CHAPTER 3. ALTERNATIVES FOR MITIGATING DISASTER EFFECTS IN LDCs

1. Introduction

In the preceding chapters we have seen that a major factor causing LDCs to be severely stricken by disasters is the lack of arrangements for protection in one form or another. In this chapter an attempt is made to show that, given the institutional characteristics of LDCs, international disaster relief may be the most important instrument for a significant improvement of disaster preparedness in such countries. We analyze why ordinary market solutions for protection may not work in LDCs. Three solutions of this kind can be distinguished.

On the individual level one solution may be to purchase insurance which in the future will grant the individual access to a given sum of money or a bundle of goods.

A second individual solution may be saving a share of current income in money or real terms to be consumed if a catastrophe occurs. In real terms, the individual may invest in physical goods appropriate for mitigating the consequences of a natural disaster. For instance, building houses which are more likely to withstand the impact of a natural disaster or storing goods, such as food, medicine, etc. expected to be vital in those circumstances.

Lastly, the individual may reduce the risk of being affected by a natural disaster by moving to a safer area.*)

*) In the solutions now mentioned, there are two different approaches by which the individual may be able to reduce the effects of disasters. One is to reduce the welfare losses by purchasing insurance or saving in money terms. The other is to limit the size of the physical damage by constructing better houses or moving to a safer

The government may have an important role to play in maintaining the institutions appropriate to each of the measures indicated here. Hence, we also analyze policies of encouraging insurance and private saving, providing information and relocation assistance, etc. Particular attention is given to the possibility of expanding (establishing) insurance markets.

Individuals that live in areas highly subject to natural disasters live under conditions of unusually great uncertainty as to the future. To the extent they are aware of this fact, they are less certain about the conditions affecting their wellbeing at future dates than individuals living in safer regions. Therefore we begin by constructing a model to use as the basis for a discussion of individual choice in the face of uncertainty. Then we discuss the implications and relevance of each of the three types of solution mentioned above. Finally, we present some policy recommendations with alternative measures to improve disaster preparedness in LDCs.

2. An Uncertainty Model

The model to be constructed here rests on the theory of decision under uncertainty.*) This theory will provide us with the tools necessary to formalize individual choices in reference to the two future states of nature of interest to us, namely, a normal state N and a disaster state D. These two states are defined with reference to all elements of importance to the issue at hand, such as injuries, access to transportation, availability of food, income levels and so on, changes in which could influence individual behavior ex ante. Moreover, in this model there are, ex ante, as many commodities

*) For an introduction to the theory of "decision under uncertainty" see, for instance, Hey, J. (1979), Malinvaud (1972, Chapter 11), Hirschleifer (1970, Chapter 8), Varian (1978, pp. 104-117).

as there are possible states of nature times the number of physical goods. For the simple case of a single physical good, e.g., food, there are two different commodities, $food_N$ and $food_D$.

We define a utility function for the individual in terms of choices between commodities or consumption claims. A consumption claim is an entitlement assuring the individual the delivery of a certain amount of goods under specified conditions. In the case of a single good (food), which we shall use here, this would be represented by an entitlement for the delivery of food in state N or in state D. The individual will choose a certain composition of consumption claims according to his attitude towards risk and according to the subjective probability he assigns (or from actual behavior is revealed to assign) to the occurrence of a natural disaster. That is, under a given budget constraint (we return to this shortly), individual i may choose a prospect P,

$$P = (x_N^i, x_D^i ; 1 - \pi^i , \pi^i)$$

where π^i and $1-\pi^i$ (hereafter π and $1-\pi$) stand for the subjective probabilities the $i^{\underline{th}}$ individual assigns to D and N, respectively, x_N^i is the quantity of food to be consumed in N and x_D^i is the quantity to be consumed in D.

