasticities of output response with respect to relative prices.

$E_X^{r/p} = \frac{\partial X}{\partial \frac{r}{p}}\frac{r}{pX}$, $E_X^{w/p} = \frac{\partial X}{\partial \frac{w}{p}}\frac{w}{pX}$, $E_L^{r/p} = \frac{\partial L}{\partial \frac{r}{p}}\frac{r}{pL}$,

$E_L^{w/p} = \frac{\partial L}{\partial \frac{w}{p}}\frac{w}{pL}$

are the elasticities of derived demand for fertilizer and labour with respect to relative prices.

E_Q^T, E_Q^F, E_X^T, E_X^F, E_L^T, E_L^F, are the elasticities of output and factor use with respect to the levels of fixed factors.

In the expression for E_M^p, the marketed surplus response to price, the two first terms are the pure inflationary effects. In other words, even if all relative prices stay constant ($dp/p = dr/r = dw/w = df/f$), so that there is no output response and no derived demand effects, there still is a marketed surplus response to price change due to the price and income effects it has on consumption. Since the price effect on marketed surplus is positive while the income effect is negative, the net impact depends on the balance between the two.

The third term in E^{p}_{M}, namely, $-\frac{Q}{M}\left(E^{r/p}_{Q} + E^{w/p}_{Q}\right)$, is the direct output response effect of relative price changes. It is negative here since product price enters as a numeraire. All the other subsequent terms represent the effects of output response and derived demand response on marketable surplus through their impact on income and hence on consumption, as either revenue or cost.

In the elasticities of marketed surplus with respect to factor prices, similarly, the first term is the pure inflationary effect where there is no output or input response, but where there is a marketed surplus response through income (cost) effects. The effects are always positive since, if factor prices increase, costs increase, income decreases, consumption is reduced, and marketed surplus increases. The second terms — $(Q/M)\ E^{r/p}_{Q}$ and $(Q/M)\ E^{w/p}_{Q}$ — are the direct output response effects of relative factor price changes on marketed surplus. They are negative for positive increases in factor prices. The remaining terms are the impacts of output and derived demand effects through income on consumption.

Collecting all the terms for pure inflationary effects in output response and derived demand, the net effect on the marketed surplus will be negative if $E^{I}_{C} > -E^{p}_{C}$. This inequality is likely to obtain except at the highest income levels. Radhakrishna *et al.* (10), for example, find the following estimates for foodgrains in India:

Income groups	Rural		Urban	
	E^{I}_{C}	E^{p}_{C}	E^{I}_{C}	E^{p}_{C}
Lower	0.81	—0.58	0.69	—0.55
Middle	0.49	—0.39	0.36	—0.29
Higher	0.36	—0.23	0.14	—0.18

Source: Radhakrishna *et al.* (10), pp. 195-196.

As a result, the dominance of income effects in rural consumption implies that pure price inflation reduces the marketed surplus.

It is also interesting to look at the impact on marketed surplus of the situation where pure inflation (*i.e.*, when $dp/p = dr/r = dw/w = df/f$) leaves income unchanged. The elasticity of income with respect to price is

$$\frac{dI}{I} = E^{p}_{I}\frac{dp}{p} + E^{r}_{I}\frac{dr}{r} + E^{w}_{I}\frac{dw}{w} + E^{f}_{I}\frac{df}{f} + E^{T}_{I}\frac{dT}{T} + E^{F}_{I}\frac{dF}{F} + E^{t}_{I}\frac{dt}{t}$$

where

$$E_I^p = \frac{pQ}{I}\left(1 - E_Q^{r/p} - E_Q^{w/p}\right) + \frac{rX}{I}\left(E_X^{r/p} + E_X^{w/p}\right) + \frac{wL}{I}\left(E_L^{r/p} + E_L^{w/p}\right).$$

$$E_I^r = \frac{pQ}{I} E_Q^{r/p} - \frac{rX}{I}\left(1 + E_X^{r/p}\right) - \frac{wL}{I} E_L^{r/p}.$$

$$E_I^w = \frac{pQ}{I} E_Q^{w/p} - \frac{wL}{I}\left(1 + E_L^{w/p}\right) - \frac{rX}{I} E_X^{w/p}.$$

