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SHOULD FOOD AID BE GIVEN AWAY OR SOLD DURING A FAMINE?

by

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I. Introduction

A serious concern in famine relief is the accurate targeting of food aid. For a relief agency with limited resources, targeting aid to only the most needy is important to achieving the lowest feasible mortality level. A common criticism of the usual method of food aid distribution, which is to simply give it away, is that it does not always perform well in this respect.[1] When food aid is given away at least some of those who already have sufficient food to ensure their survival are likely to express a demand for it. This leaves those relief workers who are in charge of distributing the food the task of distinguishing these individuals from those who are truly in need. In principle this might not appear a difficult task. The needy are likely to be more malnourished than the unneedy and there do exist methods to quickly estimate the extent of an individual's malnourishment (for example, weight for height or arm circumference measurements). In the early stages of a food crisis, however, differences in malnourishment are unlikely to be sufficiently large to be detected by such approximate methods.[2] In such situations there is often little choice but to give food aid to all those who express a demand for it and hence to both needy and unneedy individuals.

A variety of different devices designed to deter unneedy individuals from expressing a demand for food aid have been tried. These include locating distribution centers at a considerable distance from population centers, requiring individuals to line-up for long periods of time and distributing only relatively unpalatable foods.[3] A more radical alternative has been proposed by Seaman and Holt [12]. They suggest <u>selling</u> food aid rather than giving it away.[4] The idea is that if individuals are required to pay for food aid they will be less likely to demand it unless they really need it. Consequently a larger fraction of the available food aid will go to the needy and a lower level of mortality will result.

The idea that selling may be more effective than giving away in getting a commodity to those who need it most is a familiar one to economists. The advantage of selling is indeed that, ceteris paribus, individuals who do not really need the commodity will be likely to demand less of it. Selling, however, has the disadvantage that individuals who really need the commodity may be unable to transform their needs into an effective demand if they do not have much money. The issue has been analyzed formally in a fascinating paper by Weitzman [18].[5] Weitzman models a situation in which a distributing authority has a fixed stock of a scarce commodity to distribute among a population of diverse 'needs' and 'incomes'. There is no private market for the commodity in question and individuals' characteristics are private information. Weitzman demonstrates that if needs are widely dispersed and/or incomes are evenly dispersed, a more effective allocation is likely to be achieved if the distributing authority sells the commodity rather than gives it away. Interpreting an individual's 'needs' as the amount of food he requires to survive in excess of his current food holdings and an individual's 'income' as the amount of money he possesses, this result suggests that, provided the needy do have some money, Seaman and Holt's proposal may well have some merit.

In the vast majority of famines, however, the assumption that there is no private market for food will not be satisfied. Typically, food is still traded albeit at a much higher price.[6] Once this is recognised it is no longer so obvious that selling can lead to a lower level of mortality. First, it is not clear that selling will deter the unneedy from demanding food aid. Provided that the relief agency is selling food aid at a price which is less than market price, it will always pay an unneedy individual to sell his food holdings in the market and purchase his food requirements from the agency. Second, even if selling food aid does result in a larger fraction going to the needy, this does not imply a lower level of mortality. An individual's probability of survival is determined not by his consumption of food aid but by his consumption of food. An individual's food consumption will equal his food holdings together with any food aid he obtains, plus his net market purchases of food. Obviously, if an individual has to buy food aid, he will have less money available to spend in the market and thus one would expect his market purchases to be lower. It is possible, therefore, that even if selling food aid leads to a more accurate targeting of relief it will result in a higher level of mortality.

In this paper we investigate whether, in fact, selling food aid can be more effective than giving it away in a famine situation in which distinguishing needy and unneedy individuals is difficult and there is an active private market for food. A simple formal model of a region in a state of famine is constructed.[7] In this region there is a market for food and both needy and unneedy individuals. A relief agency is assumed to enter the region with a fixed amount of food aid to distribute. The agency is unable to distinguish between needy and unneedy individuals and can either distribute the food aid free of charge or offer it for sale at any price of its choosing. The distributions of food aid, the market purchases of the needy and the unneedy and the levels of expected mortality under give-away and selling policies are then calculated and compared.

The first finding of the paper is that selling at a price less than market price can never improve the distribution of food aid and will, if the selling price is sufficiently high, worsen it. Surprisingly enough, this result is not found to imply that selling at less than market price will always increase expected mortality. If the selling price is small, selling can actually increase the needy's market purchases and thereby decrease expected mortality.

A necessary condition for this to happen, however, is that the needy possess more money than the unneedy. If this rather unlikely condition is not satisfied, selling at less than market price will always decrease the needy's market purchases and hence increase expected mortality. If food aid is sold at market price, the distribution of individuals' total food consumption between market purchases and food aid purchases is not determinate. Selling at market price can therefore either improve or worsen the distribution of food aid and either increase or decrease the needy's market purchases. Again, however, it is found that if the needy possess less money than the unneedy, selling at market price will always increase expected mortality.

The organisation of the remainder of the paper is as follows: the model and its assumptions are outlined in Section II, the analysis takes place in Section III and Section IV concludes. An Appendix contains the derivation of one of the equations stated in the text.

II. The Model

Consider a region at the beginning of some time period t. There are three commodities in this region; food, a non-food good and money. Imagine that some of the population of this region are 'poor' in the sense that they may not have, or be able to obtain, sufficient food to ensure their survival. Let n denote the number of poor individuals in the population. Suppose that these individuals possess some money and food at the beginning of period t. Specifically, assume that a fraction γ of the poor hold e_m^1 units of money and e_x^1 units of food and that the remaining fraction hold e_m^2 units of money and e_x^2 units of food.

During period t markets will open for food and the non-food good. Let p denote the market price of food and q denote the market price of the non-food good. Let $x(p,q,w,\alpha)$ denote the amount of food a poor individual would demand at the prices p and q if he had 'wealth' w and possessed α units of food which he was not permitted to trade.[8] A poor individual's 'wealth' is his money holdings plus the market value of his tradeable food holdings. The reason for allowing poor individuals' demand for food to depend on holdings of non-tradeable food will become apparent later in this section. Let V(p) denote the excess supply of food of the rest of the population at the price p. It will be assumed throughout that the price of the non-food good in these markets will always be $\bar{q}$.[9]

After trade has taken place, poor individuals will consume their holdings of food and the non-food good. Their food consumption will determine their chances of survival. Let $\pi(x)$ denote the probability that a poor individual who consumes x units of food will survive in period t.

A number of assumptions are made concerning the probability of survival function, poor individuals' demand functions and the excess supply function of the rest of the population.

<u>Assumption 1</u> The function π: $\mathbb{R}_+ \to [0,1]$ has the following properties:

(i) π is continuously differentiable

(ii) there exists $c > 0$ such that $\pi'(x) > 0$ for all $x \in [o,c)$ and $\pi(x) = 1$ for all $x \geq c$.