Thus, for given values of π the individual will choose a quantity of food to be consumed in each state so as to maximize the utility he expects to get from such consumption. This utility function (of the von Neumann-Morgenstern type) is defined over the individual's consumption in N and D and may be written as $U^i(x_N^i, x_D^i; \pi)$. According to the expected utility hypothesis this can be expressed as:

$$(1) \quad U^i(P) = (1 - \pi)\, u^i(x_N^i) + \pi u^i(x_D^i).$$

Here, the so called "elementary utility functions", $u^i(x_N^i)$ and $u^i(x_D^i)$, expresses the utility the individual will get from the quantity of food consumed in the two states (see Hirschleifer, loc.cit. or Malinvaud, loc.cit.). In addition to the usual assumptions about individual preferences, it is assumed that the utility function u^i is the same for the two states of nature. That is, the consumption of an equal amount of food will provide the individual with the same utility independent of the state of nature.*) Although our assumption of a state-independent utility function may be restrictive (e.g., in case the individual's evaluation of the same amount of food in D actually differs from that in N) it will be adequate for our illustrative purpose.

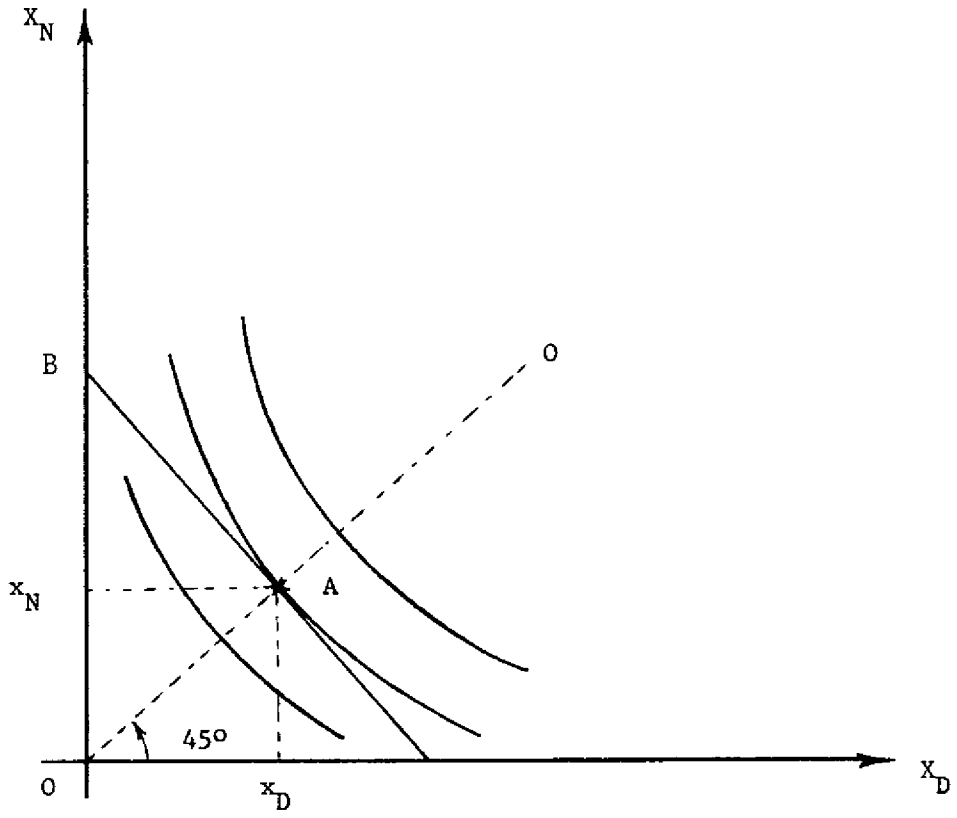
If the individual is risk averse, the elementary utility function is strictly concave and his indifference curves will be strictly convex. Plotting the quantities of food to be delivered in the state N on the vertical axis and the quantities of food to be delivered in the sate D on the horizontal axis we can represent an individual's indifference map as in figure 1.

Each point on the indifference curve represents a different combination of commodities x_N^i and x_D^i considered equally advantageous by the individual. A point on the 45^o line through the origin expresses the case of certainty in consumption ($x_N^i = x_D^i$).**) The individual choosing a strategy given by such a point will always consume the same quantity of food independent of the state of nature occurring and the individual's utility of consuming $x_N^i = x_D^i$ is given by:

*) For a further treatment of the choice of utility function see, for example, Hirschleifer, ibid. pp. 216-219 and p. 222 and Malinvaud, ibid, p. 280.

