Discussion Paper No. 724R

CASH VERSUS DIRECT FOOD RELIEF*

by

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Abstract

The usual method of providing relief to a famine region is to import food and distribute it to the needy (direct food relief). If there are markets for food in the region, however, a relief agency could just as easily distribute money to the needy and let them purchase food in the market (cash relief). This alternative has been much discussed in the famine literature recently. The purpose of this paper is to clarify the conditions under which cash relief will be more or less effective than direct food relief by analyzing the relative effectiveness of the two policies in a formal model.

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1. Introduction

The usual method of providing relief to a region in a state of famine is to import food and distribute it, free of charge, to the needy. This method, which is called 'direct food relief', has undoubtedly saved numerous lives in various famines around the world. It is not, however, the only way relief might be provided. If there are markets for food in the famine region, a relief agency could just as easily distribute money to the needy and let them purchase food in these markets. This alternative, which is termed 'cash relief', has been the subject of considerable discussion in the famine literature in the last few years.[1]

In many famines, such as the Irish famine of the 1840's, the Orissa famine of 1865/6 and the Madras famine of 1896/7, traders actually export food from the famine region.[2] Some authors have argued that, in such a famine, cash relief may be more effective than direct food relief.[3] If a relief agency employed the latter method it would be transporting food into the region while traders were transporting it out. If cash relief is used then, so the argument goes, food will simply be diverted from exports to local markets and the expense of transporting in food will be avoided. It has even been argued that cash relief may be more effective in famines in which food is not being exported.[4] If employed in such a famine cash relief will, it is argued, induce traders to import food. If traders are more efficient transporters of food, as is likely, this may be preferable to direct food relief where the relief agency does the importing.

In contrast to direct food relief, however, cash relief relies on self interested traders to provide food to the needy. Some authors have expressed doubts that traders will respond in the desired manner. How can we be sure, for example, that in a famine in which food is not being exported cash relief will induce traders to import food? Is it not possible that prices will simply rise? What will happen if traders 'manipulate' markets; that is, behave non-competitively?[5]

The purpose of this paper is to clarify the conditions under which cash relief is likely to be more or less effective than direct food relief by analyzing the relative effectiveness of the two policies in a formal model.[6] The model is of a region in which a subset of the population are very poor and hence vulnerable to starvation. In the region, there is a market for food and traders who can export to and import from a world market. Depending on the excess demand of the region's population, food can either be exported, imported or neither exported nor imported. To analyze the relative effectiveness of the two policies, it is supposed that conditions are such that the region is in a state of famine. A relief agency is assumed to enter the region with a fixed amount of money to spend on relief operations. Its objective is to minimize expected mortality and it can either employ cash or direct food relief. The relief agency's optimal policy is then analyzed and the conditions under which it will and will not involve cash relief are established. This is done first under the assumption that the traders behave competitively and then, to obtain some insight into how the relative effectiveness of the two policies changes when traders behave non-competitively, under the assumption that they collude and behave as a monopoly.

The question 'under what conditions will cash relief be more or less effective than direct food relief' has also been analyzed by Bigman (1985).[7] Bigman, however, simply postulates the existence of aggregate food demand and supply functions and does not explicitly model the underlying economy. As a consequence, such questions as 'will cash relief be more effective than direct food relief if food is being exported and traders behave competitively' or 'how does the relative effectiveness of the policies change when traders manipulate markets' cannot be addressed in his model. In addition, while Bigman does present a condition on food prices and demand and supply elasticities which tells us whether cash relief will be more or less effective than direct food relief, this condition is not only complex and hard to interpret but is also only valid locally.[8]

The organization of the remainder of the paper is as follows: the model and its assumptions are outlined in Section 2. An important preliminary result is established in Section 3. In the next two sections the optimal policy is analyzed under the assumptions that the traders behave competitively and as a monopoly. Finally, in Section 6, the results of the paper are summarized. An Appendix contains the proofs of a number of the results stated in the text.

2. The Model

Consider a region at the beginning of some time period t. Imagine that some of the population of this region are 'vulnerable' in the sense that they may be unable to obtain sufficient food to ensure their survival in period t. Let n denote the number of vulnerable individuals in the population. Suppose that these individuals possess some money and food at the beginning of period t. Specifically, assume that each vulnerable individual has e_m units of money and e_f units of food.

Suppose that during period t a market will open for food. Vulnerable and non-vulnerable individuals will go to this market and trade food. Let p denote the price of food in this market. Let x(p,w) denote a vulnerable individual's demand for food at the price p when he has wealth w and let V(p) denote the excess demand for food at the price p of the rest of the population. Further suppose that there are traders in the region who export and import food from the local to a world market. Let q denote the world price of food and assume that it costs each trader $\tau \in (0,q)$ units of money to transport one unit of food between the two markets.

After trade has taken place, vulnerable individuals will consume the quantities of food they have purchased. Their food consumption will determine their chances of survival. Let $\rho(x)$ denote the probability that a vulnerable individual who consumes x units of food will survive in period t.

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

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

(i) ρ is twice continuously differentiable

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

If a vulnerable individual's food consumption exceeds the level s, therefore, he will survive with probability one.[9] If it is less than s he will face a positive probability of non-survival. This probability will be higher the lower is his food consumption. We shall refer to s as the <u>critical level</u> of food consumption.

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

(i) $w/p \leq s$ implies $x(p,w) = w/p$

(ii) $w/p > s$ implies $x(p,w) \geq s$

(iii) x is continuously differentiable

(iv) $\partial x/\partial p < 0$, $\partial x/\partial w > 0$

(v) $(\partial x/\partial p)p + (\partial x/\partial w)w \leq 0$

Assumptions 2(i) and 2(ii) state that if a vulnerable individual has sufficient wealth to obtain 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 first, that if the price of food rises then a vulnerable individual's demand for food decreases and second, that if a vulnerable individual's wealth increases so does his demand for food. Assumption 2(v) is a technical condition which guarantees that a vulnerable individual's demand for good will never increase if the price of food increases.[10] A sufficient condition for Assumption 2(v) to hold is that if the price of any other good in the region increases, a vulnerable individual's demand for food does not decrease.[11]

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

(i) V is twice continuously differentiable

(ii) $V' \leq 0$

Assumption 3(ii) states that the excess demand for food of the rest of the population does not increase when the price of food rises. Notice that it is not required that V(p) be of any particular sign. Thus, the rest of the population could either be net suppliers ($V(p) < 0$) or net demanders ($V(p) > 0$) of food.

When analyzing the optimal policy it will occasionally be useful to have a parameterised excess demand function. In such situations, Assumption 3 will be replaced by the following assumption.

Assumption 3' The function V: $\mathbb{R}_{++} \rightarrow \mathbb{R}$ is of the following form:

$$V(p) = \alpha - \beta p$$

where $\alpha \in \mathbb{R}$ and $\beta \in \mathbb{R}_{+}$

While, in general, it is not necessary to assume that the excess demand function of the rest of the population is decreasing in price (that is; $V' < 0$) there is one circumstance in which technical difficulties will result if this condition is not satisfied. This is when vulnerable individuals have no money; that is, $e_m = 0$. To avoid these difficulties the following assumption is made.[12]

Assumption 4 Either $e_m > 0$ or $V' < 0$.

In the absence of intervention in this region, the food market would open and an equilibrium price would be established. Let $\hat{p}$ denote this equilibrium price.

Assumption 5 $e_m/\hat{p} + e_f < s$

This assumption states that, at the price $\hat{p}$, vulnerable individuals would be unable to afford the critical level of food consumption. It follows from this assumption that, in the absence of intervention, vulnerable individuals would face a positive probability of non-survival in period t. At the beginning of period t, therefore, the region is in a state of famine.

Now suppose that a relief agency, realizing that the region is in a state of famine, arrives at the outset of period t with a given amount of money y to spend on relief operations. It can either distribute money to the needy and let them purchase food in the local market (cash relief) or import food from the world market and distribute it (direct food relief).[13] It costs the relief agency $\theta\tau$ units of money to transport one unit of food from the world market to the famine region. It is assumed that θ is greater than or equal to one; that is, traders are at least as efficient at transporting food as the agency.

