

DISTRIBUTIONAL CONSEQUENCES OF RURAL FOOD LEVY AND SUBSIDIZED URBAN RATIONS

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Governments in many developing countries have imposed food levies on farmers to provide subsidized food to urban consumers. The resulting price discrimination between individuals has general equilibrium effects, so that the welfare consequences of such a policy for different socio-economic groups have been controversial. We relate the distributional consequences to the parameters of the economy and identify systematic relationships among different partitions of the outcomes. We show, for instance, that if the policy helps (hurts) richer city-dwellers, then it hurts (helps) poorer farmers.

1. Introduction

Government intervention in the agricultural sector is ubiquitous. In developed countries intervention is frequently motivated by considerations of ensuring income parity between farm and non-farm households. In developing countries, on the other hand, intervention is often based on the belief that agriculture being the largest single sector in terms of its share in national income, should be taxed (implicitly or explicitly) to generate resources for investments elsewhere in the economy. Another perhaps equally important consideration is that the food surplus of the agricultural sector is the main source of food supply to the politically important urban population consisting of white collar workers in government and industry as well as the elite blue collar workers in organized manufacturing.

Clearly, any attempt to ensure that all or a chosen subset of urban food buyers get special treatment (that is, they are able to buy all, or part, of their food purchases at prices lower than those which would have prevailed in the absence of government intervention) will have consequences for producers' and consumers' incentives, and for the government budget, depending on the particular method of intervention used. A bewildering variety of interventions have been tried in developing countries. In the extreme case, the state marketing board acts as the monopolist buyer of food from producers at home, as the sole trader with the rest of the world, and as the sole supplier of food to the urban consumers. The more common practice, however, is a coexistence of public and private food distribution systems.

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In India intervention has taken several forms at different time periods, including partial or complete restriction on private food trade across and within regions. But throughout the government has shown a commitment to provide (through the public distribution system) a specified quantity of food at below market prices to most of the urban population. In the rural sector, the government has typically promised to purchase any quantity of some crops at pre-announced *support prices* (thus providing a lower floor to the market prices), but the actual purchases for the public distribution system have been made at the so-called *procurement prices* which are announced immediately prior to each harvest. Until recently, the latter prices have been lower than the prices prevailing in the rural areas during the harvest time (*farm harvest price*), and a significant part of government procurement has entailed an element of compulsion (through direct levy imposed on farmers, as well as through imposition of delivery quotas on the middlemen). The price urban consumers pay for their food rations, called the *issue price*, has typically exceeded the procurement price (reflecting in part the transportation and other administrative costs), but as one would expect, it has been below the *open market retail price* they pay for the rest of their purchases. In all, therefore, five distinct prices (roughly, in increasing order) could be distinguished: support price, procurement price, farm harvest price, issue price, and open market retail price.

In the debate concerning the impact of such procurement cum rationing systems, a common view has been that these schemes transfer income from farm producers to urban consumers, *taxing* the producers to the extent of the difference between the procurement price and the farm harvest price on their sales to government, and subsidizing the urban consumers to the extent of the difference between the issue price and the open market price on their ration purchases. An opposite view was put forward by Dantwala (1967, 1976) who holds that 'the rise in the post-levy free market price, consequent upon the withdrawal of a part of stocks from the market through procurement, more than compensates the farmer for the "loss" suffered by him from selling the levy portion of the marketed surplus to the Government at below the market price' [Dantwala (1976)]. That is, the government intervention indeed benefits farmers because it raises the open market price (and hence the farm harvest price) above what it would have been in the absence of the intervention, and because the farmers' gains from their sales to the open market more than offset their losses on the sales to the procurement authorities. In other words, the urban rationing system enables farmers to achieve a price discrimination which they otherwise will not be able to achieve.

This paper presents a positive analysis of the impact of food procurement cum rationing schemes on the welfare of different individuals.¹ We base our

¹It is not our aim here to argue for or against such schemes, but only to analyze their implications. Such an analysis is obviously needed for assessing such arguments.

study on a simple analytical model in which the rural sector contains individuals with a continuum of farm sizes (ranging from landless workers to landlords with large farms) and the urban sector contains individuals with a range of incomes. Such an explicit treatment of individuals' heterogeneity is essential because, as we shall see, the welfare effects of an intervention on different individuals within the same sector are markedly different and, therefore, an analysis based on 'representative' individuals in each of the two sectors can be quite misleading.

In the stylized intervention that we examine, the government buys a part of the rural food surplus (from farmers who are net food sellers) at a price below the market price, and uses this 'levy' to provide limited quantities of subsidized rations to the urban consumers. Those urban individuals who wish to consume more food than the ration quantity buy it in the private food market which receives its supply from the rural sector.² Our analysis assumes that, at the margin, there is no external trade in food. This, we believe, is an appropriate representation of the unambiguous commitment to varying degrees of food self-sufficiency that several developing countries (including India) have exhibited in the past.³

It is intuitive that the consequences of a procurement cum rationing scheme are determined, in part, by other policies which are being employed by the government; for instance, policies concerning subsidy or taxation of agricultural inputs (such as fertilizer and power) and non-food consumption goods, and policies concerning the overall public budget deficit or surplus. The present analysis does not deal with commodity taxation,⁴ and assumes that the government budget concerning the public procurement and rationing system is balanced. This is partly for simplicity, but also because some of these other aspects have been studied elsewhere in the literature. For instance, Sah and Stiglitz (1985, 1987) have analyzed the positive and normative aspects of the disaggregated structure of commodity pricing and taxation (or subsidization) in the two sectors but they have abstracted from policy instruments such as procurement levies. On the other hand, empirical

²We do not consider other mechanisms to distribute subsidized food in the urban sector, such as queues or multiple pricing of rations (under which different quantities of rations are made available at different prices which increase with the total quantity of rations purchased by an individual). The latter type of schemes have been used in some countries; Gavan and Chandrasekera (1979), for instance, describe such a scheme in Sri Lanka. For a comparison of outcomes of distributing limited quantities of goods through queues, rations, and market, see Sah (1987).