If a poor individual's food consumption exceeds the level c, therefore, he will survive with probability one.[10] If it is less than c he will face a positive probability of non-survival. This probability will be higher the lower is his food consumption. We shall refer to c as the <u>critical level</u> of food consumption.

<u>Assumption 2</u> The function x: $\mathbb{R}^4_+ \to \mathbb{R}$ has the following properties:

(i) $w/p + \alpha \leq c$ implies $x(p,q,w,\alpha) = w/p$

(ii) $w/p + \alpha > c$ implies $x(p,q,w,\alpha) + \alpha > c$

(iii) x is continuously differentiable

(iv) $x_p < 0$, $x_q \geq 0$, $x_w > 0$, $x_\alpha \leq 0$.

Assumptions 2(i) and 2(ii) state that if a poor individual is able to consume a level of food consumption greater than the critical level he will and, if not, he will consume as much food as he can. The idea here is that at levels of food consumption less than the critical level an individual is extremely hungry and the utility of food is very high. Assumption 2(iv) states that a poor individual's food demand is decreasing in the price of food, non-decreasing in the price of the non-food good, increasing in his wealth and non-increasing in the amount of non-tradeable food he possesses.[11]

<u>Assumption 3</u> The function V: $\mathbb{R}_+ \to \mathbb{R}$ has the following properties:

(i) V is continuously differentiable

(ii) $V' > 0$

(iii) $V(0) < 0$

(iv) there exists p such that $V(p) > 0$.

Assumption 3(ii) states that the excess supply of food of the rest of the population increases when the price of food rises. Assumptions 3(iii) and 3(iv) state that the rest of the population are net demanders of food at a zero price but net suppliers at sufficiently high prices.

In the absence of intervention in the region poor individuals with endowments (e^i_m, e^i_x) $(i = 1,2)$ would, if the market price of food were p, have wealth $e^i_m + pe^i_x$ and would demand $x(p,\bar{q}, e^i_m + pe^i_x,0)$ units of food. The poor's total net demand for food (food demand less food endowments) at the price p would therefore be

$$n[\gamma(x(p,\bar{q},e^1_m + pe^1_x,0) - e^1_x) + (1 - \gamma)(x(p,\bar{q},e^2_m + pe^2_x,0) - e^2_x)] \qquad \text{(II.1)}$$

The equilibrium market price would be $\bar{p}$, where

$$n[\gamma(x(\bar{p},\bar{q},e^1_m + \bar{p}e^1_x,0) - e^1_x) + (1 - \gamma)(x(\bar{p},\bar{q},e^2_m + \bar{p}e^2_x,0) - e^2_x)] = V(\bar{p}) \qquad \text{(II.2)}$$

We make the following assumption about the price $\bar{p}$.[12]

<u>Assumption 4</u> (i) $e^1_m/\bar{p} + e^1_x < c$
(ii) $e^2_m/\bar{p} + e^2_x \geq c$

Assumption 4 states that at the price $\bar{p}$, poor individuals with endowments (e^2_m, e^2_x) would be able to afford the critical level of food consumption while those with endowments (e^1_m, e^1_x) would not.

It follows from Assumptions 1(ii) and 4 that, in the absence of intervention, poor individuals with endowments (e^1_m, e^1_x) would face a positive probability of non-survival. Poor individuals with endowments (e^2_m, e^2_x) would be more fortunate: since they would be able to afford the critical level, Assumption 2(ii) implies that they would survive with probability one. At the beginning of period t, therefore, the region is in a state of famine.[13] The needy - those who face a positive probability of non-survival-are those individuals with endowments (e_m^1, e_x^1). The remaining poor individuals are unneedy.

Now suppose that a relief agency, realising that the region is in a state of famine, arrives at the outset of the period with a stock of food aid $\bar{x}$ to distribute.[14] Assume that it cannot distinguish between needy and unneedy poor individuals[15] and that it can either distribute the food aid free of charge of offer it for sale at any price of its choosing. Further suppose that individuals cannot resell food aid in the market.[16] Let r denote the price the relief agency chooses. (If it distributes free of charge then, obviously, r equals zero). In addition to choosing a price, the agency must also choose a ceiling to place on each individual's purchases; for, if r is small the poor's demand for food aid may exceed the available stock. Let this ceiling be denoted by z. It will be assumed that the agency chooses a price-ceiling pair such that the entire stock of food aid is distributed.

Given any particular price-ceiling pair, what will be the corresponding market price of food, distribution of food aid, market purchases of the needy and the unneedy and level of expected mortality? Before we can answer these questions, we must first understand poor individuals' food demand. How much food would a poor individual demand from the agency and in the market if he had wealth w, the agency choose the price-ceiling pair (r,z) and the market prices of food and the non-food good were p and q. Clearly, if r were greater than p, he would demand $x(p,q,w,0)$ units of food in the market and none from the agency. If r were equal to p, he would demand $x(p,q,w,0)$ units in total and be indifferent as to whether he purchased them from the agency or in the market. If r were smaller than p, there are two possibilities. The first is that $x(r,q,w,0)$ is less than z; that is, the individual's demand at the price r is less than the ceiling. In this case he would simply demand $x(r,q,w,0)$ units from the agency and no units in the market. The second is that $x(r,q,w,0)$ exceeds z. In this case he would demand z units from the agency and $x(p,q,w - rz,z)$ units in the market.[17]

Let $p(r,z)$ denote the equilibrium market price of food corresponding to the price-ceiling pair (r,z); let $\xi_i(r,z)$ and $\zeta_i(r,z)$ denote, respectively, the amounts of food each poor individual with endowments (e_m^i, e_x^i) would obtain in the market and from the agency and let $M(r,z)$ denote the level of expected mortality in the region. It is a straightforward task to characterize the equilibrium market price. Let $\xi(p,q,r,z,w)$ denote the market demand correspondence of a poor individual with wealth w. From the discussion in the previous paragraph we know that

$$\xi(p,q,r,z,w) = \begin{cases} \{x(p,q,w,0)\} & \text{if } r > p \\ [\min\{0,x(p,q,w,0) - z\},\ x(p,q,w,0)] & \text{if } r = p \\ \{0\} & \text{if } r < p \text{ and } x(r,q,w,0) < z \\ \{x(p,q,w - rz,z)\} & \text{otherwise} \end{cases} \tag{II.3}$$

Poor individuals with endowments (e_m^i, e_x^i) would if the market price of food were p, have wealth $e_m^i + pe_x^i$. The net market demand correspondence of the poor is therefore

$$n[\gamma(\xi(p,\bar{q},r,z,e_m^1 + pe_x^1) - \{e_x^1\}) + (1 - \gamma)(\xi(p,\bar{q},r,z,e_m^2 + pe_x^2) - \{e_x^2\})] \tag{II.4}$$