For analytical convenience, it will be assumed that the relief agency can employ a mix of the two policies rather than just pure cash relief or pure direct food relief. Let m denote the amount of money the agency gives to each needy individual. It will be assumed that the agency uses all of its available resources and hence

$$f(m) = (y - nm)/n(q + \theta\tau) \tag{1}$$

will denote the corresponding amount of food given to each needy individual. Let $p^*(m)$ denote the equilibrium price of food in the region when the agency gives each needy individual m units of money (and hence $f(m)$ units of food). The determination of the equilibrium price $p^*(m)$ will, of course, depend on the traders' behavior and will be described later in the paper.[14] Let $x^*(m)$ denote the food consumption of each needy individual when the agency gives away m units of money; that is,

$$x^*(m) = x(p^*(m), e_m + m + p^*(m)(e_f + f(m))) \tag{2}$$

and let $M(m)$ denote expected mortality; that is[15]

$$M(m) = n(1 - \rho(x^*(m))) \tag{3}$$

The relief agency's problem is to choose a policy mix to minimize expected mortality. Formally, its problem can be stated as

$$\begin{array}{ll} \text{Min} & M(m) \\ \text{s.t.} & m \in [0, y/n] \end{array}$$

Let m* denote the solution to this problem. If m* equals zero, the optimal policy will be pure direct food relief; if m* equals y/n it will be pure cash relief and if m* is between zero and y/n then a mix of cash and direct food relief will be optimal.

It will be assumed that no matter what policy mix the relief agency chooses, vulnerable individuals will not be able to afford the critical level of food consumption.

<u>Assumption 6</u> For all $m \in [0,y/n]$

$$(e_m + m)/p^*(m) + e_f + f(m) < s$$

This assumption is imposed to make the agency's problem non-trivial. Notice that, together with Assumption 2, it implies that

$$x^*(m) = (e_m + m)/p^*(m) + e_f + f(m) \qquad \text{for all } m \in [0,y/n] \tag{4}$$

This completes the description of the model and its assumptions. So that it may capture a wide variety of famine situations, the model has been formulated in rather an abstract manner. Before moving on to analyze the optimal policy, therefore, it may be helpful to consider some concrete examples.

Example 1

The region is a rural region populated by large and small scale subsistence farmers. The vulnerable are the subsistence farmers and they are endowed with food - the fruits of the previous period's harvest - but no money. In a normal year the subsistence farmers will produce sufficient food to ensure their survival and the large farmers will enjoy substantial surpluses. These surpluses will be purchased by the traders and exported to the world market. The region is in a state of famine because, as a result of a crop failure, the subsistence farmers have produced insufficient food to ensure their survival.

Example 2

The region is an urban region populated by low and high wage earners. The vulnerable are the low wage earners and they are endowed with money - earnings from the previous period - but no food. Food is supplied to the region by traders who import it from the world market. The region is in a state of famine because, as a result of an increase in the world price, the market price of food would be too high to allow the low wage earners to purchase the critical level in the absence of intervention.

Example 3

The region is a rural region populated by farmers and landless laborers. The vulnerable are the laborers and they are endowed with money - earnings from the previous period - but no food. In a normal year, the farmers will have surpluses of food. These surpluses are purchased by the laborers and, in a good year, by the traders for export. The region is in a state of famine because, as a result of a bad harvest, laborers would be unable to afford the critical level in the absence of intervention.[16]

3. A Preliminary Result

Suppose that the relief agency is currently giving m units of money to each needy individual and consider the option of marginally increasing the amount of money given away. The resulting change in expected mortality will be $M'(m)$. From (3) we see that

$$M'(m) = - n\rho'(x^*(m))x^{*\prime}(m) \tag{5}$$

By Assumptions 1 and 6, $\rho'(x^*(m))$ is positive and thus expected mortality will decrease (increase) if the food consumption of a needy individual increases (decreases). It can be verified from (1) and (4) that

$$x^{*\prime}(m) = \lambda(m) - 1/(q + \theta\tau) \tag{6}$$

where

$$\lambda(m) = [p^*(m) - (e_m + m)p^{*\prime}(m)]/p^*(m)^2 \tag{7}$$

Thus the food consumption of a needy individual will increase (decrease) if $\lambda(m)$ is greater than (less than) $1/(q + \theta\tau)$.

The two terms on the right hand side of (6) have a natural interpretation. When the amount of money given away is marginally increased there are two effects. First, each needy individual's food purchases change. By (4) this change will be given by $d[(e_m + m)/p^*(m)]/dm$. As can easily be verified, this derivative equals $\lambda(m)$. Thus $\lambda(m)$ is the change in the amount of food purchased by each needy individual following a marginal increase in the amount of money given away at m. It can be thought of as the <u>marginal benefit</u> (in terms of units of food consumption) of giving away money at m. Second, the amount of food received by each needy individual changes. This change is given by $f'(m)$. From (1) we see that $f'(m)$ equals $- 1/(q + \theta\tau)$. Thus $1/(q + \theta\tau)$ is the reduction in the amount of food received by each needy individual following a marginal increase in the amount of money given away. It can be thought of as the <u>marginal cost</u> of giving away money.

If $\lambda(m)$ exceeds $1/(q + \theta\tau)$ for all m, marginally increasing the amount of money given away will always increase the needy's food consumption and hence decrease expected mortality. In this situation, therefore, pure cash relief will be optimal; that is, $m^* = y/n$. Similarly, if $\lambda(m)$ is less than $1/(q + \theta\tau)$ for all m, pure direct food relief will be optimal. If neither of these conditions is satisfied then the optimal policy could either be pure cash relief, pure direct food relief or a mix of cash and direct food relief. By the usual argument, however, if a mix of the two is optimal, the marginal benefit must equal the marginal cost at the optimum; that is, $\lambda(m^*) = 1/(q + \theta\tau)$. These facts are summarized in Lemma 1.

<u>Lemma 1</u> (i) If $\min \lambda(m) > 1/(q + \theta\tau)$

$$m^* = y/n$$

(ii) If $\max \lambda(m) < 1/(q + \theta\tau)$

$$m^* = 0$$

(iii) If $m^* \in (0,y/n)$

$$\lambda(m^*) = 1/(q + \theta\tau)$$

Lemma 1 provides the basic starting point for analyzing the optimal policy. Our task is now to obtain an explicit expression for $\lambda(m)$ and to compare it with $1/(q + \theta\tau)$. From (7) we see that $\lambda(m)$ depends on the value and derivative of the equilibrium price function. In order to complete this task, therefore, we must first characterize the equilibrium price function. This requires us to be more explicit about the determination of equilibrium and hence traders' behavior.

4. Competitive Traders

Suppose first that the traders behave competitively; that is, each trader chooses an amount of food to import (export) to maximize his profits taking the price of food in the region as given. If trader j imports I_j units of food (if $I_j < 0$ he will be exporting $- I_j$ units) and the price of food is p, his profits will be

$$\pi^j(I_j;p) = \begin{cases} [p - (q - \tau)]\, I_j & \text{if } I_j \leq 0 \\ [p - (q + \tau)]\, I_j & \text{if } I_j > 0 \end{cases} \tag{8}$$

It is clear from (8) that if the price of food is $q - \tau$, trader j will be willing to import any negative amount of food (or, equivalently, export any positive amount of food). If the price of food is $q + \tau$, trader j will be willing to import any positive amount of food and if the price is between $q - \tau$ and $q + \tau$ he will be unwilling to import any amount of food either negative or positive. Thus if $I(p)$ denotes the traders' import supply correspondence, it will be as illustrated in Figure 1.

Let $Z(p,m)$ denote the excess demand of the region's population when the price of food is p and the relief agency gives away m units of money to each vulnerable individual; that is,

$$Z(p,m) = V(p) + n\,[x(p,e_m + m + p(e_f + f(m))) - (e_f + f(m))] \tag{9}$$

The equilibrium price must be such that traders are willing to import an amount equal to the population's excess demand. To be more precise, $p^*(m)$ must satisfy

$$Z(p^*(m),m) \in I(p^*(m)) \tag{10}$$

The following lemma, which is illustrated in Figure 1, characterizes the equilibrium price.

Lemma 2 Let $m \in [0,y/n]$ and suppose that the traders behave competitively.

(i) If $Z(q - \tau,m) < 0$

$$p^*(m) = q - \tau \tag{11}$$

(ii) If $Z(q + \tau,m) > 0$

$$p^*(m) = q + \tau \tag{12}$$

(iii) If $Z(q - \tau,m) \geq 0$ and $Z(q + \tau,m) \leq 0$

$$Z(p^*(m),m) = 0 \tag{13}$$

Proof: See Appendix []

Lemma 2 tells us that given any amount of money m there are three possibilities. First, the region's population could be net suppliers of food at the price $q - \tau$ (i.e. $Z(q - \tau,m) < 0$). This would be the case, for example, if

$Z(p,m)$ were equal to $Z_1(p,m)$ in Figure 1. In this case the equilibrium price would be $q - \tau$ and the traders would export $- Z(q - \tau,m)$ units of food. Second, the region's population could be net demanders of food at the price $q + \tau$ (i.e. $Z(q + \tau,m) > 0$). This would be the case if $Z(p,m)$ were equal to $Z_2(p,m)$ in Figure 1. In this case the equilibrium price would be $q + \tau$ and the traders would import $Z(q + \tau,m)$ units of food. Finally, the region's population could be net demanders of food at the price $q - \tau$ but net suppliers at the price $q + \tau$ (i.e. $Z(q - \tau,m) \geq 0$ and $Z(q + \tau,m) \leq 0$). This would be the case if $Z(p,m)$ were equal to $Z_3(p,m)$ in Figure 1. In this case, the price of food in the region would be implicitly defined by (13) and the traders would neither export nor import.