³If there is external trade in food (at the margin) and if the country is not 'small' in the world food market then, in addition to the domestic responses of intervention considered in this paper, one would have to consider the world's response. On the other hand, if the country is small in the world food market then there will be no general equilibrium effects of intervention on the domestic food price (on which some of the previous debates have focused, and which forms a central part of the present analysis), unless the government changes the tariff on food contemporaneously with the intervention.

⁴However our analysis remains unaltered in the presence of commodity (or other) taxes, provided the procurement cum rationing scheme does not have a significant effect on the government revenue from these other taxes and on the non-food prices faced by individuals.

analyses of specific food subsidy schemes in India in a computable general equilibrium framework are available in Narayana, Parikh and Srinivasan (1987) and de Janvry and Rao (1984), but these empirical models for obvious reasons are restricted in the extent of heterogeneity among individuals, as well as in the functional forms of production and utility functions.⁵

The consequences of a procurement cum rationing scheme depend in part on whether urban individuals can resell their rations in a secondary market (legal or otherwise). Although private trading in rations is illegal in most LDCs where subsidized rations are publicly provided, it has been widely observed that secondary markets for rationed goods often exist. We analyze two polar specifications: first, there is perfect enforcement so that rations are not tradable at all and, second, there is no enforcement with rations.⁶

Section 2 describes the basic model with perfect enforcement and no secondary market. The corresponding incidence of welfare effects is studied in Section 3. Section 4 analyzes the no enforcement case. The paper concludes with brief comments on some extensions of the model.

2. The basic model

Agricultural sector: An individual's farm size is denoted by A , and the distribution function $F^a(A)$ denotes the distribution of farm sizes.⁷ A is non-negative. The food output of an individual with farm size A is $Z(A)$, and his consumption is $x^a(A)$. Obviously, these quantities also depend on prices and government policy but, for notational brevity, this dependence is suppressed.

⁵Hayami, Subbarao and Otsuka (1982) examine some of the effects of producer levy and urban rations. In their model two representative consumers (one rich and one poor) and two farmers (one large in terms of farm size and one small) respond to a weighted average of the open market and the procurement prices with a lag. They show that, at the long-term equilibrium prices of this Cobweb model, the sum of producers' and consumers' surplus is negative. This self evident conclusion follows because producer levy and urban rations must necessarily create some distortions and hence deadweight losses. The papers of Chetty and Jha (1984) and Guesnerie and Roberts (1984) deal with issues which are tangentially related to those on which we focus in this paper. Guesnerie and Roberts have addressed questions such as the characterization of some of the conditions under which rationing is Pareto improving. For several reasons (such as the presence of a levy schedule), their model does not apply to the intervention presently under consideration; specifically, we show later that a procurement cum rationing scheme can not be Pareto improving. Chetty and Jha (1984) examine the characterization and the existence of equilibrium in an economy with subsidized rations (in the background of open markets) in many commodities. Other recent studies on food policy include Chinn (1977), Gittinger et al. (1985) and Taylor et al. (1983).

⁶The paper does not compare the outcomes of tradable versus non-tradable rations. Such a comparison is important for ascertaining the economic rationale and consequences of the emphasis which LDC governments typically exhibit on restricting the tradability of rations; also such a comparison can lead to counter-intuitive conclusions. For instance Sah (1987) shows that if the supply of rationed goods is fixed then the poor are better-off under tradable rations compared not only to non-tradable rations but also compared to queues or non-intervention.

⁷By farm size, we mean cultivated area. The tenorial arrangements by which a farmer attains his cultivated area may influence his welfare and consumption. We abstract from these and other complexities such as the heterogeneity of land quality.

A rural individual's net food surplus is denoted by $Q^a(A) = Z(A) - x^a(A)$, which is positive (negative) if the individual is a net seller (buyer) of food. It is clearly negative for landless workers and small farmers, and positive for large landowners: we assume that Q^a is increasing in A . The market price of food is p , and the price at which the government procures a part of farmers' surplus is q , where $p > q$. $G^a(A) \geq 0$ denotes the procurement (or 'levy') schedule, and $G^a(A)$ is positive for at least some values of A . Many of our results do not depend on the precise specification of this schedule.

If $t = p - q$ denotes the difference between the market price and the procurement price (that is, the price 'wedge'), then the procurement policy's effect on a farmer is to reduce his full income by $tG^a(A)$. A farmer's indirect utility function is defined by

$$V^a(p, -tG^a; A) \equiv \max_{x^a, y^a} U^a(x^a, y^a) \quad \text{subject to}$$

$$m^a(A) - tG^a - px^a - ry^a \geq 0,$$

where U^a denotes the direct utility function, y^a denotes the vector of non-food consumption (including leisure), the vector r denotes the prices of non-food consumption, $m^a(A)$ denotes the maximized value of the aggregate full income. One of the components of full income is the value of food output $pZ(A)$; therefore $\partial m^a(A)/\partial p = Z(A)$.