The equilibrium market price $p(r,z)$ is the solution to the equation.[18]

$$V(p) \in n[\gamma(\xi(p,\bar{q},r,z,e_m^1 + pe_x^1) - \{e_x^1\}) + (1 - \gamma)(\xi(p,\bar{q},r,z,e_m^2 + pe_x^2) - \{e_x^2\})] \tag{II.5}$$

Characterizing the amounts of food obtained by the needy and unneedy is not quite so straightforward because the pair $(\xi_i(r,z), \zeta_i(r,z))_{i=1}^2$ is not uniquely defined when r is equal to p(r,z). We do know, however, that whatever the relative size of r and p(r,z), $(\xi_i(r,z), \zeta_i(r,z))_{i=1}^2$ must satisfy the following four equations.

$$\xi_i \in \xi(p(r,z),\bar{q},r,z,e_m^i + p(r,z)e_x^i) \quad i = 1,2 \tag{II.6}$$

$$n[\gamma(\xi_1 - e_x^1) + (1 - \gamma)(\xi_2 - e_x^2)] = V(p(r,z)) \tag{II.7}$$

$$n[\gamma\zeta_1 + (1 - \gamma)\zeta_2] = \bar{x} \tag{II.8}$$

$$\zeta_i = \begin{cases} 0 & \text{if } r > p(r,z) \\ x(p(r,z),\bar{q},e_m^i + p(r,z)e_x^i,0) - \xi_i & \text{if } r = p(r,z) \quad i = 1,2 \\ \min\{x(r,\bar{q},e_m^i + p(r,z)e_x^i,0),z\} & \text{if } r < p(r,z) \end{cases} \tag{II.9}$$

Equation (II.6) states that the amounts of food obtained by the needy and unneedy in the market must be consistent with their market demand correspondences. Equation (II.7) states that the total amount of food obtained by the poor in the market must equal the amount supplied and equation (II.8) states that the total amount of food aid obtained by the poor must equal the total stock available. Recall from our earlier discussion that a poor individual will demand no food from the agency if r exceeds p; will demand the minimum of x(r,q,w,0) and z if r is less than p and will demand x(p,q,w,0) units in total and be indifferent as to where he purchases them, if r equals p. Equation (II.9) therefore simply states that the amounts of food obtained by the needy and the unneedy from the agency must be consistent with their food aid demand functions.

The level of expected mortality in the region, $M(r,z)$, will be given by

$$M(r,z) = n\gamma(1 - \pi(\xi_1(r,z) + \zeta_1(r,z))) \tag{II.10}$$

To make the problem of selecting a distribution method interesting, it will be assumed that no matter how the agency decides to distribute its stock of food aid, expected mortality will be positive. To make this precise, we must introduce the notion of a 'feasible' price-ceiling pair. For any price-ceiling pair (r,z) in $\mathbb{R}^2_+$, let $A(r,z)$ denote the set of pairs $(\xi_i,\zeta_i)^2_{i=1}$ in $\mathbb{R}^2_+ \times \mathbb{R}^2_+$ which satisfy equations (II.6) through (II.9). There is no guarantee that, for an arbitrarily selected price-ceiling pair, $A(r,z)$ will be non-empty. Suppose, for example, that r is equal to zero and that z exceeds $\bar{x}/n$. It could well be that, in this situation, individuals' demand for food aid would exceed the available stock and hence (II.8) would not be satisfied. A price-ceiling pair will be said to be <u>feasible</u> if $A(r,z)$ is non-empty. Let F denote the set of feasible price-ceiling pairs. We now make the following assumption.

<u>Assumption 5</u> For all $(r,z) \in F$

$$\text{Max } \{\xi + \zeta : (\xi,\zeta) \in \mathbb{R}_+ \times [0,z], r\zeta + p(r,z)\xi \leq e^1_m + p(r,z)e^1_x\} < c$$

This assumption states that whatever price-ceiling pair the agency selects, needy individuals will be unable to afford the critical level of food consumption. Obviously it guarantees that expected mortality will always be positive.

This completes the description of the model and its assumptions. So that it may capture a wide variety of possible famine situations, the model has been formulated in rather an abstract manner. It may therefore aid the reader's intuition to consider some concrete examples.

Example 1

The region is a rural region populated by large farmers, small farmers and traders. All the farmers grow food. Traders purchase surplus food from the farmers and export it. In addition, they import the non-food good. The 'poor' in this region are the small farmers. The poor's endowments are the food they have grown in the previous period together with any savings they may have accumulated. The excess supply of the rest of the population consists of the large farmers' marketable surplus less the amount purchased by the traders for export. The region is in a state of famine because, as a result of a drought, some of the small farmers have been unable to produce sufficient food.[19] The 'needy' are those small farmers who have experienced a crop failure and the 'unneedy' are the remaining subsistence farmers.

Example 2

The region is a rural region populated by farmers, laborers and traders. Some of the laborers are landless and some own small amounts of land on which they grow food. Farmers also grow food and employ the laborers who are paid in cash. Traders purchase food from the farmers and export it. In addition, they import the non-food good. The 'poor' in this region are the laborers; the farmers having sufficient land to produce their subsistence needs even in a poor year. The landless laborers are endowed with their earnings from the previous period and the non-landless are also endowed with the food they have managed to grow. The excess supply of the rest of the population, consists of the farmers' marketable surplus less the amount purchased by the traders. The region is in a state of famine because, as a result of a poor harvest, demand for labor has been low and the laborers have been unable to earn sufficient money to purchase their subsistence needs.[20] Those laborers with land, however, have been able to grow sufficient food to make up this deficit. The 'needy' are therefore the landless laborers and the 'unneedy' the non-landless.

Example 3

The region is a rural region populated by small farmers and traders. Some of the farmers grow food and the remainder grow a cash crop.[21] Traders purchase the cash crop for export. In addition, they import the non-food good and additional food if necessary. The 'poor' in this region are the farmers. The food producers are 'endowed' with the food they have grown in the previous period whereas the cash crop producers are endowed with cash. The excess supply of the rest of the population consists of the traders imports. The region is in a state of famine because, as a result of a glut in world markets, the cash crop price is low and hence the cash crop producers have insufficient money to purchase their subsistence requirements. The 'needy' are those farmers producing the cash crop and the 'unneedy' are those producing food.