Lemma 2 can now be used to calculate $\lambda(m)$. Suppose first that the population will be net suppliers of food at the price $q - \tau$ whatever the level of m (i.e. $Z(q - \tau,y/n) < 0$). Provided that the large farmers have been able to produce at least some surplus food, this would be the case in Example 1. By Lemma 2, $p^*(m)$ equals $q - \tau$ and $p^{*\prime}(m)$ equals zero. In this situation, therefore, marginally increasing the amount of money given away will not change the equilibrium price of food. It will, of course, increase the needy's demand for food; by Assumptions 2 and 6 if a needy individual is given more money he will spend it all on food. This increase, however, will be met by an equal reduction in the traders' exports. The situation is depicted graphically in Figure 2. As a result of an increase of Δm in the amount of money given away, the excess demand curve shifts to the right. Price remains at $q - \tau$ but the traders' exports fall from $- Z(q - \tau,m)$ to $- Z(q - \tau,m + \Delta m)$.

Using the facts that $p^*(m)$ equals $q - \tau$ and $p^{*\prime}(m)$ equals zero, we can see from (7) that

$$\lambda(m) = 1/(q - \tau) \tag{14}$$

Our first proposition now follows immediately from Lemma 1.

<u>Proposition 1</u> Suppose that the traders behave competitively and that $Z(q - \tau, y/n) < 0$. Then

$$m^* = y/n$$

This result implies that pure cash relief should be used in Example 1 if traders behave competitively and large farmers have some surplus food.

To say that the population will be net suppliers of food at the price $q - \tau$ is, of course, equivalent to saying that food will be exported. Thus Proposition 1 tells us that if traders behave competitively and food will be exported whatever policy mix the relief agency selects, the optimal policy will be pure cash relief. The economics behind this result is really rather simple. If the relief agency chooses direct food relief, it buys food in the world market, transports it into the famine region and distributes it to the needy. If it chooses cash relief it simply distributes money to the needy and they purchase food in the local market. But this is equivalent to buying food in the local market and distributing it to the needy. Thus, the choice between cash and direct food relief is, in essence, a choice between purchasing food in the local or the world market. If the price in the local market would, in the absence of intervention, exceed the world price plus its transport costs, the agency should purchase food in the world market. If the local price would be less than the world price plus its transport costs <u>and</u> if purchasing in the local market will not increase the local price, the agency should purchase in the local market. If food would be exported in the absence of intervention and traders behave competitively, the local price would equal the world price less the traders' transport costs and hence would certainly be less than the world price plus the agency's transport costs. Moreover, as has been demonstrated, provided that food will be exported whatever policy mix the agency selects, purchasing in the local market will not increase the local price. It follows that the agency should purchase in the local market or, equivalently, should use cash relief.

Now suppose that the population will be net demanders of food at the price $q + \tau$ whatever the level of m (i.e. $Z(q + \tau, 0) > 0$). This would be the case in Example 2. By Lemma 2, $p^*(m)$ equals $q + \tau$ and $p^{*\prime}(m)$ equals zero. In this situation the increase in the needy's excess demand following an increase in the amount of money given away will be met by an equal increase in the traders' imports. The situation is depicted graphically in Figure 3. Using (7) we obtain

$$\lambda(m) = 1/(q + \tau) \tag{15}$$

Applying Lemma 1 yields our second proposition.

<u>Proposition</u> <u>2</u> Suppose that the traders behave competitively and that $Z(q + \tau, 0) > 0$.

(i) If $\theta > 1$

$$m^* = y/n$$

(ii) If $\theta = 1$

$$M(m) = M(m') \quad \text{for all } m, m' \in [0, y/n]$$

This result implies that pure cash relief should be used in Example 2 if the traders behave competitively and are more efficient transporters of food than the relief agency.

To say that the population will be net demanders of food at the price $q + \tau$ is equivalent to saying that food will be imported. Thus Proposition 2 tells us that if traders behave competitively and food will be imported whatever policy mix the agency employs, pure cash relief will be the optimal policy if traders are more efficient transporters of food. If traders are no more efficient, both policies will be equally effective. Again, the economics behind these results is very simple. If food would be imported and traders behave competitively, the local price would, in the absence of intervention, equal the world price plus the traders' transport costs. If traders are more efficient transporters, therefore, the local price would be less than the world price plus the agency's transport costs. Since purchasing in the local market will not increase the local price in this situation, it follows that the agency should use cash relief if traders are more efficient. If traders are no more efficient the local price would equal the world price plus the agency's transport costs and there is no particular advantage to using either policy.

Finally, suppose that the population will be net demanders of food at the price $q + \tau$ and net suppliers at $q - \tau$ whatever the level of m (i.e. $Z(q - \tau,0) \geq 0$ and $Z(q + \tau,y/n) \leq 0$). If the region was remote (i.e. τ was high) this situation could well arise in Example 3.[17] By Lemma 2, $p^*(m)$ is defined by (13). Using the Implicit Function Theorem, (9) and (4), it can be shown that

$$p^{*\prime}(m) = np^*(m)/[n(e_m + m) - V'p^*(m)^2] \qquad (16)$$

The right hand side of this equation is positive by Assumptions 3 and 4. Thus marginally increasing the amount of money given away will increase the equilibrium price. In the two previous cases the increase in the needy's excess demand was met, respectively, by a reduction in exports and an increase in imports. In this case, traders are neither exporting nor importing. The increase in the needy's demand is met by a price increase and an increase in the quantity of food supplied by the rest of the population. The situation is depicted graphically in Figure 4. The amount of food supplied by the rest of the population at the price p is given by $-V(p)$. The needy's excess demand curve is $n(e_m + m)/p$. At the price $p^*(m)$ the population's excess demand is zero. As a result of an increase of Δm in the amount of money given away, the needy's demand curve shifts to the right. The price rises to $p^*(m + \Delta m)$ where, once again, excess demand is zero. The quantity of food supplied to the market by the rest of the population increases from $-V(p^*(m))$ to $-V(p^*(m + \Delta m))$.

Combining (16) and (7) we obtain

$$\lambda(m) = -V'p^*(m)/[n(e_m + m) - V'p^*(m)^2] \tag{17}$$

In general, $\lambda(m)$ can either be greater or less than $1/(q + \theta\tau)$. If V' equals zero, for example, $\lambda(m)$ must equal zero which is clearly less than $1/(q + \theta\tau)$ but if e_m equals zero, $\lambda(0)$ equals $1/p^*(0)$ which, since $p^*(0)$ is less than $q + \tau$, is greater than $1/(q + \theta\tau)$. It follows that m^* could lie anywhere in the interval $[0,y/n]$.

This result tells us that if the traders behave competitively and food will be neither exported nor imported whatever policy mix the agency employs, the optimal policy could either be pure cash relief, pure direct food relief or a mix of the two. Since food would not be imported and traders behave competitively, the local price in the absence of intervention would be less than the world price plus the traders' transport costs and hence less than the world price plus the agency's transport costs. As has been demonstrated, however, purchasing in the local market will increase the local price which will reduce the amount of food the needy can purchase with their endowments of money. It is not clear, therefore, in which market the agency should purchase and hence whether cash or direct food relief should be employed.

In order to know whether, in situations in which food will neither be exported nor imported, cash relief is more or less likely to be more effective than direct food relief, it is of interest to understand how the optimal policy depends on the underlying structure of the regional economy. It is natural to expect the marginal benefit of giving away money, $\lambda(m)$, to vary positively with the degree of price responsiveness of the excess supply of the rest of the population. As can be seen from Figure 4, the smaller is $-V'$ the more the increase in the needy's excess demand will be met by a price rather than a quantity increase. One would also expect $\lambda(m)$ to be smaller the larger is each vulnerable individual's endowment of money. The larger is e_m, the greater the reduction in the needy's food purchases following any given price rise. The marginal cost of giving away money, $1/(q + \theta\tau)$, will clearly be smaller the larger the relief agency's transport costs. To summarize, then, one would expect the optimal policy to involve more cash relief the larger are $-V'$ (or β under Assumption 3') and $\theta\tau$ and the smaller is e_m. Under Assumption 3', this intuition can be shown to be correct.