**) A further illustration of the characteristics of the 45^o line is given by Hirschleifer (ibid, pp. 231-232).

Figure 1



$$(1 - \pi)\, u^i(x_N^i) + \pi u^i(x_D^i) = u(x_N^i)$$

In order to analyze individual behavior in the face of uncertainty we need to say something about the price system. Since consumption claims are involved here, the relevant prices are for conditional delivery contracts depending on the state of nature, i.e.:

p_H , where $H = N, D$.

For the purpose of our analysis we shall assume that a consumption claim is represented by real insurance, i.e., by insurance that guarantees the delivery of physical items. Here, p_D will be the "insurance premium". This is the price that the purchaser of an insurance policy will pay to the "insurance company" in order to get one unit of food if D is realized. For

this to be relevant, such insurance markets must exist. (If insurance is formally in money terms, our assumptions imply that the individual must know prices in future states.)

Assuming the existence of the markets just described a budget constraint for the individual may be defined as

$$(2) \quad p_N x_N^i + p_D x_D^i = B^i$$

where B^i stands for the $i^{\underline{th}}$ individual's initial endowments, which in case he has no other wealth, are given by the bundle

$$(\bar{x}_N^i , \bar{x}_D^i) \quad \text{where} \quad \bar{x}_N^i > 0 , \ \bar{x}_D^i \leq \bar{x}_N^i .$$

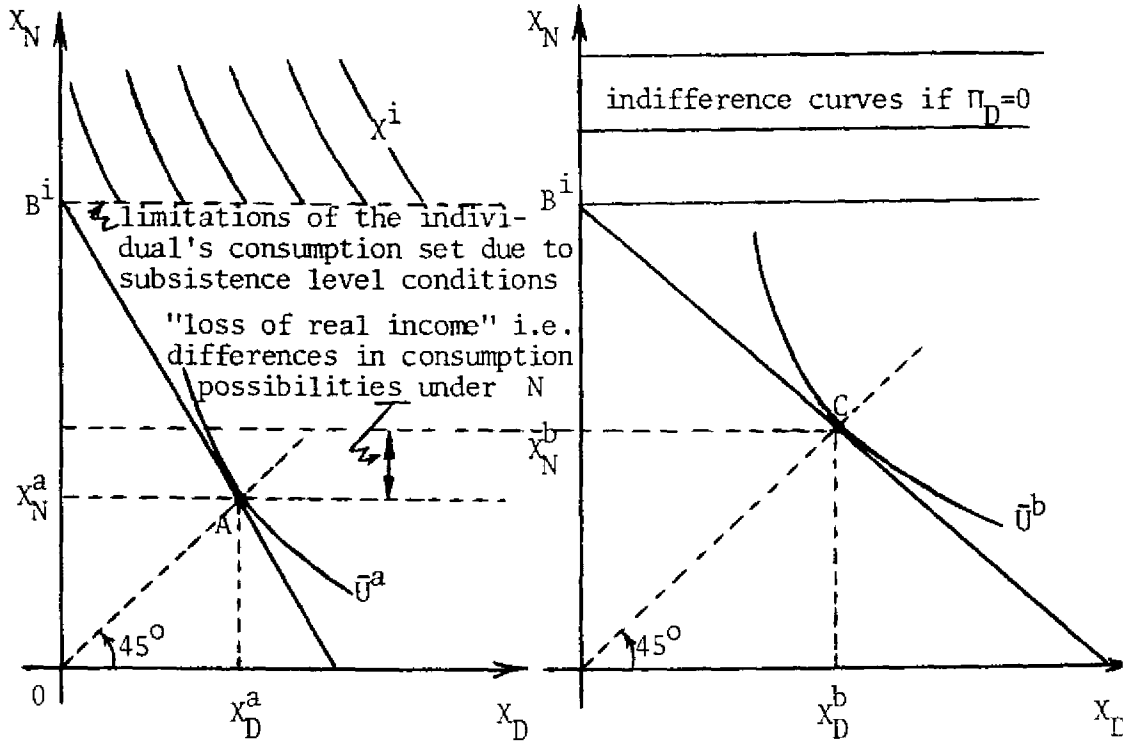
Usually, $\bar{x}_D^i$ is much smaller than $\bar{x}_N^i$, possibly even zero, as we shall assume here for simplicity. The individual's endowments B^i (point B in Figure 1) together with his probability beliefs as to the relative likelihoods of N and D, the market opportunities for trading claims, and his attitude toward risk will determine his actual choice.