Finally, it should be pointed out that if the relief agency chooses to sell food aid it will obtain some revenue. It might be argued that the agency could use this revenue to import more food aid.[22] The model just outlined, however, implicitly assumes that the agency does not use the revenue from selling for this purpose. The reason for this assumption is that the argument under investigation is that selling a fixed stock of food aid will, in famine situations in which distinguishing needy and unneedy individuals is difficult, result in a lower level of mortality than giving it away. If it is indeed the case that revenue from selling can be used to import more food aid, this would constitute a seperate argument for selling which would apply irrespective of targeting difficulties.[23]

III Analysis

Our task is now to calculate and compare the distributions of food aid, the market purchases of the needy and the unneedy and the levels of expected famine mortality under give-away and selling policies. At the outset it will be helpful to note the following fact. For all feasible price-ceiling pairs

$$e_m^1 + p(r,z)e_x^1 < e_m^2 + p(r,z)e_x^2 \tag{III.1}$$

that is, no matter how the agency distributes the food aid, unneedy individuals will always have more wealth than needy individuals. To see this note that by Assumption 5, it must be the case that needy individuals cannot afford to purchase the critical level of food consumption in the market; that is,

$$e_m^1/p(r,z) + e_x^1 < c \tag{III.2}$$

but, by Assumption 4, unneedy individuals could afford the critical level in the absence of intervention; that is,

$$e_m^2/\bar{p} + e_x^2 \geq c \tag{III.3}$$

Since the relief agency's intervention cannot increase the total market demand of the poor, $p(r,z)$ must be less than $\bar{p}$ and hence the result.[24]

Suppose first that the relief agency gives away the food aid; that is, sets r equal to zero. Let z denote the ceiling it places on each individual's purchases. We assume, of course, that $(0,z)$ is feasible (i.e. $(0,z) \in F$). Let $p°$ denote the associated market price (i.e. $p° = p(0,z)$) and let $(\xi_i^o, \zeta_i^o)_{i=1}^2$ denote the amounts of food obtained in the market and from the agency by the needy and unneedy (i.e. $(\xi_i^o, \zeta_i^o) = (\xi_i(0,z), \zeta_i(0,z))$). Since $p°$ is greater than zero, (II.3), (II.6), (II.8) and (II.9) imply that

$$\zeta_i^o = \min\{x(0,\bar{q},e_m^i + p°e_x^i,0),z\} \quad i = 1,2 \tag{III.4}$$

$$n[\gamma\zeta_1^o + (1 - \gamma)\zeta_2^o] = \bar{x} \tag{III.5}$$

and

$$\xi_i^o = \begin{cases} 0 & \text{if } x(0,\bar{q},e_m^i + p°e_x^i,0) < z \\ x(p°,\bar{q},e_m^i + p°e_x^i,z) & \text{otherwise} \end{cases} \quad i = 1,2 \tag{III.6}$$

By Assumption 2(ii) each poor individual would demand at least c units of food at a price of zero and, by Assumption 5, c must exceed $\bar{x}/n$. Thus

$$x(0,\bar{q},e_m^i + p^\circ e_x^i,0) > \bar{x}/n \qquad i = 1,2 \tag{III.7}$$

It is immediate from this inequality, (III.4) and (III.5), that z must equal $\bar{x}/n$ and that

$$\zeta_i^\circ = \bar{x}/n \qquad i = 1,2 \tag{III.8}$$

Thus the food aid will be shared equally among the poor. What about individuals' market purchases? Since z equals $\bar{x}/n$ it follows from (III.6) and (III.7) that

$$\xi_i^\circ = x(p^\circ,\bar{q},e_m^i + p^\circ e_x^i,\bar{x}/n) \qquad i = 1,2 \tag{III.9}$$

By Assumptions 2(i) and 5 needy individuals will devote their entire wealth to food consumption and hence

$$\xi_1^\circ = e_m^1/p^\circ + e_x^1 \tag{III.10}$$

Now suppose that the relief agency decides to sell the food aid. Let r^* denote the price that it charges and let z^* denote the ceiling it places on each individual's purchases. Let p^* denote the associated market price and $(\xi_i^*,\zeta_i^*)_{i=1}^2$ denote the amounts of food obtained by the needy and the unneedy. We assume that (r^*,z^*) is feasible. Notice that this assumption rules out the possibility that the agency's price exceeds the market price; for if p(r,z) is less than r, A(r,z) must be empty. This is because, in this situation, no food would be demanded and hence (II.8) would be violated. The agency's price, however, could either be less than or equal to the market price. It will prove convenient to treat these cases seperately.

Suppose first that r^* is less than p^*. Then (II.3), (II.6), (II.8) and (II.9) imply that

$$\zeta_i^* = \min\{x(r^*,\bar{q},e_m^i + p^*e_x^i,0),z^*\} \quad i = 1,2 \tag{III.11}$$

$$n[\gamma\zeta_1^* + (1 - \gamma)\zeta_2^*] = \bar{x} \tag{III.12}$$

and

$$\xi_i^* = \begin{cases} 0 & \text{if } x(r^*,\bar{q},e_m^i + p^*e_x^i,0) < z^* \\ x(p^*,\bar{q},e_m^i + p^*e_x^i - r^*z^*,z^*) & \text{otherwise} \end{cases} \tag{III.13}$$

There are two possibilities to consider. The first is that $r^* \leq n(e_m^1 + p^*e_x^1)/\bar{x}$; that is, the price chosen is such that a needy individual could afford to purchase at least $\bar{x}/n$ units of food from the agency. By (III.1) we know that, in this situation, an unneedy individual must also be able to afford to purchase at least $\bar{x}/n$ units. It follows from Assumption 2(i) and 2(ii) that

$$x(r^*,\bar{q},e_m^i + p^*e_x^i,0) \geq \bar{x}/n \qquad i = 1,2 \tag{III.14}$$

This inequality, together with (III.11) and (III.12) implies that z^* must equal $\bar{x}/n$ and that

$$\zeta_i^* = \bar{x}/n \qquad i = 1,2 \tag{III.15}$$

Thus, again, the stock of food aid will be shared equally among the poor. A needy individual's market purchases in this situation will be given by

$$\xi_1^* = (e_m^1 - r^*\bar{x}/n)/p^* + e_x^1 \tag{III.16}$$

and an unneedy individual's will be given by

$$\xi_2^* = x(p^*, \bar{q}, e_m^2 + p^* e_x^2 - r^*\bar{x}/n, \bar{x}/n) \tag{III.17}$$

The second possibility is that the price chosen is such that a needy individual is unable to purchase $\bar{x}/n$ units of food aid from the agency; that is, $r^* > n(e_m^1 + p^* e_x^1)/\bar{x}$. In this case, it is clear that z^* must exceed $\bar{x}/n$ if the entire stock of food aid is to be distributed. Thus from (III.11) and Assumption 2(i)

$$\zeta_1^* = (e_m^1 + p^* e_x^1)/r^* \tag{III.18}$$

and

$$\zeta_2^* = \min\{x(r^*, \bar{q}, e_m^2 + p^* e_x^2, 0), z^*\} \tag{III.19}$$

The needy will therefore obtain a smaller fraction of the food aid than the unneedy. A needy individual's market purchases in this situation will be zero; that is

$$\xi_1^* = 0 \tag{III.20}$$

while an unneedy individual's market purchases will be given by

$$\xi_2^* = \begin{cases} 0 & \text{if } x(r^*,\bar{q},e_m^2 + p^*e_x^2,0) < z^* \\ x(p^*,\bar{q},e_m^2 + p^*e_x^2 - r^*z^*,z^*) & \text{otherwise} \end{cases} \tag{III.21}$$