What is relevant for our analysis is how an individual's utility level changes due to a change in p and t . The preceding utility maximization, in combination with the envelope theorem, yields⁶

$$V_p^a = \lambda^a Q^a \quad \text{and} \quad V_t^a = -\lambda^a G^a, \quad (1)$$

where λ^a is the (positive) shadow price of the budget constraint, i.e., the marginal utility of income to a rural individual.

Next consider the effect of a change in p and t on a farmer's food surplus which, in a manner similar to the indirect utility function, is represented as $Q^a(p, -tG^a; A)$. It is well known that the effect of a price change on a farmer's surplus can not be predicted from the usual restrictions on the utility function and the technology set. We take the empirically supported view that the surplus is increasing in price; that is $Q_p^a > 0$. Further, the surplus response to a change in t can be expressed as $Q_t^a = Q_m^a G^a$, where Q_m^a is the surplus response with respect to full income. We assume that food is a normal consumption good. Consequently, Q_m^a is negative because a farmer's output is unaffected by exogenous changes in his income, whereas his consumption is increasing in income. Thus, $Q_t^a = x_m^a G^a \geq 0$, that is a larger price wedge leads to a larger surplus. For later use, we define the average quantity of food surplus and levy, per member of the agricultural sector, as

$$Q = \int Q^a dF^a(A) > 0 \quad \text{and} \quad G = \int G^a dF^a(A) > 0. \quad (2)$$

⁶Unless stated otherwise, a subscript denotes (throughout the paper) the variable with respect to which a partial derivative is being taken.

Urban sector: An urban consumer can buy up to X subsidized units of non-tradable food at a price $p-t$, and can supplement his consumption by buying any quantity in the market, at price p .⁹ The full income of a consumer is denoted by m , which is distributed according to the distribution function $F(m)$. In the absence of rations, the indirect utility function and the food consumption of an individual with income m are represented respectively as $V(p, m)$ and $x(p, m)$. Roy's identity implies

$$V_p = -\lambda x \quad \text{and} \quad V_m = \lambda,$$

where $\lambda(m)$ is the positive marginal utility of income. In the rest of the paper the first argument in the indirect utility function and the food consumption function of an urban individual is the effective price faced by the individual, and the second argument is his effective income.

In the presence of rationing, it is clear that utility maximization by urban consumers must imply that they fall into three groups: (i) the first group consists of those who consume less food than the ration quantity X . They receive a price subsidy of t per unit of food. Their utility level and food consumption are denoted as $V^1(m) \equiv V(p-t, m)$, and $x(p-t, m)$ respectively, (ii) the second group consists of those whose food consumption equals X , and (iii) the third group consists of those consuming more food than the ration quantity. The effect of rationing on the last group of individuals is to provide an income subsidy of tX . Their utility level and food consumption are, thus, represented by $V^2(m) \equiv V(p, m+tX)$, and $x(p, m+tX)$ respectively.

Intuitively, one would expect that the self-selection of a consumer into one of the above three groups should be systematically related to his income. This is indeed the case. In fact, given our assumption that food is a normal good, it is easily seen that those in the first group must be poorer than those in the second group, and the latter in turn must be poorer than those in the third group. Let m^1 and m^2 denote the lowest and highest income among those whose food consumption equals X . Of course, m^1 and m^2 depend, in general, on p , t and X ; this dependence is fully taken into account in the analysis below. Then it follows that the income of those consuming less food than X is less than m^1 , and the income of those consuming more food than X is more than m^2 . Moreover, we do not need to ascertain whether m^1 and m^2 are identical or not since the former situation is simply a special case of the latter.

For brevity, we refer to urban individuals with incomes smaller than m^1 as those belonging to the *lower income group*, whereas individuals with incomes larger than m^2 are referred to as those belonging to the *upper income group*. Also, we use x^1 and x^2 to denote the per capita food consumption within the lower and the upper income groups, respectively. That is, $x^1 \equiv$

⁹It is easy to work with a more general formulation in which the unit subsidy on the urban ration differs from the unit tax on the rural levy. The qualitative issues on which the present paper focuses, however, remain largely unaffected by this extension.

$[1/F(m^1)] \int_{m^L}^{m^1} x(p-t, m) dF$, and $x^2 \equiv [1/\{1-F(m^2)\}] \int_{m^2}^{m^U} x(p, m+tX) dF$, where (m^L, m^U) represents the support of the urban income distribution.

Equilibrium: If N^a and N denote the rural and the urban populations, then $n^1 = NF(m^1)/N^a$, and $n^2 = N[1-F(m^2)]/N^a$ respectively represent the urban populations in the lower and the upper income groups, as proportions of the rural population. Recalling the definitions of m^1 and m^2 , it is obvious that the numbers n^1 and n^2 are determined endogenously by the policy variables.