Plotting the "budget line" represented by expression 2 on the indifference map of figure 1 above, we can find the optimal point for the individual's consumption of food in the possible states N and D. The special case where the individual wants his consumption to be certain, $x_N^i = x_D^i$, is given by point A in figure 1.

3. Insurance as an Individual Solution

For simplicity, we assume that the individual makes his decision for one period only, that is, he decides to buy an insurance policy assuring him the delivery of food if a natural disaster occurs during the period. Let us first analyze the implications for behavior of an individual living in a "disaster-prone" region (figure 2a, below) and the "same" individual living in a "safe" region (figure 2b).

Figure 2 a b



Choice for an individual living in a "disaster-prone" region

Choice for the "same" individual living in a "safe" region

In general the shapes of the indifference curves as well as the slopes of the budget lines will differ between the two situations considered. First, we have to consider that the indifference curves are not only a reflection of individual's tastes in the usual sense and of his aversion to risk, but also of his expectations of the possibilities of the occurrence of a na-

tural disaster (cf. expression 2). This will be better understood if one considers that in case the individual's subjective probability for the occurrence of D is zero ($\pi_D = 0$), which is the same as saying that his subjective probability for N is one ($\pi_N = 1$), his indifference curves will be horizontal as shown in figure 2b and he will buy no insurance and so will use all his endowments (B^i) for consumption of x_N. The indifference curves of the individual living in a disaster-prone region where $\pi_D > 0$, will have a negative slope and, for a given point (x_N^i, x_D^i), the slope will be steeper the higher the subjective probability for the occurrence of D. Hence, as $\pi_D^a > \pi_D^b$, the slope of the indifference curve in a given point in figure 2a will be steeper than the slope of the indifference curve in the same point in figure 2b.

Mathematically, this may be shown as follows. According to expression 1 the individual's expected utility of the outcomes of prospect P can be written as:

$$U^i = (1 - \pi^i)\, u(x_N^i) + \pi^i u(x_D^i)$$

For combinations of x_N^i and x_D^i along a given indifference curve, we have

$$(3) \quad (1 - \pi^i)\, u(x_N^i) + \pi^i u(x_D^i) = C$$

where C is a constant.

Differentiating (3) with respect to x_N^i and x_D^i we get:

$$(1 - \pi^i)\, u'(x_N^i)\, dx_N^i + \pi^i u'(x_D^i)\, dx_D^i = 0 \ ;$$

or

$$(4) \quad \frac{dx_N^i}{dx_D^i} = - \frac{\pi^i}{1-\pi^i} \cdot \frac{u'(x_D^i)}{u'(x_N^i)}$$

which is the slope of the indifference curve at point (x_N^i , x_D^i). Given that the individual represented by figure 2a assigns a probability π^a to the occurrence of a natural disaster, and the individual in 2b a smaller probability π^b, it follows that the slope of the indifference curve in each point is steeper in figure 2a as

$$(5) \quad - \frac{\pi^a}{1 - \pi^a} < - \frac{\pi^b}{1 - \pi^b} .$$

The implication of this difference is that with a given budget line (i.e. given the prices p_N and p_D), the individual will demand a higher insurance coverage in case a.

Secondly, the slopes of the budget lines will in fact differ because of the difference in relative prices of insurance that is likely to arise between the two situations. The lower the probabilities for the occurrence of a catastrophe as judged by the insurance firms the lower the expected coverage costs for insurance firms. Disregarding the properties of increasing returns to scale which may characterize firms in the insurance industry, this would unequivocally lead to lower insurance premiums (p_D) in case b than in case a. Thus, the slopes of the budget lines will differ in the way shown in figure 2a and 2b.