If r^* is equal to p^* then (II.3), (II.6), (II.7), (II.8) and (II.9) imply that

$$\xi_i^* \in [\min\{0,x(r^*,\bar{q},e_m^i + r^*e_x^i,0) - z^*\},\ x(r^*,\bar{q},e_m^i + r^*e_x^i,0)] \quad i = 1,2 \tag{III.22}$$

$$n[\gamma(\xi_1^* - e_x^1) + (1 - \gamma)(\xi_2^* - e_x^2)] = V(r^*) \tag{III.23}$$

$$n[\gamma\zeta_1^* + (1 - \gamma)\zeta_2^*] = \bar{x} \tag{III.24}$$

and

$$\zeta_i^* = x(r^*,\bar{q},e_m^i + r^*e_x^i,0) - \xi_i^* \tag{III.25}$$

Assumptions 2(i) and 5, of course, imply that

$$x(r^*,\bar{q},e_m^1 + r^* e_x^1,0) = e_m^1/r^* + e_x^1 \tag{III.26}$$

Unfortunately, $(\xi_i^*,\zeta_i^*)_{i=1}^2$ is not uniquely defined by these equations. All that can be said about the amounts of food aid needy and unneedy individuals obtain is that

$$\zeta_1^* \in [0,\min\{\bar{x}/n\gamma, e_m^1/r^* + e_x^1\}] \tag{III.27}$$

and

$$\zeta_2^* \in [0,\min\{\bar{x}/n(1 - \gamma), x(r^*,\bar{q},e_m^2 + r^* e_x^2,0)\}] \tag{III.28}$$

Similarly, all that can be said about the market purchases of needy and unneedy individuals is that

$$\xi_1^* \in [0,e_m^1/r^* + e_x^1] \tag{III.29}$$

and

$$\xi_2^* \in [0,x(r^*,\bar{q},e_m^2 + r^* e_x^2,0)] \tag{III.30}$$

Having calculated the allocations achieved under each of the policies, we can now compare them. Let us begin by comparing giving away with selling at less than market price. Our first result follows immediately from (III.8), (III.15) and (III.18).

Proposition 1 Let $(r,z) \varepsilon F$ be such that $r \varepsilon (0,p(r,z))$

(i) If $r \leq n(e_m^1 + p(r,z)e_x^1)/\bar{x}$

$$\zeta_1(r,z) = \zeta_1(0,\bar{x}/n)$$

(ii) If $r > n(e_m^1 + p(r,z)e_x^1)/\bar{x}$

$$\zeta_1(r,z) < \zeta_1(0,\bar{x}/n)$$

Thus selling at a price less than market price will never improve the distribution of food aid and will, if the selling price is sufficiently high, worsen it.

At first glance, Proposition 1 may seem surprising. After all, the argument that individuals who already have sufficient food will be less likely to express a demand for food aid if they have to pay for it does not seem unreasonable. The problem with this argument, however, is that it implicitly assumes that there is no private market for food. If this assumption is not satisfied, individuals can sell their food holdings. Provided that the relief agency offers food aid at a price less than market price, it will always pay an individual with sufficient food to sell his food holdings in the market and purchase his food requirements from the agency. Thus selling at a price less than market price cannot improve the distribution of food aid. It may, however, worsen it if the selling price is so high that the needy can only afford to purchase an amount less than they would obtain if food aid were given away.

From (III.10) and (III.20) it is clear that selling food aid at a price in excess of $n(e_m^1 + p^* e_x^1)/\bar{x}$ will reduce the needy's market purchases. In addition, from (III.10) and (III.16), selling at a price between $ne_m^1/\bar{x}$ and $n(e_m^1 + p^* e_x^1)/\bar{x}$ will also reduce the needy's market purchases. We therefore have the following result

Proposition 2 Let $(r,z) \varepsilon F$ be such that $r \varepsilon (0,p(r,z))$. If $r \geq ne_m^1/\bar{x}$

$$\xi_1(r,z) < \xi_1(0,\bar{x}/n)$$

Thus selling food aid at a price which, while less than market price, is such that the value of $\bar{x}/n$ units of food aid exceeds the money holdings of a needy individual, will always reduce the needy's market purchases.

If the selling price is less than $ne_m^1/\bar{x}$, it is no longer so clear that selling at a price less than market price will reduce the needy's market purchases. From (III.10) and (III.16) we obtain

$$\xi_1^\circ - \xi_1^* = e_m^1/p^\circ - (e_m^1 - r^*\bar{x}/n)/p^* \qquad \text{(III.31)}$$

Since selling reduces the poor's market demand, p^* must be smaller than p°. Is it possible that the difference in prices could be sufficiently large to compensate for the reduction in the amount of money the needy have to spend on food and hence allow the needy to increase their market purchases? It is clear that selling cannot increase the total market purchases of the poor; for from (II.7)

$$n[\gamma\xi_1^\circ + (1 - \gamma)\xi_2^\circ] - n[\gamma\xi_1^* + (1 - \gamma)\xi_2^*] = V(p^\circ) - V(p^*) \qquad \text{(III.32)}$$

It is possible, however, that selling might change the allocation of the poor's total market purchases in favor of the needy. To make further progress some additional analysis is required.

Define the function ψ: $\{r \in \mathbb{R}_+ : (r,\bar{x}/n) \in F\} \rightarrow \mathbb{R}$ as follows:

$$\psi(r) = (e_m^1 - r\bar{x}/n)/p(r,\bar{x}/n) + e_x^1 \qquad \text{(III.33)}$$

From (III.10) and (III.16) we know that

$$\xi_1^o = \psi(o) \qquad \text{(III.34)}$$

and, since $r^* < ne_m^1/\bar{x}$,

$$\xi_1^* = \psi(r^*) \qquad \text{(III.35)}$$

Suppose that it were the case that $\psi'(r)$ was negative for all r in the interval $[0,r^*]$. Then (III.31) must be positive. Conversely, if $\psi'(r)$ was positive for all r in this interval, (III.31) must be negative.[25] In the Appendix it is established that

$$\psi'(r) = \bar{x}[n(1 - \gamma)(x_w(2)(e_m^1 - e_m^2) - x_q(2)\bar{q}) - V'p(.)]/n\sigma(r) \qquad \text{(III.36)}$$

where

$$\sigma(r) = V'p(.)^2 + n\gamma(e_m^1 - r\bar{x}/n) - n(1 - \gamma)p(.)^2(x_p(2) + x_w(2)e_x^2) \qquad \text{(III.37)}$$

and

$$x_j(2) = x_j(p(.),\bar{q},e_m^2 + p(.)e_x^2 - r\bar{x}/n,\bar{x}/n) \quad j = p,q,w \tag{III.38}$$

The first thing to notice is that, by Assumptions 2(iv) and 3(ii), if the needy possess less money than the unneedy (i.e. $e_m^1 \leq e_m^2$) the numerator of equation (III.36) is negative for all r. Since $\sigma(r)$ is positive by Assumptions 2(iv) and 3(ii), it follows that $\psi'(r)$ is negative for all r. We therefore have the following proposition.