We ignore at present the transportation and administrative expenses associated with the public and the private distribution systems; these costs are discussed later. A balanced budget intervention, thus, implies that the quantity of food procured in the rural sector should equal the quantity distributed through the ration system; that is

$$G = n^1 x^1 + (n - n^1)X, \quad (3)$$

where $n = N/N^a$ denotes the urban population as a proportion of the rural population. A slightly different but perhaps more transparent way to write the public budget constraint (3) is to observe that every low income urban individual consumes only what he buys from the ration shop and every individual who is not in the lower income group receives the same ration X . Thus the quantity X equals the levy, net of the consumption of lower income individuals, divided by the number of non-low income persons. That is

$$X = (G - n^1 x^1) / (n - n^1).$$

Further, the balance between the food supply and demand in the market requires

$$Q - G = n^2(x^2 - X). \quad (4)$$

The policy variables in the present model are p , t , X , and the levy schedule $G^a(A)$. Since these four variables must satisfy two restrictions represented by eqs. (3) and (4), any two of the variables can be treated in general as controls; the values to be taken by the other two being determined by the constraints, given the set values of the control variables. In the analysis below, the tax rate t per unit of levy (or, equivalently, the rate of subsidy per unit of ration) and the levy schedule $G^a(A)$ are the control variables. Other policy variables (for instance, the price and quantity of urban rations) are determined endogenously. This choice is natural in the present context; in any event, our results remain unaltered if a different set of control variables were to be chosen (for instance, if the price and the quantity of urban rations were chosen as control variables and other policy variables were determined

endogenously). An additional advantage of our choice of policy variables is that at $t=0$, the above model implies non-intervention, regardless of what $G^a(A)$ and X might be.¹⁰

3. Distributional incidence

Price and quantity effects: We first investigate the effect of intervention on the market price of food. For brevity, we focus on the case in which the government introduces a small wedge between the market and the ration (procurement) prices; that is, the effects of a change in t are evaluated in the neighborhood of $t=0$. As we shall see, the results to be derived below hold for any levy schedule that the government might choose. Parenthetically we note that many of the results hold even when the existing wedge is not small.¹¹

To ascertain the effects of a change in t , (3) and (4) are perturbed with respect to (p, t, X) , treating $G^a(A)$ as parametrically specified. This is done in two steps. First, differentiation of (3) with respect to t yields

$$\frac{dX}{dt} = -n^{-1}x_p^1 \left(\frac{dp}{dt} - 1 \right) / (n - n^1), \quad (5)$$

where $x_p^1 = [1/F(m^1)] \int_{m^1}^1 x_p(p-t, m) dF$ is the average price response of food consumption of urban individuals in the lower income group.¹² For later use, x_p^2 and x_m^2 are defined analogously. Obviously x_p^1 and x_p^2 are negative, whereas x_m^2 is positive.

Expression (5) characterizes the changes in p and X , corresponding to a change in t , which keeps the government budget in balance. The change in the ration quantity, dX/dt , turns out to be proportional to x_p^1 , which is the average price response in the lower income group. This should not be surprising because the food demanded by the lower income group depends on the ration price $q = p - t$, which is affected symmetrically by changes in p and t .

¹⁰A referee suggested that, instead of modelling a spectrum of individuals in each of the two sectors (as we have done in this paper), we should base our analysis on a specification where there are only two income groups in each sector. While the latter specification simplifies the analysis considerably (see the example in the last paragraph of section 3) it does not permit an adequate analysis of the distributional consequences of intervention. Also, as we shall see, different subgroups of individuals turn out to be important in examining different questions; and the definitions of these different subgroups are endogenous because they are determined in part by the nature of intervention itself.

¹¹The induced effect that the intervention might have on the intersectoral population migration is ignored in this paper. It is possible, however, to embed a migration mechanism within the present model. See Sah and Stiglitz (1987) and references therein for such models in the context of urban and rural pricing and taxation.

¹²It is important to note that x_p^1 is different from the partial derivative of x^1 , because the latter would also include the derivative of the upper limit of integration.

Next, the derivative of the market equilibrium condition, (4), with respect to t can be rearranged as

$$\frac{dp}{dt} = \left\{ (n^2 X x_m^2 - Q_i) - n^2 (1 - t x_m^2) \frac{dX}{dt} \right\} / (Q_p - n^2 x_p^2). \quad (6)$$

The denominator in the above expression represents the effect of a marginal increase in the market price p on the net market supply; that is, the price induced increase in the rural supply minus the decrease in the demand by the higher income group. The numerator represents the direct as well as the induced increase (through the effect on X) in the net market demand due to a marginal change in the wedge t . In general, the direct effect of t on the market demand (that is, $n^2 X x_m^2 - Q_i$) is of ambiguous sign because a larger t increases the food demanded by the upper income urban group, but it also increases the supply from the rural sector.¹³

Substitution of (5) into (6), evaluated at $t=0$, yields

$$\frac{dp}{dt} = [n^1 n^2 x_p^1 - (n - n^1) (n^2 X x_m^2 - Q_i)] / \Delta, \quad \text{where} \quad (7)$$

$$\Delta = n^1 n^2 x_p^1 - (n - n^1) (Q_p - n^2 x_p^2). \quad (8)$$

Clearly, $\Delta < 0$ because x_p^1 and x_p^2 are negative and Q_p is positive. The sign of the numerator in (7), on the other hand, is ambiguous; the source of this ambiguity has already been noted earlier. For small values of X (and correspondingly small values of G^a),¹⁴ however, the expression (7) is positive, and the following conclusion holds.

Proposition 1. The market price increases in response to an intervention, provided the ration size is small.