$$E_I^f = -\frac{fF}{I}.$$

$$E_I^T = \frac{pQ}{I} E_Q^T - \frac{rX}{I} E_X^T - \frac{wL}{I} E_L^T.$$

$$E_I^F = \frac{pQ}{I} E_Q^F - \frac{rX}{I} E_X^F - \frac{wL}{I} E_L^r - \frac{fF}{I}.$$

$$E_I^t = \frac{pQ}{I} E_Q^t - \frac{rX}{I} E_X^t - \frac{wL}{I} E_L^t.$$

Hence, there is no income effect of inflation only when

$$\frac{dI}{I} = \frac{dp}{p}(pQ - rX - wL - fF)\frac{1}{I} = 0$$

i.e., when $pQ - rX - wL - fF = I = 0$.

Thus, there will be an income effect of pure inflation, and hence a marketed surplus response, even if all $dp/p = dr/r = dw/w = df/f$, for as long as $I \neq 0$. It should be noted that, even if $dI = 0$, *i.e.*, $E_C^I = 0$, and there is no supply and derived demand responses because all relative prices remain constant, there will still exist a price effect on marketed surplus. The elasticities of marketed surplus are then :

$$E_M^p = -\frac{C}{M} E_C^p > 0$$

$$E_M^r = E_M^w = E_M^f = 0$$

III

MEASUREMENT OF OUTPUT AND DERIVED DEMAND RESPONSES

In order to estimate the normative output supply functions and the demand functions for labour and fertilizer inputs, the profit function formulation suggested by Lau and Yotopoulos(6) is preferred over the production function approach. The profit function is a function of the normalized input prices and the quantities of fixed inputs. Since these variables are exogenous, by estimating the profit function we avoid the problem of simultaneous equation bias that occurs in single equation estimation. This bias arises from the fact that the quantities of the variable factors that constitute the explanatory variables in the production function are not exogenous: they are determined jointly with output in the process of profit maximization.

Consider the short-run Cobb-Douglas production function with the usual neo-classical properties:

$$Q = A\, X^{\alpha_1}\, L^{\alpha_2}\, T^{\beta_1}\, F^{\beta_2}$$

where Q is output, X is the variable fertilizer input, L is the variable labour input, and T and F are the fixed inputs of land and capital respectively. Following Lau and Yotopoulos, the profit, factor demand, and supply equations are as follows :

Normalized restricted profit equation:

$$\Pi^* = A^* \left(\frac{r}{p}\right)^{\alpha_1^*} \left(\frac{w}{p}\right)^{\alpha_2^*} T^{\beta_1^*} \quad F^{\beta_2^*}$$

where $A^* = (1-\alpha)\, A^{\theta}\, \alpha_1^{\alpha_1\theta}\, \alpha_2^{\alpha_2\theta}$, $\alpha = \alpha_1 + \alpha_2$, $\theta = (1-\alpha)^{-1}$

$$\alpha_1^* = -\alpha_1\theta, \quad \alpha_2^* = -\alpha_2\theta, \quad \beta_1^* = \beta\theta_1, \text{ and } \beta_2^* = \beta_2\theta$$

Labour demand equation:

$$L = \alpha_1^* \; A^* \left(\frac{r}{p}\right)^{\alpha_1^*} \left(\frac{w}{p}\right)^{\alpha_2^*-1} T^{\beta_1^*} \quad F^{\beta_2^*}$$

Fertilizer demand equation:

$$X = \alpha_2^* \; A^* \left(\frac{r}{p}\right)^{\alpha_1^*-1} \left(\frac{w}{p}\right)^{\alpha_2^*} T^{\beta_1^*} \quad F^{\beta_2^*}$$

Product supply equation:

$$Q = A^*\theta \left(\frac{r}{p}\right)^{\alpha_1^*} \left(\frac{w}{p}\right)^{\alpha_2^*} T^{\beta_1^*} \quad F^{\beta_2^*}$$

where

Π^* = Π/p = normalized profit or unit output price profit.

Π = profit, defined as current revenues less current total variable input cost.