Proposition 3 Suppose that the traders behave competitively, that $Z(q - \tau,0) > 0$ and $Z(q + \tau,y/n) < 0$ and that Assumption 3' is satisfied. Then if $m^* \in (0,y/n)$

(i) $\partial m^*/\partial\beta > 0$

(ii) $\partial m^*/\partial e_m < 0$

(iii) $\partial m^*/\partial\theta\tau > 0$

<u>Proof:</u> See Appendix []

In Example 3, therefore, if food will be neither exported nor imported and traders are competitive either pure cash relief, pure direct food relief or a mix of the two could be optimal. The optimal policy is likely to involve more cash relief, however, the greater the price responsiveness of the farmers' supply of food, the larger are the relief agency's transport costs and the smaller are the laborers' money holdings.

It is important to note that it is possible that the direction of the food flows between the local and world markets will depend on the policy mix employed by the relief agency. For example, a region which will be exporting food under pure direct food relief might be neither exporting nor importing under pure cash relief. In such a situation, however, the nature of the optimal policy can be deduced from the results we have already established. In the above example, for instance, cash relief should be employed until the point where food will no longer be exported. From this point on, the choice between cash and direct food relief should depend on the values of the variables identified in Proposition 3.

5. Monopoly Traders

Suppose now that the traders collude and behave as a monopoly; that is, they choose an amount of food to import (export) to maximize their total profits taking into account the effect of their decision on the price of food in the region. Formally, of course, this is equivalent to assuming that the traders choose the price of food in the region subject to the constraint that their imports must equal the population's excess demand. Since our purpose is to characterize the equilibrium price function $p^*(m)$, it will be convenient to view the traders as choosing a price rather than a level of imports.

The traders' profits when they choose a price p and each vulnerable individual is given m units of money will be given by

$$\pi(p,m) = \begin{cases} [p - (q - \tau)]\ Z(p,m) & \text{if } Z \leq 0 \\ [p - (q + \tau)]\ Z(p,m) & \text{if } Z > 0 \end{cases} \tag{18}$$

The equilibrium price $p^*(m)$ will be that price which maximizes the traders' profits. Using the first order conditions for this maximization problem, the following characterization of the equilibrium price may be obtained.

<u>Lemma 3</u> Let $m \varepsilon [0,y/n]$ and suppose that the traders behave as a monopoly.

(i) If $Z(q - \tau,m) < 0$, then $Z(p^*,m) < 0$ and

$$[p^* - (q - \tau)]\ \partial Z(p^*,m)/\partial p + Z(p^*,m) = 0 \tag{19}$$

(ii) If $Z(q + \tau,m) > 0$, then $Z(p^*,m) > 0$ and

$$[p^* - (q + \tau)]\ \partial Z(p^*,m)/\partial p + Z(p^*,m) = 0 \tag{20}$$

(iii) If $Z(q - \tau,m) \geq 0$ and $Z(q + \tau,m) \leq 0$, then

$$Z(p^*,m) = 0 \tag{21}$$

<u>Proof:</u> See Appendix [ ]

As in the competitive case, therefore, given any amount of money m there are three possibilities. First, the population could be net suppliers of food at the price $q - \tau$. In this case the equilibrium price would be defined by (19) and the traders would export. The price would be lower than the corresponding competitive equilibrium price $q - \tau$ and a smaller amount of food would be exported.[18] Second, the population could be net demanders at the price $q + \tau$. In this case the equilibrium price would be defined by equation (20) and the traders would import. The price would be higher than the corresponding competitive equilibrium price $q + \tau$ and a smaller amount of food would be imported. Finally, the population could be net demanders at the price $q - \tau$ but net suppliers at $q + \tau$. In this case the equilibrium price would be defined by equation (21) and the traders would neither export nor import. The price would be identical to the corresponding competitive equilibrium price.

Lemma 3 can now be used to calculate $\lambda(m)$. Suppose first that the population will be net suppliers of food at the price $q - \tau$ whatever the level of m (Example 1). It follows from Lemma 3 that $p^*(m)$ is defined by (19). Using the Implicit Function Theorem, (19) and (4) it can be shown that

$$p^{*\prime}(m) = p^* n(q - \tau)/[(q - \tau)2n(e_m + m) - (2V' + (p^* - (q - \tau))V'')p^{*3}] \quad (22)$$

The right hand side of this equation is positive.[19] Thus, marginally increasing the amount of money given away will increase the equilibrium price. The increase in the needy's excess demand decreases the excess supply of food at the price p^* and hence the traders' exports. The traders will find it profitable to raise the price to at least partially offset this decrease in their exports. The new level of exports may, in general, be higher or lower than the original level.

Substituting (22) into (7) yields

$$\lambda(m) = \frac{[(q - \tau)n(e_m + m) - (2V' + (p^* - (q - \tau))V'')p^{*3}]}{p^*[(q - \tau)2n(e_m + m) - (2V' + (p^* - (q - \tau))V'')p^{*3}]} \tag{23}$$

In general, $\lambda(m)$ can be greater or less than $1/(q + \theta\tau)$. If e_m equals zero, for example, $\lambda(0)$ equals $1/p^*(0)$ which is greater than $1/(q + \theta\tau)$ and it is straightforward to construct examples where the inequality is reversed.[20] It follows that m^* could lie anywhere in the interval $[0,y/n]$.

If the traders behave as a monopoly and food will be exported, therefore, the optimal policy could either be pure cash relief, pure direct food relief or a mix of the two. The local price in the absence of intervention would be less than the world price less the traders' transport costs and hence certainly less than the world price plus the agency's transport costs but, in contrast to the corresponding competitive case, it would increase if the agency were to purchase in the local market. This makes it unclear which policy the agency should choose. Notice, however, that in Example 1 the needy have no money and therefore, since $\lambda(0)$ is greater than $1/(q + \theta\tau)$, at least some of the agency's resources should be devoted to cash relief, even if the traders behave as a monopoly.

How does the optimal policy depend on the underlying structure of the economy in this situation? One would again expect $\lambda(m)$ to be smaller the larger is each vulnerable individual's endowment of money. In addition, since the price charged by the traders will vary inversely with their transport costs, it is also natural to expect $\lambda(m)$ to vary positively with τ. Clearly, $1/(q + \theta\tau)$ will again be smaller the larger are the relief agency's transport costs. One would therefore expect m^* to be larger the smaller is e_m and the larger are τ and θ.

Proposition 4 Suppose that the traders behave as a monopoly, that $Z(q - \tau, y/n) < 0$ and that Assumption 3' is satisfied.

Then if $m^* \varepsilon (0, y/n)$

(i) $\partial m^*/\partial e_m < 0$

(ii) $\partial m^*/\partial \tau > 0$

(iii) $\partial m^*/\partial \theta > 0$

Proof: See Appendix []

Now suppose that the population will be net demanders of food at the price $q + \tau$ whatever the level of m (Example 2). By Lemma 3 $p^*(m)$ is defined by (20) and consequently

$$p^{*\prime}(m) = p^* n(q + \tau)/[(q + \tau)2n(e_m + m) - (2V' + (p^* - (q + \tau))V'')p^{*3}] \quad (24)$$

The right hand side of (24) is positive. Increasing the amount of money given away increases the excess demand for food at the price $p^*(m)$ and hence the traders' imports. The traders will find it profitable to raise the price to choke back some of this increase in excess demand. The new level of imports may be higher or lower than the original level.

Substituting (23) into (7) we obtain

$$\lambda(m) = \frac{[(q + \tau)n(e_m + m) - (2V' + (p^* - (q + \tau))V'')p^{*3}]}{p^*[(q + \tau)2n(e_m + m) - (2V' + (p^* - (q + \tau))V'')p^{*3}]} \quad (25)$$

The value of $\lambda(m)$ is always less than $1/p^*(m)$. Thus, since $p^*(m)$ is greater than $q + \tau$, $\lambda(m)$ will be less than $1/(q + \theta\tau)$ if θ equals 1. By Lemma 1, we have the following proposition.

<u>Proposition 5</u> Suppose that the traders behave as a monopoly and that $Z(q + \tau, 0) > 0$. If $\theta = 1$, then

$$m^* = 0.$$

If θ is greater than 1, however, it is possible that $p^*(m)$ could be less than $q + \theta\tau$ and thus, in general, $\lambda(m)$ may be greater or less than $1/(q + \theta\tau)$.