From an economic viewpoint, a critical sign is that of $dp/dt - 1$. To see this, suppose for a moment that this sign were positive. From $p - t = q$, this would imply $dq/dt > 0$; that is, an increase in the subsidy on rations actually increases the price at which rations can be sold. Thus, if dp/dt were to exceed unity in the neighborhood of $t=0$, then a small government intervention is incapable of lowering the ration price below the market price! This possibility, however, does not arise in the present case. To ascertain this, we obtain the following from (7)

$$\frac{dp}{dt} - 1 = (n - n^1) [(Q_p + Q_i) - n^2 (x_p^2 + X x_m^2)] / \Delta. \quad (9)$$

¹³The latter follows from $Q_i = \int Q_i^a dF^a = \int x_m^a G^a dF^a > 0$.

¹⁴In which case, in the numerator in the right-hand side of (7), the term $n^2 X x_m^2 - Q_i = n^2 X x_m^2 - \int x_m^a G^a dF^a$ is negligible compared to the other term.

Now, let $x_p^u(m)$ denote the compensated price response of an urban individual with income m . Then, the standard Slutsky relationship implies $x_p^2 + X x_m^2 = [1/\{1 - F(m^2)\}] \int_{m^2}^m [x_p^u - (x - X)x_m] dF$. The last expression is negative because $x > X$ for $m > m^2$, and $x_p^u \leq 0$. Therefore, the right-hand side of (9) is negative, and the following conclusion emerges.

Proposition 2. *The increase in the market price is less than proportional to the increase in the wedge between the market and the ration price.¹⁵*

Further, since $dp/dt - 1 < 0$, it follows from (5) that $dX/dt < 0$. That is: A larger price wedge corresponds to a smaller ration size. This is what we would expect because a larger wedge increases the food consumption of those consuming below X . This increase, in turn, requires a reduction in the per person ration quantity that can be made available in the urban sector.

The above qualitative results do not depend on the precise characteristics of the rural levy schedule $G^a(A)$, even though the equilibrium prices and quantities (that is, the level of p and X corresponding to a given level of t) obviously depend in general on the levy schedule. In the noteworthy special case in which the Engel curve for food is linear in income the equilibrium prices and quantities are also independent of any mean preserving change in the rural levy schedule. To see that, first note from (3) and (4) that the rural variables which influence the equilibrium are the average levy per farmer, $G = \int G^a(A) dF^a$, and the average surplus, $Q = \int Q^a(A) dF^a$. Also, recall that $Q^a = Z - x^a(p, -tG^a)$. Since the levy has no direct effect on the output, Z , of a farmer, it is straightforward to establish that when x^a is linear in $-tG^a$, a mean preserving change in G^a not only leaves Q unchanged but also, by definition, leaves G unchanged. From (3) and (4), the equilibrium values of p and X are thus unaffected.

Therefore: *If the Engel curve for food is linear, then any mean preserving change in the rural levy schedule has no effect on those in the urban sector; its only effect is on the income distribution within the rural sector.* This result is useful even if the Engel curve is linear only within parts of the entire range of the rural income distribution, as is more likely to be the case in practice. In this case, the above result holds for mean preserving changes in the levy schedule within the range of incomes (farm sizes) where the Engel curve is linear.

Welfare effects: We now ascertain the effects of government intervention on the welfare of different individuals in the economy. From (1),

$$dV^a(A)/dt = \lambda^a Q^a \left(\frac{dp}{dt} - \frac{G^a}{Q^a} \right) \quad (10)$$

¹⁵This result holds for a range of positive values of t . In fact, it can be verified that a sufficient condition for it to hold is $t < 1/x_m^2$.

represents the effect of intervention on the utility of a rural individual. The corresponding expressions for an urban individual within the lower and the upper income groups, respectively, are

$$dV^1(m)/dt = \lambda x \left(1 - \frac{dp}{dt} \right) \quad \text{and} \quad (11)$$

$$dV^2(m)/dt = \lambda x \left(\frac{X}{x} - \frac{dp}{dt} \right). \quad (12)$$

For those urban individuals whose food consumption is exactly equal to the ration quantity X , it is easy to see that either expression (11) or (12) represents the effect of intervention.¹⁶

In analyzing expressions (10) to (12), we restrict ourselves as earlier to those cases where $1 > dp/dt > 0$. It is also reasonable to require that the rural individuals with negative surpluses (that is, landless workers and small farmers) do not pay any levy, while for others, the levy quantity is always smaller than their surplus. That is, $G^s = 0$, if Q^s is negative; and $Q^s > G^s$, if G^s is positive. It follows then that (10) is negative if Q^s is negative. Also, (11) shows that $dV^1(m)/dt > 0$, and that the welfare incidence is analogous for those urban consumers whose food consumption is X . The above results can be summarized as follows:

Proposition 3. The urban individuals whose food consumption is not larger than the ration quantity become better-off due to the intervention. The landless workers and the small landowners in the rural sector, on the other hand, become worse-off due to the intervention.

The welfare effects on the rest of the population depend critically on the precise magnitude of dp/dt . For instance, if dp/dt is large (say, close to one) then, from (10) and (12), one would expect all rural surplus suppliers to become better-off, and the urban individuals consuming large quantities of food to become worse-off. The welfare effects would be reversed if dp/dt is sufficiently small (say, close to zero). The preceding observation suggests that if the intervention makes a specific group of individuals better-off, then it must make some other well-defined group of individuals worse-off. To derive specific results of this nature, we begin by establishing certain monotonicity properties in the welfare effects of the intervention.