Proposition 3 Let $(r,z) \varepsilon F$ be such that $r \varepsilon (0,p(r,z))$. If $r < ne_m^1/\bar{x}$ and $e_m^1 \leq e_m^2$

$$\xi_1(r,z) < \xi_1(0,\bar{x}/n)$$

Thus, if the needy have less money than the unneedy, selling food aid at a price less than market price will reduce the needy's market purchases even if the price is such that the value of $\bar{x}/n$ units of food aid is less than the money holdings of a needy individual.

To understand this result intuitively it is necessary to understand how selling changes the allocation of the poor's total market purchases between the needy and the unneedy. Selling at less than market price has two effects; it reduces the money holdings of each poor individual and it lowers the market price of food. If the unneedy's demand for food does not depend on the price of the non-food good, selling will shift the allocation of total market purchases in favor of that group with the largest money holdings. This is because a fall in the market price of food results in a larger increase, relative to that which would result from an increase in money holdings, in the food demand of an individual with a larger endowment of money. If the unneedy's demand for food does depend on the price of the non-food good, selling can still shift the allocation of total market purchases in favor of the unneedy even if they have smaller money holdings than the needy. This is because a lower market price of food increases the relative price of the non-food good and hence further increases the unneedy's demand for food. It follows from this discussion that, if the needy have less money than the unneedy, selling will always shift the allocation of total market purchases towards the unneedy. Consequently, since it cannot increase the total market purchases of the poor, selling must decrease the needy's market purchases.

In the majority of famine situations one would expect the needy to have less money than the unneedy. There may, however, be situations in which this is not true. In Example 3, for instance, the needy (the cash crop producers) may have more money than the unneedy (the food producers). In such a situation, selling may increase the needy's market purchases. Suppose, for example that e_m^1 is greater then e_m^2 and that x_q and V' are zero.[26] It is clear from (III.36) that $\psi'(r)$ is positive. To understand this intuitively, notice from (III.32) that if V' is equal to zero, selling food aid at a small price will not change the poor's total market purchases. Thus, if selling shifts the allocation of total market purchases in favor of the needy, it must surely increase their market purchases. But, as we have argued, if the needy have larger money holdings than the unneedy and the unneedy's demand for food is independent of the price of the non-food good, selling will have this effect.

If V' and x_q are positive, it is still possible that selling might increase the needy's market purchases but it is no longer sufficient that e_m^1 be greater than e_m^2. From (III.36) it can be verified that $\psi'(r)$ is positive if and only if

$$e_m^1 - e_m^2 > x_q(2)\bar{q}/x_w(2) + V'p(.)/n(1 - \gamma)x_w(2) \qquad \text{(III.39)}$$

This makes good intuitive sense; for if V' is positive then selling reduces the poor's total market purchases and hence the fact that selling shifts the allocation of total market purchases in favor of the needy is not sufficient to guarantee that it increases the needy's market purchases. Similarly, if x_q is positive, selling will no longer necessarily shift the allocation of total market purchases in favor of the needy.

Using the previous three propositions and (II.10) it is straight forward to compare the levels of expected mortality achieved under giving away and selling at less than market price. Combining Propositions 1 and 2 yields:

Proposition 4 Let $(r,z) \in F$ be such that $r \in (0,p(r,z))$. If $r \geq ne_m^1/\bar{x}$

$$M(r,z) > M(0,\bar{x}/n)$$

Thus selling food aid at a price which, while less than market price, is such that the value of $\bar{x}/n$ units of food aid exceeds the money holdings of each needy individual will always increase expected mortality. From Propositions 1,2 and 3 it follows that

Proposition 5 Let $(r,z) \in F$ be such that $r \in (0,p(r,z))$. If $e_m^1 \leq e_m^2$

$$M(r,z) > M(0,\bar{x}/n)$$

Selling food aid at less than market price will always increase expected mortality, therefore, if the needy have less money than the unneedy. If the needy do have more money than the unneedy, of course, than it is possible that selling at less than market price might decrease expected mortality.

Let us now compare giving away with selling at market price. From (III.8) and (III.27) we obtain the following result.

<u>Proposition 6</u> Let $(r,z) \in F$ be such that $r = p(r,z)$

(i) If $r \leq n(e_m^1 + p(r,z)e_x^1)/\bar{x}$

$$\zeta_1(r,z) \gtreqless \zeta_1(0,\bar{x}/n)$$

(ii) If $r > n(e_m^1 + p(r,z)e_x^1)/\bar{x}$

$$\zeta_1(r,z) < \zeta_1(0,\bar{x}/n)$$

Thus selling food aid at market price may either improve or worsen the distribution of food aid if the price is such that a needy individual could afford $\bar{x}/n$ units of food. If this condition is not satisfied, it will definitely worsen the distribution.

Since r^* must be less than $p°$, it follows from (III.10) and (III.29) that selling at market price may either increase or decrease the needy's market purchases. Thus we have the following proposition.

<u>Proposition 7</u> Let $(r,z) \in F$ be such that $r = p(r,z)$. Then

$$\xi_1(r,z) \gtreqless \xi_1 \ (0,\bar{x}/n)$$

The question which remains to be answered, is will selling at market price result in a lower or higher level of expected mortality than giving away? A needy individual's total food consumption under giving away will be

$$\xi_1^{\circ} + \zeta_1^{\circ} = e_m^1/p^{\circ} + e_x^1 + \bar{x}/n \qquad \text{(III.40)}$$

and under selling will be

$$\xi_1^* + \zeta_1^* = e_m^1/r^* + e_x^1 \tag{III.41}$$

This follows from (III.8), (III.10), (III.25) and (III.26). It is clear from (III.40) and (III.41) that if r^* exceeds $ne_m^1/\bar{x}$, a needy individual's total food consumption will be larger under giving away than selling. We therefore have the following proposition.

<u>Proposition 8</u> Let $(r,z) \varepsilon F$ be such that $r = p(r,z)$. If $r \geq ne_m^1/\bar{x}$

$$M(r,z) > M(0,\bar{x}/n)$$

When combined with Proposition 4, this result tells us that selling at any price such that the value of $\bar{x}/n$ units of food exceeds the money holdings of each needy individual will always increase expected mortality.