The data collected under a farm records project of the Division of Agricultural Economics of the Indian Agricultural Research Institute, New Delhi were used. Under this project, detailed information on randomly selected farms from two villages of the Delhi Union Territory were collected by cost accounting method between 1968-69 and 1975-76. Mexican wheat and hybrid bajra are the most important *rabi* and *kharif* crops respectively of the study area. Wheat farms are classified into small and large farms: small with less than 7.5 acres of wheat and large with more. The average wheat area is 4.2 acres for the small farms and 15.8 for the large.[1]

1. Fixed capital factors include: expenditure on bullock labour, value of seed, expenditure on irrigation, expenditure on tractor, value of plant protection measures used, expenditure on threshing and transporting, land revenue, and interest paid on crop loan.

The three equations—the profit function, labour, and fertilizer demand functions—for small and large wheat farms were estimated jointly using Zellner's (13) method to impose the restrictions that $\alpha_1^* = \alpha_1^*$ and $\alpha_2^* = \alpha_2^*$ in the profit and demand equations. Because 100 per cent of the area planted in wheat is irrigated, introduction of a weather index in the profit function as well as of year dummy variables proved to be always insignificant.

The elasticity estimates for the wheat supply and the fertilizer and labour derived demand equations, obtained from the fits of profit function, are presented in Table I for large and small farms. These elasticities appear quite reasonable in the light of prior econometric studies.[2] It is interesting to note that the elasticities of output and derived demand responses to prices are the same on small and large farms, indicating an identical pattern of production behaviour towards price movements. Because the income position of these farms is, however, markedly different, this analogy in production behaviour does not carry to behaviour with respect to the marketed surplus.

IV

ELASTICITIES OF MARKETED SURPLUS WITH RESPECT TO PRODUCT AND FACTOR PRICES

Table II provides the basic data requirements to calculate, along with the results in Table I, the elasticities of marketed surplus. The marketed surplus is equal to 30 per cent of production on small farms and to 65 per cent on large farms [Sidhu (12)]. The total marketed surplus for the sample is consequently 55 per cent of production. This percentage is high compared to the national average which has been estimated at 30 to 35 per cent [Nadkarni (8, p. 51)]. But it is to be remembered that the farms surveyed are larger than the national average and that they are part of the relatively small area of India (the States of Punjab, Haryana, and Gujarat) which ensures the bulk of commercial wheat sales in India. In these three States, the marketed surplus of wheat was respectively 89, 71 and 52 per cent in 1974-75 [Nadkarni (8)].

The choice of elasticities of wheat consumption with respect to price and income is based on a survey of existing literature. Small farms in our sample correspond on the average to a medium-third rural income position while large farms correspond to the upper-third income level.

The income elasticities for wheat vary widely and seem at this stage still rather unreliable. We have consequently opted for income elasticities of the magnitude obtained by Radhakrishna *et al.*(10) and Mellor(7) for foodgrains. The magnitudes retained are 0.55 for small farms and 0.30 for large farms. Estimates of price elasticities are more consistent among studies and we have retained the values of —0.4 for small farms and —0.2 for the large ones.

2. In a recent survey by Askari and Cummings (1) of elasticities of agricultural supply response estimated using the Nerlove model, the short run elasticity for wheat in different regions of India is found to be, on the average, equal to 0·18 and the long run elasticity to 0·31.

TABLE I—ELASTICITIES FOR OUTPUT RESPONSE, FERTILIZER DEMAND AND LABOUR DEMAND FUNCTIONS FOR WHEAT FARMS, DELHI

Elasticities	Small farms	Large farms
Wheat output response with respect to		
Wheat price E_Q^p	0·25	0·24
Fertilizer price $E_Q^{r/p}$	—0·11	—0·08
Wage $E_Q^{w/p}$	—0·14	—0·16
Land E_Q^T	0·87	0·74
Capital E_Q^F	0·11	0·08
Fertilizer demand with respect to		
Wheat price E_X^p	1·24	1·24
Fertilizer price $E_X^{r/p}$	—1·11	—1·08
Wage $E_X^{w/p}$	—0·14	—0·16
Land E_X^T	0·87	0·74
Capital E_X^F	0·11	0·08
Labour demand with respect to		
Wheat price E_L^p	1·24	1·24
Fertilizer price $E_L^{r/p}$	—0·11	—0·08
Wage $E_L^{w/p}$	—1·14	—1·16
Land E_L^T	0·87	0·74
Capital E_L^F	0·11	0·08