¹⁶If the social welfare were to be represented through a Bergson-Samuelson social welfare function, then it is apparent that the aggregate impact of an intervention can be assessed from (10), (11) and (12). This aggregate impact, in turn, can be used to identify the qualitative properties of socially optimal intervention. However, we do not undertake a normative analysis.

We first show that: *If a consumer belonging to the upper income urban group becomes better-off (worse-off) due to the intervention, then all members of this group who are poorer (richer) than this consumer must also become better-off (worse-off).* That is

$$\text{If } dV^2(\tilde{m})/dt \geq 0, \text{ then } dV^2(m)/dt \geq 0 \text{ for all } m \leq \tilde{m}. \quad (13)$$

The above result is a direct consequence of the fact that $\{X - x dp/dt\}$ is the net income gain (which could be positive or negative) to an individual in the upper income urban group, from an increase in the subsidy t [see expression (12)]. This net income gain decreases with income because an individual's consumption, x , increases with income. Therefore, if the net income gain is positive (negative) for a particular individual then it must also be positive (negative) for those with smaller (larger) incomes than this individual.¹⁷

Whether or not a similar monotonicity characterizes the gains or losses of the surplus sellers in the rural sector depends, in part, on the nature of the levy schedule $G^a(A)$. In the rest of this paper, we focus on a linear $G^a(A)$ but, as we shall see, our results also hold for certain non-linear schedules. Specifically, we consider a levy schedule under which farmers with farm sizes below some level A_0 are not required to contribute to the procurement, and the quantity procured from those with farm sizes above A_0 is proportional to their farm size.¹⁸

Assuming that food yield is not significantly affected by the farm size, the food surplus can be expressed as $Q^a = Az - x^a$, where z is the food output per unit of land. For levy-paying farmers, then, $\partial(G^a/Q^a)/\partial A = (\epsilon_{xA}^a - 1)G^a x^a / (Q^a)^2 A$, where $\epsilon_{xA}^a = \partial \ln x^a / \partial \ln A$ is the elasticity of food consumption with respect to land area. Also, if π denotes the net profit from unit land, and $\epsilon_{xm}^a = \partial \ln x^a / \partial \ln m^a$ represents the income elasticity of food consumption, then $\epsilon_{xA}^a = (A\pi/m^a)\epsilon_{xm}^a$. Next, $A\pi < m^a$, because the net farm profit is only a part of the full income, which also includes the value of the labor endowment. Thus, since the income elasticity of food is typically less than one, it follows that $\epsilon_{xA}^a < 1$, and

$$\frac{\partial}{\partial A} (G^a/Q^a) < 0. \quad (14)$$

¹⁷Formally, if $x(p, m + tX)$ is denoted for brevity as $x(m)$, then (12) shows that: $dV^2(\tilde{m})/dt > 0$ implies $X/x(\tilde{m}) > dp/dt$. This, in turn, means $X/x(m) > dp/dt$, for $m < \tilde{m}$, because the food consumption $x(m)$ is increasing in income. Using (12), once again, it follows that $dV^2(m)/dt > 0$, for $m < \tilde{m}$. A parallel argument can be used to establish the rest of the expression (13).

¹⁸This is akin to proportional land tax above a certain farm size. For a discussion of the administrative and informational considerations concerning land taxation, see Sah and Stiglitz (1985).

We obtain, in other words, the following result:

Proposition 4. *If the farm size does not significantly affect the food yield then, under a linear levy schedule, the levy quantity as a proportion of the surplus sold by a farmer declines with farm size.¹⁹*

An immediate consequence of expressions (10) and (14) is that: *If a levy-paying farmer becomes better-off (worse-off) due to the intervention, then all levy-paying farmers with a larger (smaller) farm size must also become better-off (worse-off). That is*

$$\text{If } dV^*(\bar{A})/dt \geq 0, \text{ then } dV^*(A)/dt \geq 0 \text{ for } A \geq \bar{A}. \quad (15)$$

The economic intuition behind the above result is easily understood. From (10), $dp/dt - G^s/Q^s$ is the net income gain from intervention to a farmer on a unit of surplus and, from (14), this gain increases with farm size. Thus, if this gain is positive for a smaller farmer, it must be positive for a larger farmer. Alternatively, if the gain is negative for a larger farmer, it must also be negative for a smaller farmer.

The above monotonicity properties allow us to derive certain systematic relationships between those who gain in one sector versus those who lose in another sector. For brevity in exposition, we define a 'representative' farmer with land area \bar{A} , such that $G^s(\bar{A})/Q^s(\bar{A}) = G/Q$. That is, the representative farmer is the one whose levy payment as a proportion of his surplus is the same as the rural sector's average levy as a proportion of the rural food surplus. Analogously, the 'average' consumer, with income \bar{m}^2 , in the upper income urban group is defined such that $x(p, \bar{m}^2 + tX) = x^2$; that is, this consumer's food consumption is the same as the mean consumption in the higher income urban group. Using these definitions, we establish the following:

$$\text{If } dV^2(m)/dt \geq 0 \text{ for any } m \geq \bar{m}^2, \text{ then } dV^s(A)/dt < 0 \text{ for all } A \leq \bar{A}, \quad (16)$$

$$\text{If } dV^s(A)/dt \geq 0 \text{ for any } A \leq \bar{A}, \text{ then } dV^2(m)/dt < 0 \text{ for all } m \geq \bar{m}^2. \quad (17)$$