If the traders behave as a monopoly and food will be imported, therefore, pure direct food relief will be the optimal policy if traders are no more efficient at transporting food than the agency. If traders are more efficient, however, the optimal policy could be pure cash relief, pure direct food relief or a mix of the two. To understand these results intuitively, notice that the local price in the absence of intervention would exceed the world price plus the traders' transport costs. If traders are no more efficient at transporting food, the local price would therefore exceed the world price plus the agency's transport costs and hence the agency should purchase in the world market. If traders are more efficient, however, the local price may be less than the world price plus the agency's transport costs. In this situation, depending on the size of the resulting price increase, it may be that the agency should purchase in the local market.

One would again expect m^* to vary positively with θ and negatively with e_m. In addition, since the price charged by the traders will be higher the less price responsive is the excess demand of the rest of the population, one would expect m^* to vary positively with $-V'$.

Proposition 6 Suppose that the traders behave as a monopoly, that $Z(q + \tau, 0) > 0$ and that Assumption 3' is satisfied.

Then if $m^* \varepsilon (0, y/n)$

(i) $\partial m^*/\partial e_m < 0$

(ii) $\partial m^*/\partial \beta > 0$

(iii) $\partial m^*/\partial \theta > 0$

Proof: See Appendix []

Thus, in Example 2, if the traders behave as a monopoly, pure direct food relief should be used if the relief agency is just as efficient at transporting food. If the traders are more efficient then it is possible that some cash relief should be used. This will be less likely, the larger are the money holdings of the low wage earners, the smaller is the price responsiveness of the high wage earners' demand for food and the smaller is the difference between the agency's and traders' transport costs.

Finally, suppose that the population will be net demanders of food at the price $q - \tau$ and net suppliers at $q + \tau$ whatever the level of m. By Lemma 3, $p^*(m)$ will equal the corresponding competitive equilibrium price. Consequently, the findings of the previous section remain valid when the traders behave as a monopoly. This result should come as no surprise. If the traders are neither exporting nor importing, then whether they behave competitively or as a monopoly is of little consequence.

6. Summary

This paper has attempted to clarify the conditions under which cash relief is likely to be more or less effective than direct food relief by comparing the performance of the two policies in a formal model. Before the results of the paper are summarized the reader should be reminded that the model assumes that the policy objective is to simply minimize expected mortality. Consequently, the results do not reflect the different effects of the two policies on variables other than mortality. For example, they do not take into account the fact that cash relief, by providing a demand for trade and transportation, may help keep alive the economic infrastructure of the famine region.[21]

The results of this paper suggest that the relative effectiveness of cash and direct food relief will depend critically on the behavior of traders and on whether food will be exported, imported or neither exported nor imported. If food will be exported from the famine region, it was found that cash relief will be optimal if traders behave competitively. This result, of course, lends strong support to the argument that cash relief will be more effective in famines in which food will be exported. If traders behave as a monopoly, however, it was found that cash relief will no longer always be optimal. While the assumption that traders behave as a monopoly certainly represents the extreme of non-competitive behavior, this finding does suggest that the argument for cash relief when food will be exported requires the caveat that traders behave competitively. Cash relief will be more likely to be optimal when food will be exported and traders behave as a monopoly, the smaller are the money holdings of the needy, the more remote the famine region and the more inefficient is the relief agency at transporting food.

If food will be imported, the relative effectiveness of the two policies was also found to depend on how efficient the traders are at transporting food relative to the relief agency. Both policies will be equally effective if the traders are competitive and no more efficient at transporting food than the agency. If they are more efficient, cash relief will be optimal. The latter result lends support to the argument that cash relief will be more effective even if food is not being exported provided that traders are more efficient transporters. When the traders behave as a monopoly, however, the findings were rather different. Cash relief will no longer always be optimal if traders are more efficient and direct food relief will be optimal if they are no more efficient. These findings suggest that the concerns about the effectiveness of cash relief when traders are non-competitive are well founded. When traders are more efficient and behave as a monopoly, cash relief is less likely to be optimal the smaller the degree of price responsiveness of the excess supply of food of the unneedy, the larger are the money holdings of the needy and the more efficient is the relief agency at transporting food.

If food will be neither exported nor imported, the relative effectiveness of the two policies will be unaffected by the traders' behavior. Neither policy, however, has a clear advantage in this situation. Conditions were found under which cash relief will be optimal and under which direct food relief will be optimal. This result is important since it demonstrates that even if traders are competitive and more efficient transporters of food, cash relief will not necessarily always be more effective. In general, cash relief will be less likely to be optimal when food will be neither exported nor imported, the smaller the degree of price responsiveness of the excess supply of the unneedy, the smaller the relief agency's transport costs and the larger the money holdings of the needy.

Appendix

Proof of Lemma 2: Let $m \in [0,y/n]$. The equilibrium price $p^*(m)$ is defined by the following equation

$$Z(p^*(m),m) \in I(p^*(m)) \tag{26}$$

By the argument given in the text we know that

$$I(p) = \begin{cases} \mathbb{R}_- & \text{if } p = q - \tau \\ \{0\} & \text{if } p \in (q - \tau, q + \tau) \\ \mathbb{R}_+ & \text{if } p = q + \tau \end{cases} \tag{27}$$

We also claim that

$$\partial Z/\partial p < 0 \tag{28}$$

To see this note from (9) that

$$\partial Z/\partial p = V' + n[(\partial x/\partial p) + (\partial x/\partial w)(e_f + f(m))] \tag{29}$$

By Assumption 3, $V' \leq 0$. By Assumptions 2(iv) and 2(v)

$$p[(\partial x/\partial p) + (\partial x/\partial w)(e_f + f(m))] \leq (\partial x/\partial p)p + (\partial x/\partial w)(e_m + m + p(e_f + f(m)))$$
$$\leq 0 \tag{30}$$

and hence $[(\partial x/\partial p) + (\partial x/\partial w)(e_f + f(m))] \leq 0$. If $V' < 0$, (28) is clearly true.

If $V' = 0$, $e_m > 0$ by Assumption 4. In this case, (30) holds as a strict inequality and hence $[(\partial x/\partial p) + (\partial x/\partial w)(e_f + f(m))] < 0$, which implies (28).

We can now prove the Lemma. Suppose first that $Z(q - \tau,m) < 0$. Then by (27) $Z(q - \tau,m) \varepsilon I(q - \tau)$ and hence by (26) $p^*(m) = q - \tau$. Now suppose that $Z(q + \tau,m) > 0$. Then by (27) $Z(q + \tau,m) \varepsilon I(q + \tau)$ and hence by (26) $p^*(m) = q + \tau$. Finally, suppose that $Z(q - \tau,m) \geq 0$ and $Z(q + \tau,m) \leq 0$. Let $\bar{p}$ be the solution to the equation $Z(p,m) = 0$. By (28) $\bar{p}$ is unique and an element of $[q - \tau,q + \tau]$. Since $0 \varepsilon I(p)$ for all $p \varepsilon [q - \tau,q + \tau]$, $Z(\bar{p},m) \varepsilon I(\bar{p})$ and hence by (26) $p^*(m) = \bar{p}$. []

Proof of Proposition 3: Let

$$\delta(m,\beta,e_m,\theta\tau) = \beta p^*/[n(e_m + m) + \beta p^{*2}] - 1/(q + \theta\tau) \tag{31}$$

By Lemma 1 if $m^* \varepsilon (0,y/n)$, $\lambda(m^*) = 1/(q + \theta\tau)$ or, equivalently, by (17)

$$\delta(m^*,\beta,e_m,\theta\tau) = 0 \tag{32}$$

By the Implicit Function Theorem, therefore, provided that $\partial\delta/\partial m \neq 0$

$$\frac{\partial m^*}{\partial\beta} = -\frac{\partial\delta/\partial\beta}{\partial\delta/\partial m} \tag{33}$$

$$\frac{\partial m^*}{\partial e_m} = -\frac{\partial\delta/\partial e_m}{\partial\delta/\partial m} \tag{34}$$

$$\frac{\partial m^*}{\partial\theta\tau} = -\frac{\partial\delta/\partial\theta\tau}{\partial\delta/\partial m} \tag{35}$$

Differentiating (31) we obtain

$$\frac{\partial\delta}{\partial m} = \frac{(\beta n(e_m + m) - \beta^2 p^{*2})(\partial p^*/\partial m) - \beta n p^*}{(n(e_m + m) + \beta p^{*2})^2} \tag{36}$$

$$\frac{\partial\delta}{\partial\beta} = \frac{n(e_m + m)p^* + (\beta n(e_m + m) - \beta^2 p^{*2})(\partial p^*/\partial\beta)}{(n(e_m + m) + \beta p^{*2})^2} \tag{37}$$

$$\frac{\partial\delta}{\partial e_m} = \frac{(\beta n(e_m + m) - \beta^2 p^{*2})(\partial p^*/\partial e_m) - \beta n p^*}{(n(e_m + m) + \beta p^{*2})^2} \tag{38}$$

$$\frac{\partial\delta}{\partial\theta\tau} = \frac{(\beta n(e_m + m) - \beta^2 p^{*2})(\partial p^*/\partial\theta\tau)}{(n(e_m + m) + \beta p^{*2})^2} + \frac{1}{(q+\theta\tau)^2} \tag{39}$$