TABLE II—BASIC DATA FOR THE CALCULATION OF ELASTICITIES OF MARKETED SURPLUS, DELHI

	Small farms	Large farms	Average farms
Farm size (acres)	4·2	15·8	8·7
Wheat production (quintals) Q	55	190	108
Net income (Rs.) I	3,686	15,268	8,203
PQ/I	1·54	1·37	1·47
rX/I	0·10	0·11	0·10
wL/I	0·19	0·11	0·16
fF/I	0·24	0·15	0·20
M/Q	0·30	0·65	0·44
C/M	2·33	0·54	1·63
Marketed surplus (Rs.) M	1,707	13,585	6,339

For the non-farm population, which is composed of both the lower rural income levels and all urban consumers, we have retained an income elasticity of 0.5 and a price elasticity of —0.4.[3]

The elasticities of marketed surplus with respect to wheat price are negative for small farms (—0.23) and positive for large farms (0.26) (Table III). For small farms, the negative elasticity is due to the fact that the marketed surplus adjustment to higher wheat prices is dominated by the income effect in consumption, which is negative on the marketed surplus. On the larger farms, by contrast, the income effect is small and the positive output response to higher wheat prices dominates the adjustment in marketed surplus. Due to the dominance of large farms in total production, the aggregate elasticity of marketed surplus response is positive (0.18) but much inferior to the elasticities of output response (0.24). The elasticities of market-

TABLE III—ELASTICITIES OF MARKETED SURPLUS AND FARM INCOME WITH RESPECT TO WHEAT, FERTILIZER, LABOUR, AND FIXED FACTOR PRICES, DELHI

	Small farms	Large farms	Average farms
Elasticities of marketed surplus with respect to			
Product price E_M^p	—0·23	0·26	0·18
Fertilizer price E_M^r	—0·19	—0·10	—0·11
Wage E_M^w	—0·24	—0·23	—0·23
Fixed capital price E_M^f	0·31	0·02	0·07
Land E_M^T	1·51	1·01	1·09
Fixed capital E_M^F	0·19	0·11	0·12
Elasticities of farm income with respect to			
Product price E_I^p	1·56	1·43	
Fertilizer price E_I^r	—0·14	—0·09	
Wage E_I^w	—0·18	—0·18	
Fixed capital price E_I^f	—0·24	—0·15	
Land E_I^T	1·09	0·85	
Fixed capital E_I^F	0·14	0·09	

3. The unsatisfactory state of affairs with price and, especially, income elasticities of demand for wheat by income classes implies that the results presented here are only first approximations that will have to be calculated over when more reliable estimates become available.

ed surplus with respect to fertilizer and labour prices are negative for both small and large farms. In this case, the negative output and marketed surplus response to higher factor prices far dominates the positive income effect on marketed surplus.

As to fixed factors, an increase in their prices leads to an increase in marketed surplus on all farms through the negative effect on income and consumption. This effect is large on small farms (0.31) but negligible on the larger farms (0.02).

We can measure from these elasticities the impact on the marketed surplus of a pure inflationary effect where $dp/p = dr/r = dw/w = df/f$. Since all relative prices remain constant, the elasticities of output and derived demands with respect to relative prices are all equal to zero. The elasticities of marketed surplus are then:

	E^p_M	E^r_M	E^w_M	E^f_M
Small farms	—1.04	0.12	0.24	0.31
Large farms	—0.11	0.02	0.02	0.02
Total	—0.26	0.04	0.06	0.07

Since $dM/M = dp/p \left(E^p_M + E^r_M + E^w_M + E^f_M\right)$, the elasticity of marketed surplus with respect to the rate of inflation is:

	Small farms	Large farms	Total
$\frac{dM}{dp}\frac{p}{M}$	—0.37	—0.05	—0.10

Pure inflation thus has a negative effect on marketed surplus through dominance of income effects in consumption. As all prices increase, (positive) income increases by the same percentage. As a result, consumption increases and the marketed surplus falls. Thus, even though pure inflation is neutral on output level and factor use, it has a strong negative effect on the marketed surplus of small farms (—37 per cent). Without productivity change, total marketed surplus declines by 10 per cent of the rate of inflation.