Given the individual's risk attitude this disparity in insurance premiums tends to counteract the difference in insurance behavior derived from the difference in the indifference curves described earlier. The net effects on the choice of x_N^i and x_D^i in the two cases will depend on the relationship between the subjective probabilities for the individual and those of the insurance firms. If they coincide and if relative prices reflect probability changes perfectly, the consumption of both x_N^i and x_D^i will be higher in case b. As an

illustration, assume that the individual prefers point A in figure 2a ($x_N^a = x_D^a$). Then the slope of the budget line equals $-\frac{\pi^a}{1-\pi^a}$ as in equilibrium it equals the slope of the indifference curve for which $u'(x_D^a) = u'(x_N^a)$ in this particular point. "Moving" to case b, where $\pi^b < \pi^a$ and given that prices perfectly reflect this probability change (assumed to be identical to the individual and the insurance firms), we get a point like C in figure 2b. That is, we have that

$$(6) \quad \begin{cases} x_N^b > x_N^a \\ x_D^b > x_D^a \end{cases}$$

In general, however, the subjective probabilities will not coincide as was assumed here. They may in fact differ to the extent that $x_N^b > x_N^a$ and $x_D^b < x_D^a$ or vice versa. To see this assume the insurance premium is significantly reduced but the individuals' subjective probabilities are the same in case a and case b. Given a sufficiently small change of the slope along the indifference curves, it may be so that $x_N^b < x_N^a$.

An example of the opposite case would be when the insurance premium is (approximately) the same and the individual's subjective probability is less in case b than in case a. This is, of course, the situation discussed in connection with expression (5) where indifference curves were made less steep and the budget line was assumed to be unchanged when moving from case a to case b, giving $x_D^b < x_D^a$. Thus, we have that

$$(7)\quad \begin{cases} x_N^b > x_N^a \\ x_D^b \gtreqless x_D^a \end{cases}$$

or

$$\begin{cases} x_N^b \gtreqless x_N^a \\ x_D^b > x_D^a \end{cases}$$

Moreover, in general, the welfare of the individual is higher in case b given a lower objective probability of a disaster, provided that this implies lower insurance premiums or reduced individual subjective probabilities or both and provided that $x_D^i \leq x_N^i$. These conditions are assumed to be fulfilled as we shall in the sequel take it for granted that for all individuals the level of welfare or real income will be lower in disaster-prone areas, ceteris paribus.

Let us now extend this discussion to the concrete case of an individual living in a disaster-prone region in an LDC. On the basis of observations by Themptander,*) one may conclude that in disaster-prone regions in LDCs it is often the case that the institutional prerequisites for insurance transactions do not exist. ("No coverage" or coverage "on a very reduced basis" is provided by the insurance industry.) Or, if they

*) Robert Themptander in his article: "Earthquake and Insurance" says: "even people living in highly eartquake-prone areas show a remarkably low interest in insuring their property against the earthquake risk. In most Latin-American countries, for instance, less than 10 % of private dwellings and their contents are covered, and in many countries this figure falls below 5 %... However, not only property owners' attitudes are of importance. In many seismically active countries no earthquake coverage is provided by the insurance industry or is provided only on a very reduced basis.... Only some 10 % of the actual losses in Nicaragua on December 23, 1972 and in Guatemala on February 4, 1976 were payable under insurance contracts." Nordisk Försäkringstidskrift no 1, 1979.

exist, insurance is not used to any significant extent. This may be because of a low degree of awareness of the risk of catastrophe or because of low levels of income in the society. Let us look at these two factors in turn.*)

A low level of awareness in LDCs would imply an estimate of the probability of a disaster that is too low so that at the individual level normal consumption will not be sacrificed to enable consumption in case of disaster. If relevant, this means that individuals in such countries will usually choose a consumption point like B^i on the vertical axis.

The second factor, the low levels of income in the society, refers to the fact that in disaster-prone areas in LDCs a large part of the population appears to live at the minimum subsistence level. In such circumstances, low income individuals will be in a situation with some kind of lower bound in their consumption set x^i (the subsistence level) like the one represented for the individual in our example in figure 2a.**) This means that the indifference curve of the individual will be replaced by a horizontal curve given by the limitations of his consumption set, and that the individual will consume a quantity of food x_N which has to be at least equal to the subsistence level quantity $\bar{x}_N$. This implies that also in this case the volume of insurance will be reduced.

A low level of awareness as well as living close to

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*) Another reason suggested for the failure to demand actuarially beneficial flood and earthquake insurance is so-called "cognitive dissonance" (see Akerlof and Dickens, 1982).