Proposition 5. (i) *If the intervention helps any urban consumer who is richer than the average consumer in the upper income group, then it must hurt all*

¹⁹This result holds for certain nonlinear levy schedules as well. To see this, note that $\partial(G^s/Q^s)/\partial A = [\epsilon_{GA} - 1 + x^s(\epsilon_{xA}^s - 1)/Q^s]G^s/Q^sA$, where $\epsilon_{GA} = \partial \ln G^s / \partial \ln A$ is the elasticity of the procurement quantity with respect to the farm size. Since $\epsilon_{xA}^s < 1$, it is apparent that (14) holds if $\epsilon_{GA} \leq 1$, and it may hold for values of ϵ_{GA} larger than one as well, provided they are not too large.

levy-paying farmers whose farm size is smaller than that of the representative farmer, and (ii) If the intervention helps any levy-paying farmer with farm size smaller than that of the representative farmer, then it must hurt all consumers richer than the average consumer in the upper income urban group.

The above proposition is established in two steps. First it is easily seen that the average levy as a proportion of the average rural surplus exceeds the per capita ration as a proportion of the average food consumption in the upper income urban group; that is

$$G/Q > X/x^2. \quad (18)$$

This can be confirmed by using (3) and (4), and noting that by definition $x^2 > X$. Next, for brevity we denote $x(p, m + tX)$ as $x(m)$, and show that: if $dV^2(m)/dt \geq 0$, for any $m \geq \bar{m}^2$, then

$$\frac{dp}{dt} \leq \frac{X}{x(m)} \leq \frac{X}{x^2} < \frac{G}{Q} \leq \frac{G^a(A)}{Q^a(A)}, \quad (19)$$

for all $A \leq \bar{A}$. The first inequality in the above expression is from (12), the second inequality arises because $x(m)$ is increasing in m , the third inequality is (18), and the last inequality is from (14). The first and the last part of the chain of inequalities (19), along with (10), yield (16). Using similar reasoning, it can be shown that if $dV^2(A)/dt \geq 0$, for any $A \leq \bar{A}$, then

$$\frac{dp}{dt} \geq \frac{G^a(A)}{Q^a(A)} \geq \frac{G}{Q} > \frac{X}{x^2} \geq \frac{X}{x(m)}, \quad (20)$$

for all $m \geq \bar{m}^2$. Taking the first and the last part of the above, and using (12), one obtains (17).

To see the economic content of the above proposition, first consider the expression (16). An urban consumer at the higher end of the distribution of incomes (who obviously consumes more food than the ration quantity) can gain from the intervention only if the rise in the market price is relatively small, so that the gains to this consumer from subsidized rations exceed his loss from the increased price he pays on the food purchased from the market. But if the rise in the market price is small, then it must also be the case that (i) the relatively poorer urban consumers, who buy even smaller quantities of food in the market, are better-off, and (ii) levy-paying farmers with smaller farms are worse-off, because their gain (from the increased market price) on the sale of surplus is inadequate to compensate for their loss on the quantity collected from them as levy. Expression (17) can be understood in a similar manner.

The conflict between the gains and losses of different groups can be seen more sharply in a simpler but somewhat unrealistic example in which there are only two internally homogeneous income classes in each sector. In particular, the rural sector consists of landless workers (who are net food buyers and, obviously, do not pay any levy) and landlords (who are surplus suppliers and pay a levy), and the urban sector consists of the poor (consuming less food than the ration quantity) and the rich (consuming more food than the ration quantity). In this special case, Propositions 3 and 5 imply that (i) the intervention hurts the landless workers and helps the urban poor, and (ii) of the remaining two groups (the urban rich and the landlords) one must become better-off while the other must become worse-off due to the intervention. Thus, in the case where the urban rich become better-off due to the intervention, it is appropriate to characterize the intervention as a transfer from the rural to the urban sector. On the other hand, if the urban rich become worse-off then the welfare incidence turns out to be quite unexpected: *the intervention entails a transfer from the rural poor and the urban rich to the urban poor and the rural rich*. This case, in other words, entails a transfer from those who are net buyers of food in the market to the net food sellers and to those not involved in the market at all.

4. Tradable rations

It was assumed in the preceding analysis that the ration recipients can not resell their rations. This specification depicts the official policy (or more accurately, the belief of policy makers) which accompanies typical public distribution systems. In this section, we study the opposite specification where rations are fully tradable. We assume that rations are provided only to the urban individuals with incomes below some level (say, m^*). This means that the government can identify individuals with incomes below m^* . If it can not, it provides rations to all urban consumers (the latter case is equivalent to setting $m^* = m^U$). Since tradable rations entail a direct income gain, it is apparent that the government intervention is equivalent in this case to an income tax on farmers and a uniform income subsidy to those urban individuals who receive rations.