V

TRANSMISSION OF FACTOR PRICE INFLATION TO PRODUCT PRICE: POLICY IMPLICATIONS

The estimated model of marketed surplus response to factor price changes can now be used to derive the normative product price changes needed to reach specified consumption goals.

Product Price Adjustment Needed to Compensate for Factor Price Inflation in order to Maintain dM = 0 with Constant Real Income for Non-farm Consumers

The relative change in marketed surplus is then:

$$\frac{dM}{M} = 0.18\frac{dp}{p} - 0.11\frac{dr}{r} - 0.23\frac{dw}{w} + 0.07\frac{df}{f} = 0.$$

This can be solved for the elasticity of product price with respect to the rate of inflation (dr/r = dw/w = df/f):

$$\frac{dp}{dr}\,\frac{r}{p} = 1.5$$

This very high elasticity—a 15 per cent increase in product price for a 10 per cent inflation in factor prices—indicates the types of structural inflationary pressures to which is submitted an economy where an important fraction of agricultural production is retained for home consumption by producers. To maintain a constant marketed surplus, product price inflation must be sufficiently high that it induces enough output response to cancel increased farm consumption occurring through the large income effect of inflation.[4]

With dr/r = dw/w = df/f = 1 and dp/p = 1.5, we have the following marketed surplus and income effects on small and large farms:

	Small farms	Large farms	Total
dM/M	—0.47	0.8	0
dI/I	1.78	1.73	

On the wheat market, supply will balance demand if the monetary income of non-farm consumers increases to maintain demand and hence real income constant. This required increase in monetary income is obtained from:

$$\frac{dD}{D} = E_D^p\frac{dp}{p} + E_D^I\frac{dI}{I} = 0$$

$$\text{If } E_D^p = -0.4 \text{ and } E_D^I = 0.5, \frac{dI}{I} = \frac{-E_D^p\frac{dp}{p}}{E_D^I} = 1.2$$

Thus, maintaining constant consumer real income in the face of strong inflationary pressures in wheat production costs of 100 per cent would require

4. Note that, while the magnitude of (dp/dr) (r/p) for dM = 0 depends upon the size of the elasticities of output and derived demand responses, the fact that agriculture acts as an accelerator of inflation, *i.e.*, that (dp/dr) (r/p) > 1 for dM = 0 and dr/r = dw/w = df/f = 1, only depends upon satisfying the inequality $E_C^I > -E_C^p$. As we saw above, this condition is satisfied in Indian agriculture at all income levels.

a massive increase in monetary income of 120 per cent. The model can also be used to estimate the product price adjustment needed to compensate for factor price inflation in order to maintain (*i*) constant monetary income for non-farm consumers, and (*ii*) farm income constant through appropriate algebraic manipulation.

Productivity Adjustments to Compensate for Observed Price Changes and Maintain dM = O or dM = dD

For the observed inflationary factor price changes during the period 1968-69—1975-76, the annual rates of productivity growth in output E_Q^t, needed to maintain dM = 0 with constant non-farm real income and to maintain dM = dD with constant non-farm monetary income are:

	dM = 0	dM = dD
E_Q^t	0.04	0.02

As the indexes of total factor productivity growth calculated for Punjab and Haryana by Evenson and Jha(4) indicate, the growth rate in yields is an accurate proxi for the rate of change in total factor productivity growth. The observed rate of change in wheat yields in Delhi and Haryana during the period 1968-71 to 1975-78 was 0.023 per annum. Hence, the combination of observed price changes and productivity gains during the period under study was more than enough to maintain dM = dD with constant non-farm monetary income, but not enough to maintain dM = 0 with constant non-farm real income.

If, on the other hand, there is a situation of pure price inflation with dp/p = dr/r = dw/w = df/f = 1, the rate of productivity growth on output to reach these same goals is :

	dM = 0	dM = dD
E_Q^t	0.07	0

In a situation of pure price inflation, the rate of technological change need only equal 7 per cent of the rate of inflation to maintain dM = 0 and is unnecessary for dM = dD with constant non-farm consumer monetary incomes since product price adjustment is already more than enough for that purpose.