As in the case of selling at less than market price, when r^* is less than $ne_m^1/\bar{x}$ it is no longer so clear that selling will reduce the needy's total food consumption. Fortunately, however, the same analysis can be applied. Substituting (III.34) into (III.40) yields

$$\xi_1^o + \zeta_1^o = \psi(0) + \bar{x}/n \tag{III.42}$$

Adding and subtracting $\bar{x}/n$ from the right hand side of (III.41) we may write

$$\xi_1^* + \zeta_1^* = (e_m^1 - r^*\bar{x}/n)/r^* + e_x^1 + \bar{x}/n \tag{III.43}$$

We know from (III.24) that when the agency sells food aid at market price, the poor must purchase, in total, $\bar{x}$ units of food aid but we do not know exactly how these $\bar{x}$ units will be distributed between the needy and the unneedy. Notice, however, that the equilibrium market price of food does not depend on the distribution of food aid; for, from (III.23), (III.24) and (III.25) we obtain

$$n[\gamma(x(r^*,\bar{q},e_m^1 + r^*e_x^1,0) - e_x^1) + (1 - \gamma)(x(r^*,\bar{q},e_m^2 + r^*e_x^2,0) - e_x^2)] = V(r^*) + \bar{x} \qquad \text{(III.44)}$$

An equation which uniquely defines r^* but which is independent of the distribution of food aid. Since the needy can afford $\bar{x}/n$ units at the price r^*, it follows that r^* must equal $p(r^*,\bar{x}/n)$ and that $(r^*,\bar{x}/n)$ is a feasible price-ceiling pair. Recalling (III.33) we may therefore write

$$\xi_1^* + \zeta_1^* = \psi(r^*) + \bar{x}/n \qquad \text{(III.45)}$$

It follows from (III.42) and (III.45) that $\xi_1^\circ + \zeta_1^\circ$ will be greater (less) than $\xi_1^* + \zeta_1^*$ if $\psi'(r)$ is negative (positive) for all r in the interval $[o,r^*]$. We may therefore conclude from (III.36) that, if the needy have less money than the unneedy, selling at market price will always reduce the needy's total food consumption.

<u>Proposition 9</u> Let $(r,z) \in F$ be such that $r = p(r,z)$. If $e_m^1 \leq e_m^2$

$$M(r,z) > M(0,\bar{x}/n)$$

This result together with Proposition 5 implies that if the needy have less money than the unneedy, selling food aid at any price will always increase expected mortality. We may also conclude from (III.36) that selling at market price could increase the needy's total food consumption and hence decrease expected mortality, if they possess more money than the unneedy.

IV Conclusion

The results of this paper provide little support for the argument that selling food aid is an appropriate policy to employ in famine situations in which distinguishing needy and unneedy individuals is difficult.[27] Selling at less than market price will not deter unneedy individuals from expressing a demand for food aid. All that it will achieve is to take money away from both the needy and the unneedy. If the needy have less money than the unneedy, as one would expect, the effect of this will be to reduce the needy's market purchases and hence increase expected mortality. Selling at market price may improve the distribution of food aid but, again, if the needy have less money than the unneedy, it will reduce the needy's total food consumption and hence increase expected mortality.

The question which remains to be answered is what is the correct policy response to targeting difficulties? One further distribution method which deserves consideration in this context is 'food-for-work'. As its name suggests, this method requires individuals to work on relief agency sponsored projects in order to obtain food aid. As a method for achieving the lowest possible level of mortality, food-for-work is not without its drawbacks. First, because physical labor burns up calories, making individuals work is likely to increase their food requirements and hence intensify the existing shortage. Second, as an individual becomes more malnourished the amount of physical labor he can do declines and hence seriously malnourished individuals may be unable to obtain aid under a food-for-work policy. Nonetheless, it does seem reasonable to suppose that unneedy individuals will be considerably less likely to express a demand for food aid if they have to work to get it. Indeed, this was a commonly used argument supporting the use of this method in nineteenth century India.[28] Further research analysing how food-for-work can help in situations where targeting is difficult, may prove useful.

Appendix

Derivation of equation (III.36): Differentiating (III.33) we obtain

$$\psi'(r) = -(p(.)\bar{x}/n + p_r(.)(e_m^1 - r\bar{x}/n))/p(.)^2 \qquad (A.1)$$

To evaluate this derivative we need to obtain an expression for $p_r(r,\bar{x}/n)$. We first establish the following claim:

Claim: For all $(r,\bar{x}/n) \in F$, $p(r,\bar{x}/n)$ solves the equation

$$n[\gamma(e_m^1 - r\bar{x}/n)/p + (1-\gamma)(x(p,\bar{q},e_m^2 + pe_x^2 - r\bar{x}/n,\ \bar{x}/n) - e_x^2)] = V(p) \qquad (A.2)$$

Proof: Since $(r,\bar{x}/n) \in F$ we know by (II.8) and (II.9) that

$$x(r,\bar{q},e_m^i + p(.)e_x^i,0) \geq \bar{x}/n \qquad i = 1,2 \qquad (A.3)$$

If r is less than $p(r,\bar{x}/n)$ it follows immediately from (A.3), (II.3), (II.6) and (II.7) that

$$n[\gamma(x(p(.),\bar{q},e_m^1 + p(.)e_x^1 - r\bar{x}/n,\bar{x}/n) - e_x^1) + (1-\gamma)(x(p(.),\bar{q},e_m^2 + p(.)e_x^2 - r\bar{x}/n,\ \bar{x}/n) - e_x^2)] = V(p(.)) \qquad (A.4)$$

By Assumption 2(i) and 5

$$x(p(.),\bar{q},e_m^1 + p(.)e_x^1 - r\bar{x}/n,\bar{x}/n) = (e_m^1 - r\bar{x}/n)/p(.) + e_x^1 \qquad (A.5)$$

Substituting (A.5) into (A.4) yields the result. Now suppose that r is equal to $p(r,\bar{x}/n)$. Combining (II.7), (II.8) and (II.9) we obtain

$$n[\gamma(x(p(.),\bar{q},e_m^1 + p(.)e_x^1,0) - e_x^1) + (1 - \gamma)(x(p(.),\bar{q},e_m^2 + p(.)e_x^2,0) - e_x^2)] = V(p(.)) + \bar{x} \tag{A.6}$$

or, equivalently,

$$n[\gamma(x(p(.),\bar{q},e_m^1 + p(.)e_x^1,0) - \bar{x}/n - e_x^1) + (1 - \gamma)(x(p(.),\bar{q},e_m^2 + p(.)e_x^2,0) - \bar{x}/n - e_x^2)] = V(p(.)) \tag{A.7}$$