**) In figure 2a an extreme case of subsistence level conditions has been represented. In reality the lower bound of the consumption set will be somewhere in between point A and B which will reflect the fact that poverty is impeding the individual from choosing an optimal insurance volume, i.e., the one given by point A in this particular case.

the minimum subsistence level will lead the individuals to act as if they were extreme risk takers. In addition, if only a few people actually buy insurance and if there are increasing returns to scale in the insurance industry, premiums will be high and there will be an even lower volume of insurance. In an extreme case, the insurance market would disappear, thus drastically reducing the option even for those who are aware of disaster risks and live above the subsistence level, and consequently would insure under more favorable conditions. Thus, if there should be a natural disaster individuals would be without insurance coverage and could fall into complete poverty. This, then, is one of the factors causing a natural disaster to become a catastrophe in a real sense.

Summarizing the results, we conclude that:

- in general, the greater risk associated with living in disaster-prone areas implies that the individual's consumption possibilities will be reduced due to higher insurance premiums and hence a downward shift of the budget line, ceteris paribus.
- in LDCs, the low awareness of the risk of catastrophe and the fact that people in disaster-prone areas often are close to the minimum subsistence level will give rise to what may appear to be an extreme risk taking attitude. Furthermore, these factors will reduce demand for insurance which may increase insurance premiums and lead to lower insurance volumes than would otherwise have been the case.

4. Extensions of the Model

The insurance behavior of an individual can be taken to be influenced by his actual experience of disasters. This is of course a relevant distinction to make for a disaster-prone country. A simple way to analyze the

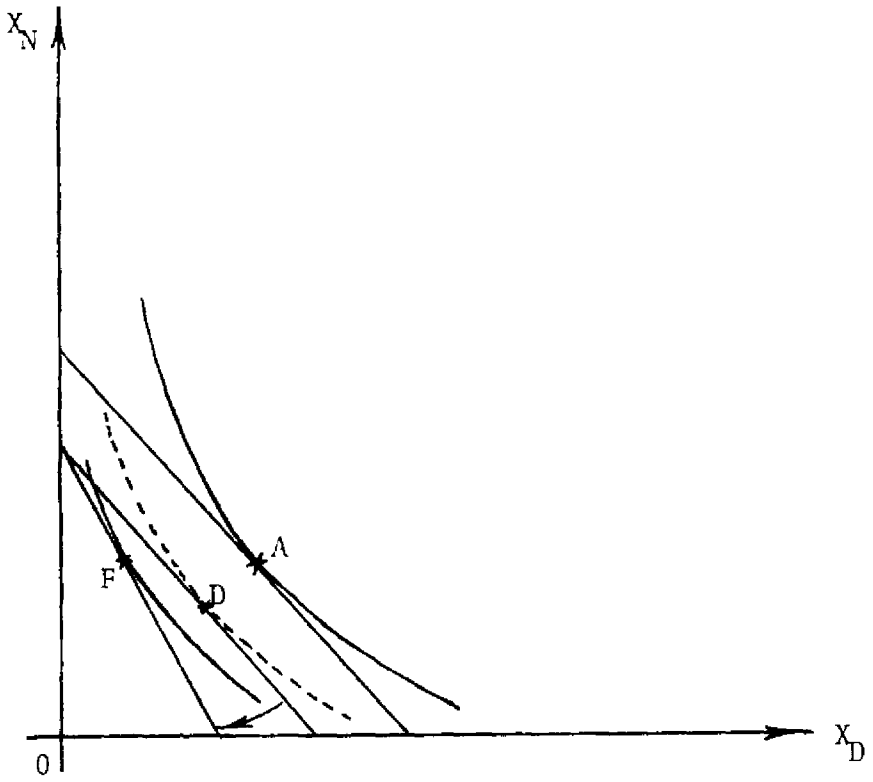
effects of a disaster on insurance behavior is to take the situation described in the preceding section as one where the individual is in a normal state and compare it with an alternative case where the individual is in a state of disaster and makes consumption plans for the immediate future.

Typically, there will be two differences between the two points of departure. First, given a recent disaster the individual will have a lower real income, i.e., a lower budget line than in figure 2. Secondly, his indifference curves may change as the result of his recent experience. We shall discuss these two aspects in turn.

