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DISTRIBUTIONAL CONSEQUENCES OF RURAL FOOD LEVY
AND SUBSIDIZED URBAN RATIONS

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ABSTRACT

In many developing economies, governments provide limited quantities of subsidized food rations to their urban population. This paper presents a positive analysis of the impact of such subsidy systems on the welfare of heterogeneous individuals within the urban and the rural sectors, when the urban subsidy is funded through a levy on farmers. Though such an intervention has the appearance of a transfer from the rural to the urban sector, we characterize the conditions under which the opposite happens; that is, certain groups in the rural sector become better-off due to the intervention, while some of those in the urban sector become worse-off. Moreover, the rich turn out to be among the gainers while the poor are among the losers from the intervention. Such counter-intuitive outcomes arise not only because of the general equilibrium effects of the intervention, but also because a procurement cum rationing system entails particular types of price discrimination among individuals. In addition, we identify systematic patterns between the groups which gain versus those who lose from the intervention.

DISTRIBUTIONAL CONSEQUENCES OF RURAL FOOD LEVY
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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.

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 the government has shown a continuing 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); the government procurement has thus entailed an element of compulsion. 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 price they pay for the rest of their purchases. In all, therefore, five distinct prices (roughly, in an increasing order) could be distinguished: support price, procurement price, farm harvest price, issue price, and open market 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 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 aggregate sectoral representation 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 some of these other aspects have been studied elsewhere in the literature. For instance, Sah and Stiglitz (1985) have analyzed the positive and normative aspects of the disaggregated structure of commodity taxes and subsidies in the two sectors but they have abstracted from policy instruments such as procurement and rations. On the other hand, empirical analyses of specific food subsidy schemes in India in a computable general equilibrium framework are available in Narayana, Parikh and Srinivasan (1984) 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 parameterization of production and utility functions.⁵

Section I describes the basic model in which urban consumers are precluded from selling their rations in the secondary market. The corresponding incidence of welfare effects is studied in Section II. Section III releases the resale restriction. The paper concludes with brief comments on some of the possible extensions of the model.

I. 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.⁶ 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 at present. A rural individual's net food surplus is denoted by $Q^a(A) = Z(A) - x^a(A)$, which can be positive or negative depending on whether the individual is a net seller or buyer of food. The food surplus is clearly negative for landless workers and small farmers, and it is 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. We postpone a discussion of the schedule $G^a(A)$ until later because, as we shall see, many of our results do not depend on the 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 utility level and his food surplus are respectively denoted as $V^a(p, -tG^a; A)$, and $Q^a(p, -tG^a; A)$. Then, the changes in V^a due to a change in p and t are

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

where $\lambda^a(A)$ denotes the positive marginal utility of income to an individual with farm size A .⁷

Next consider the effect of a change in p and t on a farmer's food surplus, Q^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 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

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

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 consump-

tion by buying any quantity in the market, at price p .⁸ The income of a consumer is denoted by m , which is distributed according to the distribution function $F(m)$. Clearly, the self-selection of urban consumers must imply that there are three groups of consumers: (i) The first group consisting 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 $V^1(m) = V(p - t, m)$, and $x(p - t, m)$ respectively, (ii) The second group consisting of those whose food consumption equals X , and (iii) The third group consisting of those consuming more food than the ration quantity. The effect of rationing on these individuals is to provide an income subsidy of tX . Their utility level and food consumption are, thus, represented by $V^2(m) = V(p, m + tX)$, 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 must be poorer in turn 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 . Furthermore, we do not need to ascertain whether m^1 and m^2 are identical or not (the former situation is simply a special case of

the latter) because, as we shall see, our analysis does not depend on this issue.

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 as those belonging to the upper income group. Further x^1 and x^2 denote the per capita food consumption within the lower and the upper income groups, respectively.

That is, $x^1 = [1/F(m^1)] \int_{m^L}^{m^1} x(p - t, m) dF$, and

$x^2 = [1/[1 - F(m^2)]] \int_{m^2}^{m^U} x(p, m + tX) dF$, 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. For the moment we ignore 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

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

where $n = N/N^a$ denotes the urban population as a proportion of the rural population. Further, the balance between the food supply and demand in the market requires

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

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 equations (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 variables t and the schedule $G^a(A)$ are treated as controls. The key advantage of this specification is that at $t = 0$, the above model implies non-intervention, regardless of what $G^a(A)$ and X might be.

II. 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. Also, as we shall note parenthetically, many of the results hold even when the existing wedge is not small.⁹

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

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

where $x_p^1 = [1/F(m^1)] \int_m^m x_p(p - t, m) dF$ is the average price response of food consumption of urban individuals in the lower income group.¹⁰ 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 change 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 .