From Lemma 2(iii), Assumption 3' and (4) we know that

$$\alpha - \beta p^* + n(e_m + m)/p^* = 0 \tag{40}$$

Using (40) and the Implicit Function Theorem it is straightforward to calculate $\partial p^*/\partial m$, $\partial p^*/\partial\beta$, $\partial p^*/\partial e_m$ and $\partial p^*/\partial\theta\tau$. By substituting these expressions into (36), (37), (38) and (39) it can be verified that $\partial\delta/\partial m < 0$, $\partial\delta/\partial\beta > 0$, $\partial\delta/\partial e_m < 0$ and $\partial\delta/\partial\theta\tau > 0$. The Proposition then follows from (33), (34) and (35). []

Proof of Lemma 3: Let $m \in [0, y/n]$. By definition

$$p^*(m) = \text{argmax } \{\pi(p,m) : p \in \mathbb{R}_{++}\} \tag{41}$$

To prove (i) assume that $Z(q - \tau, m) < 0$. We first claim that $Z(p^*,m) < 0$. Suppose not. Then it must be the case that $Z(p^*,m) \geq 0$. Since $\partial Z/\partial p < 0$, this implies that $p^* < q - \tau$. From (18) it follows that $\pi(p^*,m) \leq 0$. Notice however, that if $\varepsilon > 0$ is chosen so that $Z(q - \tau - \varepsilon, m) > 0$ then from (18)

$$Z(q - \tau - \varepsilon, m) = - \varepsilon Z(q - \tau - \varepsilon, m) > 0$$

This contradicts (41). Since $Z(p^*,m) < 0$, it follows from (41) and (18) that

$$p^*(m) = \text{argmax } \{[p - (q - \tau)]Z(p,m) : Z(p,m) < 0,\ p \in \mathbb{R}_{++}\} \tag{42}$$

But (19) is just the first order necessary condition for this maximization problem. The proof of (ii) is similar.

To prove (iii) assume that $Z(q - \tau, m) \geq 0$ and that $Z(q + \tau, m) \leq 0$ and suppose that $Z(p^*,m) \neq 0$. Then either $Z(p^*,m) > 0$ or $Z(p^*,m) < 0$. If $Z(p^*,m) > 0$ then, since $\partial Z/\partial p < 0$, $p^* < q + \tau$ and thus from (18) $\pi(p^*,m) < 0$; a contradiction. Similarly, if $Z(p^*,m) < 0$, then $p^* > q - \tau$ and thus from (18) $\pi(p^*,m) < 0$. Thus $Z(p^*,m) = 0$. []

Proof of Proposition 4: Let

$$\delta(m, e_m, \tau, \theta) = \frac{n(e_m + m)(q - \tau) + 2\beta p^{*3}}{(2n(e_m + m)(q - \tau)p^* + 2\beta p^{*4})} - \frac{1}{(q + \theta\tau)} \tag{43}$$

By Lemma 1 if $m^* \varepsilon (0,y/n)$, $\lambda(m^*) = 1/(q + \theta\tau)$ or, equivalently, by (23)

$$\delta(m^*, e_m, \tau, \theta) = 0 \tag{44}$$

By the Implicit Function Theorem, therefore, provided that $\partial\delta/\partial m \neq 0$

$$\frac{\partial m^*}{\partial e_m} = - \frac{\partial\delta/\partial e_m}{\partial\delta/\partial m} \tag{45}$$

$$\frac{\partial m^*}{\partial \tau} = - \frac{\partial\delta/\partial \tau}{\partial\delta/\partial m} \tag{46}$$

$$\frac{\partial m^*}{\partial \theta} = - \frac{\partial\delta/\partial \theta}{\partial\delta/\partial m} \tag{47}$$

Differentiating (43) we obtain

$$\frac{\partial\delta}{\partial m} = - \frac{(4\beta^2 p^{*6} + 2n^2(e_m + m)^2(q - \tau)^2)(\partial p^*/\partial m) + 2\beta n(q - \tau)p^{*4}}{(2n(e_m + m)(q - \tau)p^* + 2\beta p^{*4})^2} \tag{48}$$

$$\frac{\partial\delta}{\partial e_m} = - \frac{(4\beta^2 p^{*6} + 2n^2(e_m + m)^2(q - \tau)^2)(\partial p^*/\partial e_m) + 2\beta n(q - \tau)p^{*4}}{(2n(e_m + m)(q - \tau)p^* + 2\beta p^{*4})^2} \tag{49}$$

$$\frac{\partial\delta}{\partial \tau} = \frac{2\beta n(e_m + m)p^{*4} - (2n^2(e_m + m)^2(q - \tau)^2 + 4\beta^2 p^{*6})(\partial p^*/\partial\tau)}{(2n(e_m + m)(q - \tau)p^* + 2\beta p^{*4})^2} + \frac{\theta}{(q + \theta\tau)^2} \tag{50}$$

$$\frac{\partial \delta}{\partial \theta} = \frac{\tau}{(q + \theta\tau)^2} - \frac{(2n^2(e_m + m)^2(q - \tau)^2 + 4\beta^2 p^{*6})(\partial p^*/\partial \theta)}{(2n(e_m + m)(q - \tau)p^* + 2\beta p^{*4})^2} \tag{51}$$

From Lemma 3 (i), Assumption 3' and (4) we know that

$$-(p^* - (q - \tau))(p^{*2}\beta + n(e_m + m))/p^{*2} + \alpha - \beta p^* + n(e_m + m)/p^* = 0 \tag{52}$$

Using (52) and the Implicit Function Theorem it is straightforward to calculate $\partial p^*/\partial m$, $\partial p^*/\partial e_m$, $\partial p^*/\partial \tau$ and $\partial p^*/\partial \theta$. By substituting these expressions into (48), (49), (50) and (51) it can be verified that $\partial \delta/\partial m < 0$, $\partial \delta/\partial e_m < 0$, $\partial \delta/\partial \tau > 0$ and $\partial \delta/\partial \theta > 0$. The Proposition then follows from (45), (46) and (47). []

Proof of Proposition 6: This is similar to the proof of Proposition 4 and hence is omitted. []

Footnotes

* I am very grateful to my supervisor Bill Rogerson for his help and encouragement in writing this paper. I would also like to thank Sharon Tennyson and an anonymous referee for helpful comments.

1 See, for example, Devereux and Hay (1986), Sen (1982),(1986), Stewart (1986) and World Bank (1986). Cash relief has actually been used recently by UNICEF in Ethiopia.

2 See Woodham-Smith (1962) and Ghose (1982). More recently, as noted by Sen (1981), there were reports of food being exported from Wollo during the 1973 famine.

3 This argument is made, for example, by Sen (1986), p.14 and World Bank (1986), p.39.

4 This argument is made, for example, by Sen (1986), p.14.

5 See Devereux and Hay (1986), p.205. Sen (1986), p.13 suggests that cash relief may not be effective if traders manipulate markets.

6 Two other papers which address famine relief issues using formal models are Coate (1986) and Ravallion (1985).

7 In fact, the question considered by Bigman is 'under what conditions will cash transfers be a more or less costly way of achieving a given increase in the food consumption of a particular subset of the population of some region than food transfers', but this is clearly very similar.

8 The condition is obtained by taking linear approximations around the no intervention equilibrium.

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

10 This is established in the proof of Lemma 2 which is contained in the Appendix.

11 Let $r_1,\ldots,r_k$ denote the prices of the other goods in the region. By zero degree homogeneity.

$$\Sigma_{j=1}^{k}(\partial x/\partial r_j)r_j + (\partial x/\partial p)p + (\partial x/\partial w)w = 0$$

and thus

$$(\partial x/\partial p)p + (\partial x/\partial w)w = -\Sigma_{j=1}^{k}(\partial x/\partial r_j)r_j$$

If $\partial x/\partial r_j \geq 0$ for all j, Assumption 2(v) will clearly hold.

12 The problem which arises is that the excess demand function of the region's population (vulnerable plus non-vulnerable) may be non-decreasing in price.

13 We are implicitly assuming here that the agency can identify the needy and hence are abstracting from the difficult problem of accurately targeting relief. See Coate (1986) for more on this problem.