It follows from utility maximization that

$$x(p,q,w,0) \geq z \text{ implies } x(p,q,w,0) = x(p,q,w-pz,z) + z \tag{A.8}$$

Using (A.3), (A.8) and the fact that $r = p(.)$ we may rewrite (A.7) as

$$n(\gamma(x(p(.),\bar{q},e_m^1 + p(.)e_x^1 - r\bar{x}/n,\bar{x}/n) - e_x^1) + (1 - \gamma)(x(p(.),\bar{q},e_m^2 + p(.)e_x^2 - r\bar{x}/n,\bar{x}/n) - e_x^2)] = V(p(.)) \tag{A.9}$$

By Assumptions 2(i) and 5 we know that

$$x(p(.),\bar{q},e_m^1 + p(.)e_x^1 - r\bar{x}/n,\bar{x}/n) = (e_m^1 - r\bar{x}/n)/p(.) + e_x^1 \tag{A.10}$$

Substituting (A.10) into (A.9) yields the result□

It follows from the Claim and the Implicit Function Theorem, that

$$p_r(.) = -(\gamma + (1-\gamma)p(.)x_w(2))\bar{x}p(.)/\sigma(r) \tag{A.11}$$

where $\sigma(r)$ and $x_w(2)$ are as defined in (III.37) and (III.38). Substituting (A.11) into (A.1) we obtain, after some manipulation,

$$\psi'(r) = \bar{x}[n(1-\gamma)(x_p(2)p(.) + x_w(2)(e_m^1 + e_x^2 p(.) - r\bar{x}/n)) - V'p(.)]/n\sigma(r) \tag{A.12}$$

It follows from utility maximisation that x(.) is homogeneous of degree zero in (p,q,w). Thus by Euler's Theorem

$$x_p(2)p(.) + x_q(2)q + x_w(2)(e_m^2 + p(.)e_x^2 - r\bar{x}/n) = 0 \tag{A.13}$$

Using (A.13) we may rewrite (A.12) as follows

$$\psi'(r) = \bar{x}[n(1-\gamma)(x_w(2)(e_m^1 - e_m^2) - x_q(2)\bar{q}) - V'p(.)]/n\sigma(r)$$

which is (III.36).

Footnotes

1 See, for example, Seaman and Holt [12] p. 296 and Sen [14] p. 454.

2 See Keys et al [6] p. 14, for a brief discussion of the difficulties involved in estimating the extent of an individual's malnourishment.

3 For further discussion see Indian Famine Commission [5] and Masefield [7].

4 The policy of selling emergency food aid is used in practice. The United States, for example, permits 'cooperating sponsors' to sell U.S. donated emergency food aid if "(1) no other source of funds exists for transporting or storing the commodities or (2) a sale is the only effective mechanism for reaching the needy." U.S.G.A.O. [17] p.11 (emphasis added). In fact, in fiscal year 1984, a remarkable 43% of the total U.S. emergency food aid provided to Africa was sold; see U.S.G.A.O. [17] p.11.

5 Weitzman's paper generated a number of extensions and comments; see Rivera - Batiz [10] and Spence [15]. An interesting related paper is by Sah [11].

6 See, for example, the case studies in Sen [13]. For those readers unfamiliar with the economics of famine, this book is the seminal work on the topic. A useful recent paper is by Desai [3]. Valuable surveys of the recent literature are provided by Devereux and Hay [4] and Ravallion [9].

7 Two other papers which address famine relief issues using formal models are Coate [2] and Ravallion [8].

8 If $u(f,y)$ denotes a poor individual's utility function defined over food f and the non-food good y

$x(p,q,w,\alpha) = \arg\max \{u(\alpha + x,(w - px)/q): x \in [o,w/p]\}$.

9 Ours is a partial equilibrium analysis of the food market.

10 We are abstracting here from other possible causes of death.

11 The utility function

$$u(f,y) = \begin{cases} f & \text{if } f \leq c \\ c + (f - c)^{\theta} y^{(1-\theta)} & \text{otherwise} \end{cases}$$

generates a demand function which satisfies Assumption 2.

12 It is straightforward to verify that under our assumptions $\bar{p}$ exists and is unique.

13 By a region in a 'state of famine' is meant a region in which, in the absence of outside aid, a significant number of individuals are likely to die as a result of insufficient food.

[14] Imagine that this food aid has been donated by the government of another country.

[15] It is assumed that either the agency can distinguish poor individuals from the rest of the population or that the 'rich' do not attempt to obtain food aid.

[16] This assumption is made because it would seem to be the most favorable to the policy of selling. If individuals could resell food then arbitrage would be possible. In practice, the reselling of food aid can be deterred by distributing it pre-cooked. See Masefield [7] for a discussion of this issue. The reader should note, however, that the analysis can easily be adapted to the case where resale is possible and that none of the results of the paper are substantially altered.

[17] If resale were possible and r were less than p, an individual would demand z units from the agency and $x(r,q,w + (p-r)z,p) - z$ units in the market.

[18] Using the following fact (which is implied by utility maximization) $x(p,q,w,0) \geq z$ implies $x(p,q,w,0) = x(p,q,w - pz,z) + z$ it is straightforward to verify that $\bar{p}(r,z)$ exists and is unique.

[19] The reason that only some of the small farmers have been unable to produce sufficient food may be because some areas of the region were not as badly affected or because the size of land holdings vary.

[20] It is often argued that the famines which occured in nineteenth century India were 'famines of work rather than of food'; see Masefield [7] p.77. For further details on Indian famines in this period see Bhatia [1].

[21] Cash crops are grown in many famine prone countries. For example, according to Tolley, Thomas and Wong [16], in Bangladesh jute covers "nearly 20 percent of the total cropped area during the aus and just growing season." p.59.

[22] A further option might be to redistribute the revenue among the poor. As will become clear, however, the policy of selling food aid (at a small price) and redistributing the proceeds is equivalent to simply giving it away.

[23] When emergency food aid is sold in practice, the revenues do not appear to be used to import more food. Rather they are used, at least in theory, to meet distribution expenses and to support development and rehabilitation projects in the famine region. See U.S.G.A.O. [17]. It is not clear why this is so; possible reasons are (i) that there are substantial time lags involved in importing more food and (ii) that revenues are in inconvertible currencies.

[24] Notice that this argument also implies that the relief agency's intervention cannot jeopardise the survival of unneedy individuals.

[25] It is straightforward to verify that $r < r'$ and $(r',\bar{x}/n) \in F$ implies $(r,\bar{x}/n) \in F$ and thus ψ is defined on $[o,r^*]$.

[26] In Assumption 3, we assumed that V' was positive so what we really mean here is that V' is extremely small.

27 The reader should be reminded that this does not imply that food aid should never be sold. As was mentioned earlier, if the revenue can be used to import more food aid there may be a case for selling food aid irrespective of targeting difficulties.

28 Food-for-work was a key part of British famine relief policy in nineteenth century India. For further details see Indian Famine Commission [5].

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