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

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

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, $n^2 X x_m^2 - Q_t$) has an 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.¹¹

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

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

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

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),¹² 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 $dp/dt - 1$. 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. Furthermore, 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)

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

Now, let $x_p^u(m)$ denote the compensated price response of an urban individual with income m . Then, the standard Slutsky relationship implies $x_p^2 + Xx_m^2 = [1/(1 - F(m^2))] \int_m^m [x_p^u - (x - X)x_m] dF$. 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.¹³

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 capita ration quantity that can be made available in the urban sector.

It is useful to point out here that 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) depend, in general, on the levy schedule. A noteworthy special case in which the equilibrium prices and quantities themselves are independent of any mean preserving change in the rural levy schedule is when the Engel curve for food is linear in income. To see this, 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, provided 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. We should also note here that 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 approximately linear.

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

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

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

$$(11) \quad dV^a(A)/dt = \lambda_x \left(1 - \frac{dp}{dt} \right), \quad \text{and}$$

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

where $\lambda(m)$ denotes the positive marginal utility of income to an urban individual with income m . For the 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.¹⁴

In analyzing expressions (10) to (12), we restrict ourselves to those cases (discussed in the previous section) where: $1 > dp/dt > 0$. It is also reasonable to restrict the levy schedule such that the rural individuals with negative surpluses (that is, landless workers and small farmers) do not pay any levy, while for others who pay levies, the levy quantity is always smaller than their surplus quantity. That is, $G^a = 0$, if Q^a is negative; and $Q^a > G^a$, if G^a is positive. It follows then that (10) is negative if Q^a is negative. Further, (11) shows that $dV^1(m)/dt > 0$. The same is true 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 reverse welfare effects would arise if dp/dt is 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.

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

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

The above result is a direct consequence of the fact that $\{X - xdp/dt\}$ 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.¹⁵

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.¹⁶

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, $\partial(G^a/Q^a)/\partial A = (\varepsilon_{xA}^a - 1)G^a x^a / (Q^a)^2 A$, where $\varepsilon_{xA}^a = \partial \ln x^a / \partial \ln A$ is the elasticity of food consumption with respect to land area. Further, if π denotes the net profit from unit land, m^a denotes the full income of a farmer, and $\varepsilon_{xm}^a = \partial \ln x^a / \partial \ln m^a$ represents the income elasticity of food consumption, then $\varepsilon_{xA}^a = (A\pi/m^a)\varepsilon_{xm}^a$. Now $A\pi < m^a$, because the net farm profit is only a part of the full income, which also includes the value of the labor endowment. Further, since the income elasticity of food is typically less than one, it follows that $\varepsilon_{xA}^a < 1$, and

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

Thus 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.¹⁷

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

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

The economic intuition behind the above result is easily understood. From (10), $dp/dt - G^a/Q^a$ 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 also 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 $G^a(\bar{A})/Q^a(\bar{A}) = G/Q$. 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, the average consumer's food consumption is the same as the mean consumption in the higher income urban group. Using these definitions, we establish the following.

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

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

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 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

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

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 $\hat{x}(m)$, and show that: if $dV^2(m)/dt \geq 0$, for any $m \geq \bar{m}^2$, then

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

for all $A \leq \bar{A}$. The first inequality in the above is from (12), the second inequality arises because $\hat{x}(m)$ 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 $dV^a(A)/dt \geq 0$, for any $A \leq \bar{A}$, then

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

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 much more sharply in a simplified specification in which there are only two (internally homogeneous) income classes in each sector. Specifically, 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, Proposi-

tions 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. The transfer in this case is 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.

III. TRADABLE RATIONS

It was assumed in the preceding analysis that the ration recipients can not or do not resell their rations. This specification depicts the official policy (or more accurately, the belief of policy makers) which accompanies typical public distribution systems. However, individuals often have strong incentives to buy and sell rationed goods in underground (illegal) markets. In this section, we briefly examine the case in which rations are provided only to urban individuals below some income level (say, m^1), but there is unrestrained trade of rations in secondary markets. Since tradable rations entail a direct income gain, it is apparent that the government intervention, in this case, is equivalent 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 populations below and above the income level m^1 , respectively, as proportions of the rural population.¹⁸ 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 public distribution system requires: $G = n^1 X$. The corresponding balance in the market is given by

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

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

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

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

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

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

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 is intuitive because of the income transfers (from the rural sector to the lower income urban group) which is being attempted through the present intervention. Further, note that both the urban rich as well as the rural poor (for whom, it will be recalled, $Q^a < 0$, and $G^a = 0$) are net food buyers in the market. Not surprisingly, therefore, expressions (10) and (23) show that the rural poor as well as those in the upper income urban group 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, therefore, we conduct an analysis similar to the one in the concluding parts of the last section.