14 To avoid inessential technicalities, it will simply be assumed that the equilibrium price function $p^*: [0,y/n] \to IR_{++}$ is well defined or equivalently, that $p^*(m)$ exists and is unique for all $m \in [0,y/n]$. In fact, Assumptions 2,3 and 4 are sufficient to guarantee existence and uniqueness when traders behave competitively. In the monopoly case, sufficient conditions are that $x(p,w) = w/p$ and Assumptions 3' and 4.

15 Equation (3) implies, of course, that non-vulnerable individuals will survive with probability one no matter what policy mix the agency chooses. Thus we are implicitly assuming that if the relief agency's intervention raises the market price of food above its no intervention level it does not do so to such an extent that the survival of non-vulnerable individuals is jeopardised.

16 There are likely to be two forces at work in this type of famine: laborers' incomes will be depressed because of diminished employment opportunities and food prices are likely to be high.

17 A situation in which food would be neither exported nor imported would be likely to arise if the famine region were remote and hence τ was large. As Devereux and Hay note "communities which live in remote areas may well operate in what are virtually closed economies." (Devereux and Hay (1986), p.205)

18 Thus, in this situation, expected mortality will be lower if the traders behave as a monopoly rather than competitively!

19 This follows from the second order conditions for the traders' maximisation problem and the assumption that $p^*(m)$ is unique.

20 Suppose, for example, that $V(p) = \alpha$ where $\alpha < 0$. By (19) $p^*(m) = [-(q-\tau)n(e_m + m)/\alpha]^{1/2}$ and by (23) $\lambda(m) = 1/2p^*(m)$. If $q = 1.2$, $\tau = 0.1$, $\theta = 1$ and $-n(e_m + m)/\alpha = 1$, then $\lambda(m) < 1/(q + \theta\tau)$.

21 Sen (1986) p.14 and Stewart (1986) p.319 have argued that this may be an important merit of cash relief.

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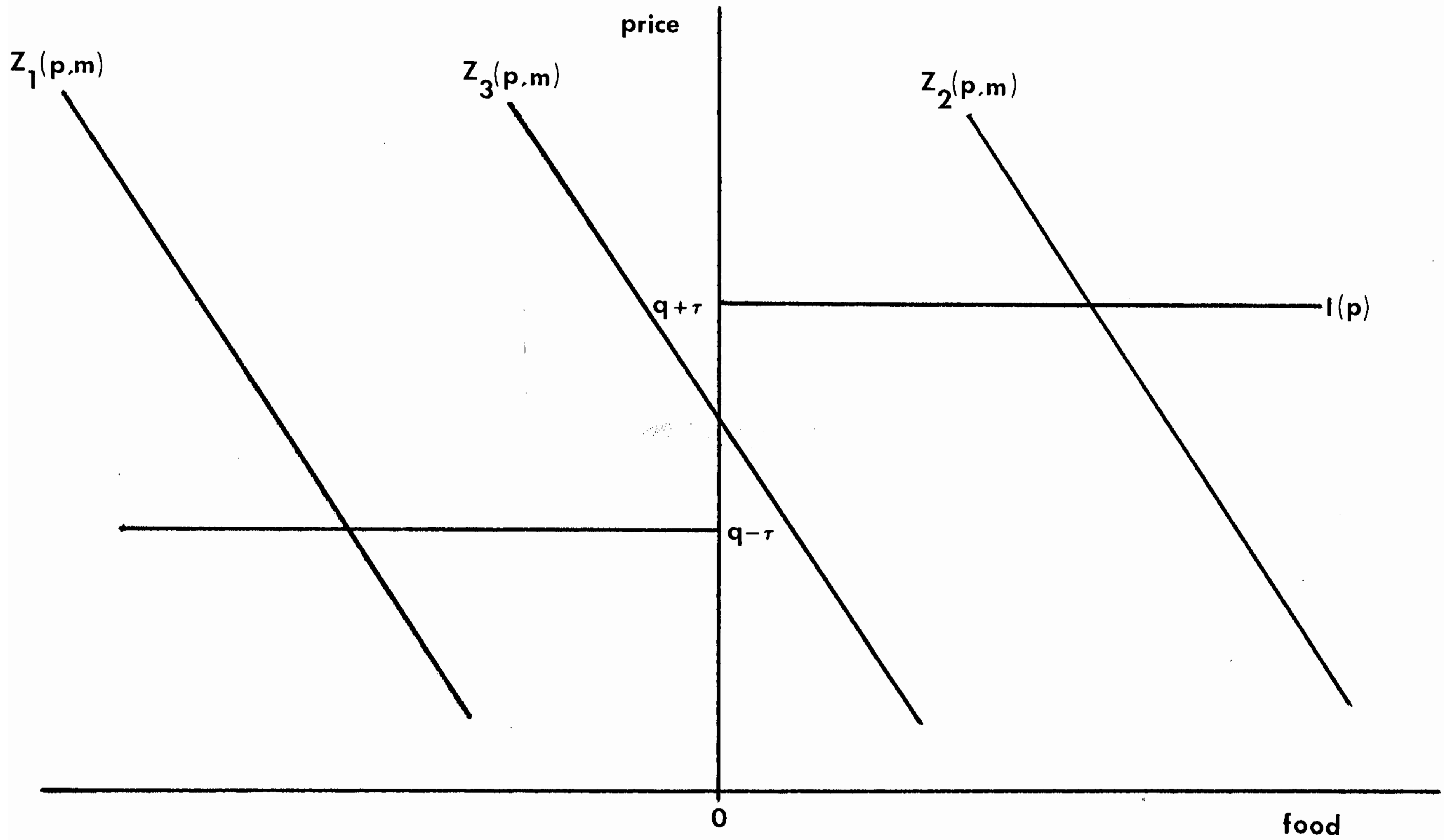