Let n^1 and n^2 denote the urban population below and above the income level m^* , respectively, as proportions of the rural population.²⁰ We refer to these two groups as the lower and upper income urban groups. Also, for $h=1$ and 2, define x^h , x_p^h and x_m^h to represent the average food consumption, and the average price and income response of food consumption, within the two urban groups. The balance between supply and demand within the

²⁰Obviously, $n^2 = 1 - n^1$. Also, note that n^1 and n^2 defined here do not bear any relationship to those in the earlier sections. These numbers are a policy choice here, whereas they were endogenous variables in the preceding analysis.

public distribution system requires: $G = n^1 X$. The corresponding balance in the market is given by

$$Q - G = n^1(x^1 - X) + n^2 x^2. \quad (21)$$

The welfare effect of the intervention (that is, of introducing the price wedge t) on the rural population continues to be expressed by (10). The utility levels of individuals in the lower and the upper income urban groups, respectively, are: $V^1 = V(p, m + tX)$ and $V^2 = V(p, m)$. The corresponding welfare effects of the intervention are represented by

$$dV^1(m)/dt = \lambda x \left(\frac{X}{x} - \frac{dp}{dt} \right), \quad (22)$$

$$dV^2(m)/dt = -\lambda x \frac{dp}{dt}. \quad (23)$$

A perturbation in (21) with respect to (p, t) yields

$$\frac{dp}{dt} = [Gx_m^1 - Q_t] / [Q_p - n^1 x_p^1 - n^2 x_p^2]. \quad (24)$$

The denominator in the above right-hand side is positive. In the numerator, recall that $x_m^1 > 0$ and that $Q_t = \int x_m^a G^a dF^a > 0$. It is obvious thus that the sign of dp/dt is ambiguous in general, and that this sign depends critically on the magnitudes of the income responses in the rural sector compared to those in the lower income urban group.

The above dependence of the induced change in the market price on the relative income effects arises because of the income transfer (from the rural sector to the lower urban group) associated with the intervention. Further, recall that both the urban rich as well as the rural poor are net food buyers in the market. Not surprisingly, therefore, expressions (10) and (23) show that the individuals in these two groups are hurt (helped) by the intervention if it raises (lowers) the market price.

For the remaining two groups (that is, levy-paying farmers and the members of the lower income urban group) there is a conflict in the direction of welfare effects. If dp/dt is negative then, from (10) and (22), the levy-paying farmers lose and the lower income urban individuals gain. If dp/dt is positive, on the other hand, then the welfare effects are less obvious. To obtain a better understanding we need to probe further.

From (21) and the public distribution system's budget balance (that is, $G = n^1 X$), it is easily ascertained that $X/x^1 > G/Q$. Next, let \bar{m}^* be the income

at which an urban consumer's food consumption is x^1 . Then, using (10), (13), (15) and (22), the following relationships are obtained, the interpretation of which should now be apparent.

Proposition 6.

If $dV^1(m)/dt \leq 0$ for any $m \leq \bar{m}^*$, then $dV^u(A)/dt > 0$ for all $A \geq \bar{A}$.
(25)

If $dV^u(A)/dt \leq 0$ for any $A \geq \bar{A}$, then $dV^1(m)/dt > 0$ for all $m \leq \bar{m}^*$.
(26)

An implication of the above result is that if a farmer at the upper end of the land distribution is worse-off due to the intervention, then all urban consumers at the lower end of the income distribution must be better-off. On the other hand, if one of the latter individuals is worse-off then the former set of individuals must be better-off.

If the Engel curve for food is linear, then (24) yields $dp/dt = 0$,²¹ and expressions (10), (22), and (23) lead to the following result: *With tradable rations and a linear Engel curve for food, intervention has no effect on the market price.*²² It helps those urban individuals who receive rations, hurts levy-paying farmers, and leaves other individuals in the economy unaffected. In this case, intervention implies an unambiguous transfer from the rich farmers to the poor urban consumers.

5. Concluding remarks

Our positive analysis of the distributional effects of food procurement cum rationing schemes suggests that in many circumstances such schemes have unexpected welfare consequences for different groups of heterogeneous individuals; that is, those individuals who were 'intended' to be helped by the intervention end up being hurt. We show also that specific groups of individuals must become worse-off due to the intervention, if some other well-defined groups become better-off, and vice versa.

To keep our analysis simple, however, we have abstracted from a number of important issues. For instance, our specification assumes that the government budget concerning the procurement cum rationing scheme is balanced.

²¹Because $Q_i = Gx_m^u$, and $x_m^u = x_m^1$. Accordingly, the numerator in the right-hand side of (24) is zero.

²²This effect is parallel to that in the transfer problem in international trade where, as was originally pointed out by Ohlin (1929), inter-country income transfers do not affect the terms of trade when Engel curves are linear.

Also, as was noted in the introductory section, we have not attempted an analysis of the role of secondary markets in rations and that of bureaucratic corruption in public distribution systems; instead, we have analyzed two polar cases, one in which there is no secondary trade in rations and another in which there is unhindered secondary trade. We have ignored administrative costs (that is, storage, transportation and other costs) of the public distribution system. These could be significant. We close this paper with brief remarks on the role of such costs.

What matters for our analysis is not administrative costs per se, but whether such costs differ between the public and private food distribution system. Our conclusions remain unaltered if they do not significantly differ. If on the other hand this cost is significantly larger for the public system (as has sometimes been alleged to be the case, because of bureaucratic inefficiencies), and if this 'excess' cost is allocated to both sectors (that is, this cost is absorbed by lowering the procurement price and by raising the issue price at which rations are sold) then it is natural to expect that there are fewer gainers and more losers from intervention than those identified in the preceding analysis. In fact, if the public system's administrative costs are sufficiently larger than those of the private system, then a procurement cum rationing scheme could be Pareto-inferior to no intervention!

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