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 $\bar{m}^1$ 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:

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

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 $dp/dt = 0$,¹⁹ and expressions (10), (22), (23) lead to the following result: With tradable rations and a linear Engel curve for food, intervention has no effect on the market price.²⁰ It helps those urban individuals who receive rations, hurts levy-paying farmers, and leaves other individuals in the economy unaffected. In this case, therefore, intervention implies a transfer from the rich farmers to the poor urban consumers.

IV. CONCLUDING REMARKS

This paper has undertaken a positive analysis of the distributional effects of food procurement cum rationing schemes. We have pointed out many of the circumstances under which such schemes have unexpected overall incidence on the welfare of different groups of heterogeneous indivi-

duals; that is, those individuals who were "intended" to be helped by the intervention end up being hurt. Furthermore, we have established results which show 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. Also, we have not attempted an analysis of the role of underground (illegal) transactions 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. Another important aspect from which we have abstracted is that of administrative costs (that is, storage, transportation and other costs) associated with the maintenance of the public distribution system. We close this paper with brief remarks on the role of such costs.

What matters for an analysis such as ours is not that there are administrative costs, but how do such costs for the public food distribution system differ from the corresponding costs for the private distribution system. Our conclusions remain unaltered if the administrative cost of handling a unit of food in the public system is not significantly different from that in the private system. 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 "excessive" cost is allocated to both sectors (that is, if the pro-

curement price is lowered and the price at which rations are sold is raised) 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 in principle it is possible that a procurement cum rationing scheme is Pareto worsening.

FOOTNOTES

¹We should stress that it is not our aim here to argue for or against such schemes, but we believe that a clearer understanding of their implications is needed in assessing such arguments.

²We do not consider here 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, calculate the effect of such a scheme in Sri Lanka on aggregate producers' and consumers' surpluses. For a comparison of outcomes of distributing limited quantities of goods through queues, rations, market and some other allocation systems, see Sah (1986).

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 the effects of intervention on the domestic food price (on which some of the previous debates have focussed, and which forms a central part of the present analysis) are missing, unless the government introduces a change in food tariff contemporaneously with the intervention.

⁴We should point out however that 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.

⁵Among other recent studies on food policy are Gittinger et al. (1985) and Taylor et al. (1983). Guesnerie and Roberts (1986) have addressed somewhat different questions; for instance, 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. We should also mention here the papers by Chetty and Jha (1984) which examine the characterization and the existence of equilibrium in an economy with subsidized rations (in the background of open markets) in many commodities.

⁶By farm size, we mean cultivated area. The tenurial 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.

⁷Unless stated otherwise, a subscript denotes (throughout the paper) the variable with respect to which a partial derivative is being taken.

⁸It is easily possible to work with a more general formulation in which the unit subsidy on the urban rations differs from the unit tax on the rural levy quantities. The qualitative issues on which the present paper focuses, however, remain largely unaffected by this extension.

⁹The 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 (1985) for such models in the context of urban-rural pricing and commodity taxation.

¹⁰Note 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.

¹¹The latter follows from $Q_t = \int Q_t^a dF^a = \int x_m^a G^a dF^a > 0$.

¹²In which case, in the numerator in the right hand side of (7), the term $n^2 X x_m^2 - Q_t = n^2 X x_m^2 - \int x_m^a G^a dF^a$ is negligible compared to the other term.

¹³This 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 $t < 1/x_m^2$.

¹⁴If the societal 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 analyzed to identify the qualitative properties of socially optimal intervention. However, as mentioned earlier, the present paper does not undertake a normative analysis.

¹⁵Formally, if $x(p, m + tX)$ is denoted (for brevity) as $\hat{x}(m)$, then (12) shows that: $dV^2(\tilde{m})/dt > 0$ implies $X/\hat{x}(\tilde{m}) > dp/dt$. This, in turn, means $X/\hat{x}(m) > dp/dt$, for $m < \tilde{m}$, because the food consumption $\hat{x}(m)$ 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).

¹⁶This is akin to a 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).

¹⁷This result holds for certain nonlinear levy schedules as well. To see this, note that $\partial(G^a/Q^a)/\partial A = [\varepsilon_{GA} - 1 + x^a(\varepsilon_{xA}^a - 1)/Q^a]G^a/Q^aA$, where $\varepsilon_{GA} = \partial \ln G^a / \partial \ln A$ is the elasticity of the procurement quantity with respect to the farm size. Since $\varepsilon_{xA}^a < 1$, it is apparent that (14) holds if $\varepsilon_{GA} \leq 1$, and it may hold for values of ε_{GA} larger than one as well, provided they are not too large.

¹⁸Note that m^1 , n^1 and n^2 defined here do not bear any relationship to those in the earlier sections. In particular, m^1 here is a policy choice, whereas it was an endogenous variable in the preceding analysis.

¹⁹Because $Q_t = Gx_m^a$, and $x_m^a = x_m^1$. Accordingly, the numerator in the right hand side of (24) is zero.

²⁰This 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.

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