Finally, if we have an inflationary situation on the side of factor prices such that dr/r = dw/w = df/f = 1, and we want to depend exclusively on technological change to ensure complete product price stability (dp/p = 0), then the required rate of productivity growth is $E_Q^t = 0.20$. This is less than three times as high as the required rate of productivity change of 0.07 needed to maintain dM = 0 when product price is adjusted by 100 per cent of the rate of factor price inflation. For 1979-80, for example, if we had wanted to fully counteract the observed rate of inflation in agricultural costs of about 16 per cent, the required annual rate of productivity increase would have been 3.2 per cent.[5] This, by no means, appears Herculean; while a product price adjustment of 150 per cent of factor price inflation (*i.e.*, of 24 per cent, in 1979-80) required to maintain dM = 0 without productivity change is both socially unbearable and highly detrimental to industrial growth. Hence, the need to refocus the debate on the terms of trade away from claims for product price adjustments to principally productivity adjustments. Yet, the productivity issue has been generally overlooked in the terms of trade debate.

VI

CONCLUSION

Short run response of the marketed surplus to changes in the terms of trade for agriculture is highly inelastic due to the combination of (1) dominance of subsistence consumption over disappearance of agricultural output and sizable income effects in agricultural consumption, and (2) movements along a given production function instead of response via technological change and horizontal expansion. The result is that inflationary pressures on the cost side are either amplified by agriculture (case where dM = 0 with constant consumer real income) or result in high welfare costs for non-agricultural producing consumers, particularly the rural and urban poor (case where dM = dD with constant consumer monetary incomes). These results are thus more consistent with the structuralist than with the monetarist view of inflation.

The policy implication is that inflationary pressures on the cost side of agriculture are highly destabilising forces that have rightly received considerable attention in the debate on the terms of trade and need to be effectively counteracted. Yet, for the burden of adjustment not to be borne by the poor, this need occur inasmuch as possible via programmes to enhance technological change and horizontal expansion (irrigation) instead of through compensatory price policies on the product side. The Green Revolution has effectively fulfilled this purpose during the 1970s. With relative exhaustion of this compensatory mechanism, new irrigation schemes and improved efficiency in the management of existing irrigation facilities must be the effective instrument for the 1980s.

Since the most advanced farmers and regions are already using irrigated land and are close to technological ceilings, productivity gains via technological change and irrigation will have to come from other farmers and areas, while price adjustments would imply that the bulk of supply response is obtained in the already most advanced farms and areas. Hence, in agri-

5. If population grows at the annual rate of 2·2 per cent, then the target of constant marketed surplus, dM = 0, should be redefined on a constant per capita basis as dM = 0·022. In this case, the required rates of productivity change with:
(*i*) pure price inflation of 1 is 0·08 instead of 0·07;
(*ii*) product price stability with factor price inflation of 1 is 0·22 instead of 0·20;
(*iii*) product price stability with factor price inflation of 16 per cent as observed in 1979-80 is 3·5 per cent instead of 3·2 per cent.
For policy purposes, the results remain consequently essentially the same.

culture, countervailing cost inflation via product price increase allows defence of the social status quo and deepening of the existing inequalities. By contrast, the spread of HYVs and of irrigation facilities to new farms and areas appears as a progressive force towards levelling out the prior structure of differential rents. These very complex distributional issues deserve careful analysis. They reveal, however, the political underpinnings of the debate on the terms of trade in terms of price versus productivity adjustments as not only a confrontation between net sellers and net buyers of food but also, among different regions and farm types within agriculture itself.

With this paper, we have established the outer limits to the debate on the terms of trade. One limit consists of calling for a full product price adjustment to cost inflation, disregarding changes in productivity. As we have seen it, the mechanics of the marketed surplus response imply that required adjustment results in excessive welfare costs for the poor. The other limit consists of calling on the countervailing power of non-price adjustments, namely, productivity growth through technological change and irrigation, in order to maintain product price stability. We have shown that this solution is indeed quite feasible at the existing rates of inflation if the rates of productivity gains of the last 12 years can be sustained. Yet, productivity change is itself conditioned by the rate of profit on investment in agriculture (as well as the availability and possibility of change for individual farmers), and hence by relative prices. Exploring the relevant solution within these two limits thus requires the urgent task of understanding the determinants of productivity change in Indian agriculture.

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