FIGURE 1

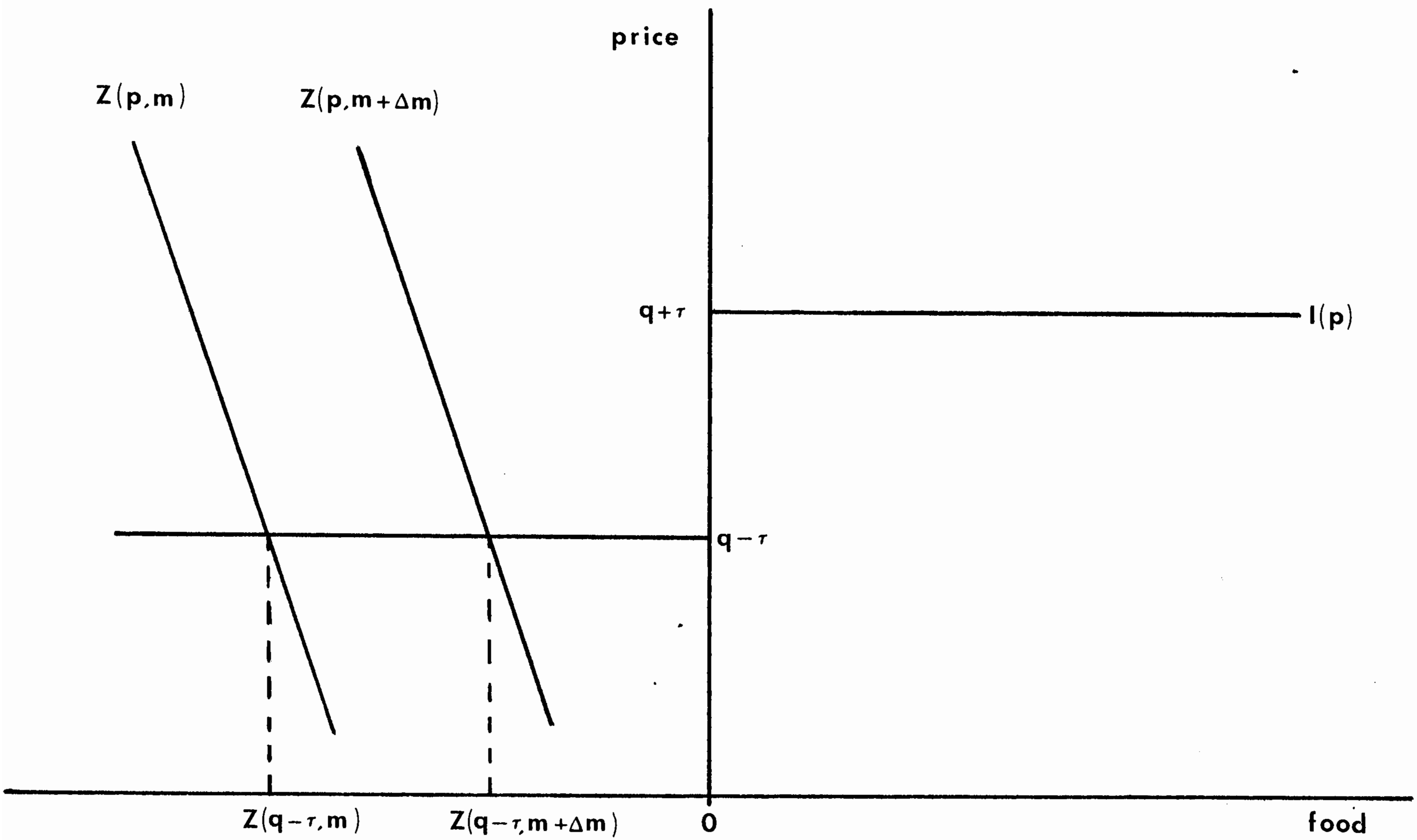

FIGURE 2

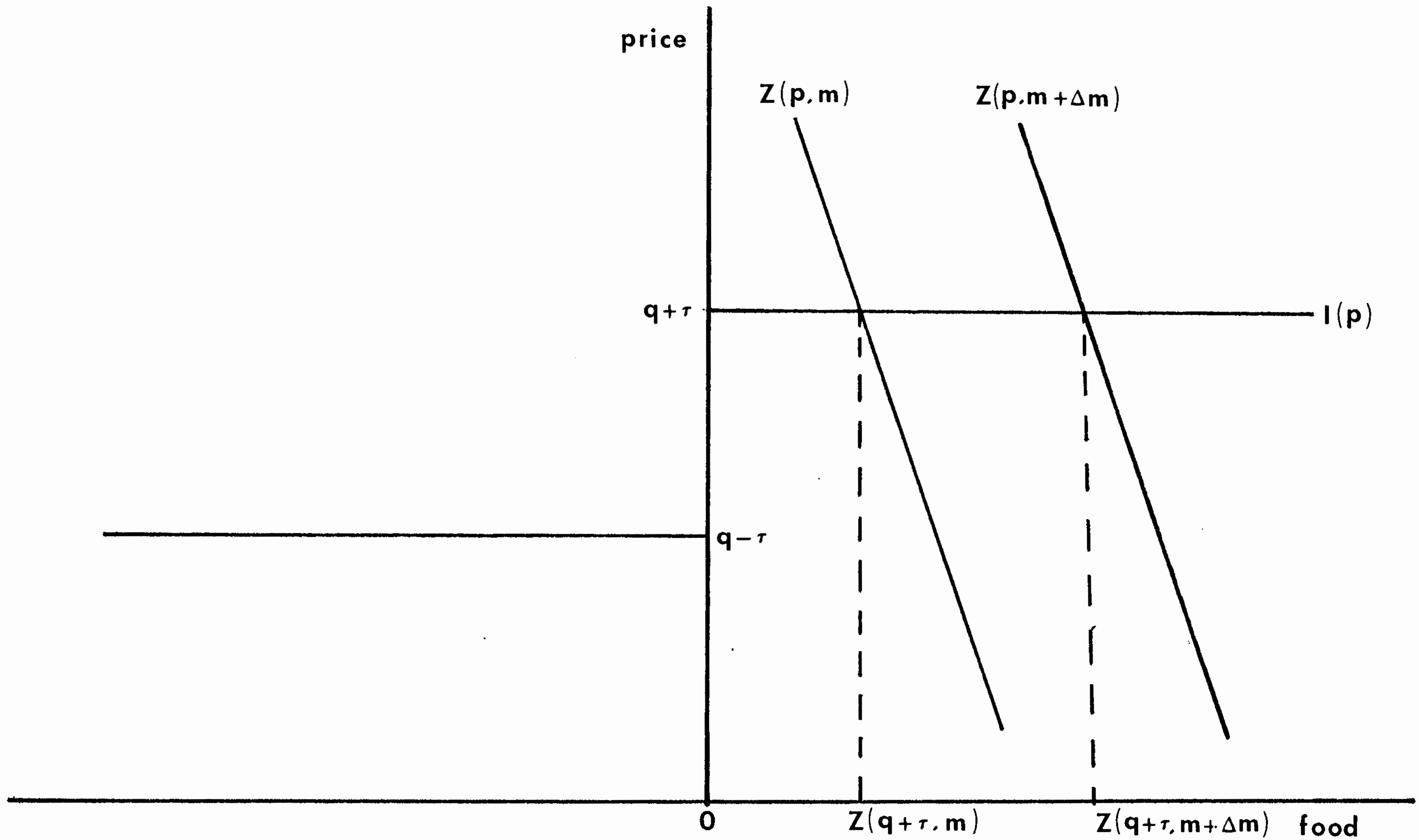

FIGURE 3

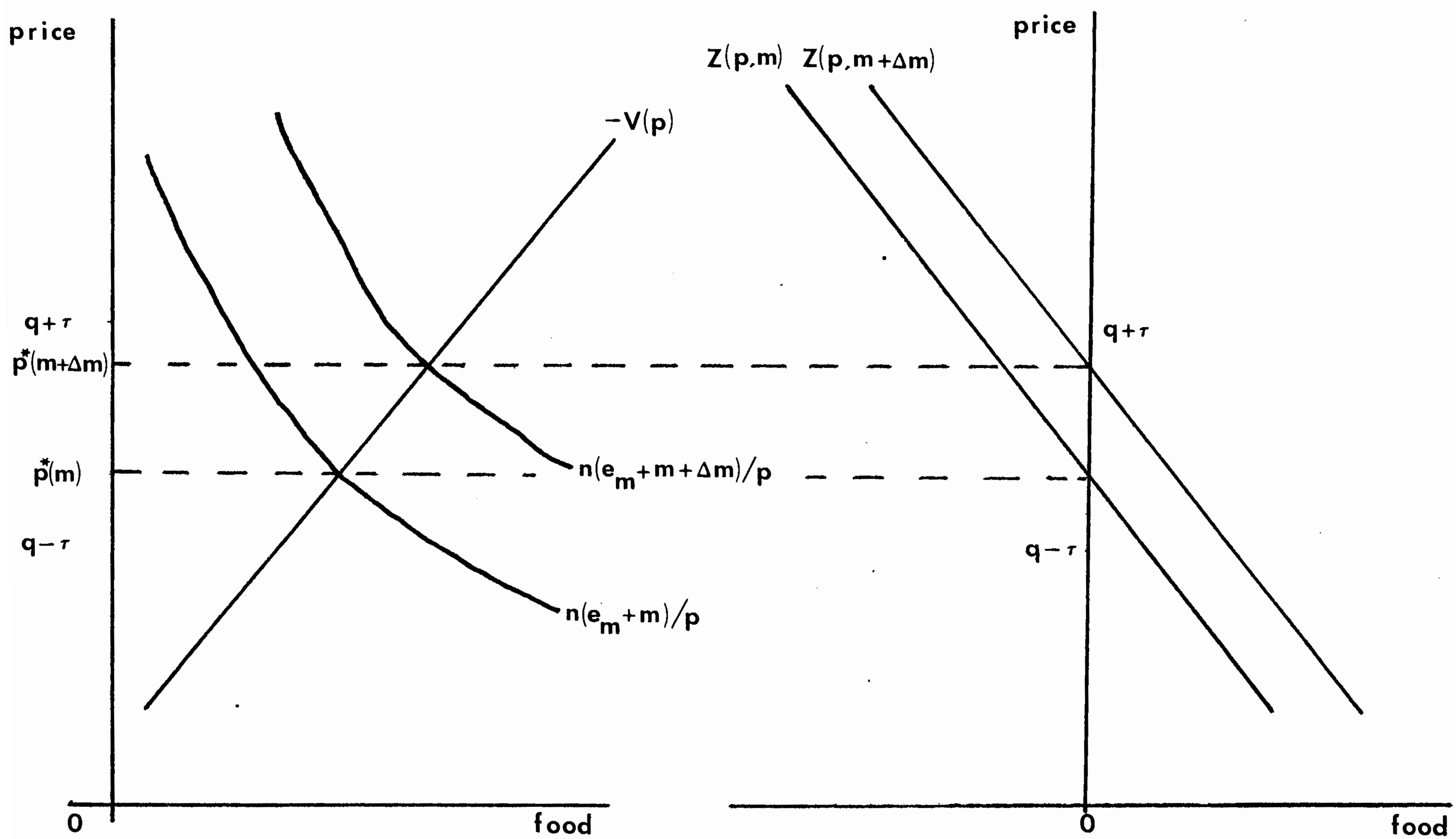
price
q+τ
p*(m+Δm)
p*(m)
q−τ
0
food
−V(p)
n(e_m+m+Δm)/p
n(e_m+m)/p
Z(p,m) Z(p,m+Δm)
price
q+τ
q−τ
0
food

FIGURE 4