Assuming that the occurrence of a natural disaster will reduce the real income levels of the typical individuals afflicted, we may analyze its implications as follows. In figure 3 the fall in real income will be seen as an inward shift of the budget line. If the individual is not trapped by a minimum subsistence level as mentioned in the preceding section the new optimal situation possible for the individual can be represented by point D. This change is assumed to imply a reduction in the quantities of both normal and insured consumption for the individual.

On the other hand, the reduced demand for insurance characterizing point D will tend to drive the insurance premium upwards. This may be so because of the properties of increasing returns to scale in the insurance industry indicated in the previous section. Such an effect will reinforce the tendencies of the demand for insurance to fall. This will weaken the institutional prerequisites for such contracts. In figure 3, the new position of the budget line shows that the individual will choose a new composition of consumption like the one given by point F.

Figure 3



However, the occurrence of a natural disaster with its devastating effects will inform individuals about the consequences of disasters and about how to behave in such cases in order to reduce the risk for undesirable effects in the future. In addition, people's ideas of the probability of the occurrence of natural disasters may be influenced.

Previously, it was indicated that the indifference curves in our model are not only a reflection of the individual's tastes in the usual sense and of his aversion to risk but also of his subjective idea of the possibilities of the occurrence of a natural disaster. Thus, the changes in attitudes mentioned above may change the shape of the indifference curve. The shift in the indifference curves would tend to lower the ratio of normal to insured consumption. This implies

that the changes in individual attitudes may - for a given real income - increase the demand for claims to insure consumption against future natural disasters. In that case, the tendency for insurance premiums to go up may also be counteracted.

In LDCs the possibilities for the counteracting effects just mentioned are, however, not confirmed by evidence. For instance, Themptander in his exposition concerning the case of earthquakes (p. 19, op.cit.) affirms: ".... For some time after a catastrophic quake the awareness is high but too soon it is fading again....". This means that the results indicated previously (reduced insurance activities each time a natural disaster occurs) would seem to be the most relevant effects to be considered. If so, the natural disaster will lead people (especially those suffering the burden of the catastrophe) to reduce their demand for insurance thus increasing the probability that a coming natural disaster will be a real catastrophe. Thus, this weakening of the insurance markets due to low levels of income for individuals in LDCs explains the limited relevance of this alternative of disaster preparedness.

5. Individual Saving as an Alternative to Insurance

In the analysis above it was shown that on the individual level one solution may be to purchase insurance which in the future will grant the individual access to a previously determined bundle of goods. A more common solution is to buy insurance which grants the individual access to a given sum of money or which covers the value of real assets destroyed by a misfortune. However, in LDCs, the institutional prerequisites for these types of comprehensive insurance do not appear to be satisfactorily developed, or they may be available to only a few people (see Themptander, op.cit.).

Even in more developed market economies insurance policies tend to have limited coverage. In particular, they do not always cover damage resulting from natural disasters, war, etc. In reference to earthquake insurance, it has been argued that "insurance can be only a secondary strategy at best in disaster mitigation". This may be so for the following reasons:

1) "the insurance industry writes cover for only a small fraction of the structures which represent a country's national wealth";

2) "the insurance in developing countries has not been particularly concerned with housing, and the value of insurance in mitigating the human disasters attendant upon earthquake is, at least for the present, lessened still further" (Driscoll, 1979, 1980).

In addition, we have pointed to various reasons why insurance premiums in LDCs tend to be prohibitively high. We should add that the well-known difficulties connected with assessing the probability of the occurrence of disasters is another factor impeding the development of domestic insurance markets. In these circumstances, an individual trying to reduce the costs of a catastrophe may be faced with the following alternatives:

- he may move to safer areas, or
- he may save a share of current income to be consumed or utilized when a catastrophe occurs.

As for the first alternative, it is hardly realistic to expect poor individuals in LDCs to move on their own initiative. What is more likely is that such a solution may work with the intervention of governmental authorities. A further discussion of this solution is left to later sections (see section 7c below).

In the second alternative, the individual attempting

to confront the risk of natural disasters by saving a share of his current income will choose one or a combination of the following two forms of saving. He will either choose to keep saving in money terms alone or he will invest his savings in some kind of goods the availability of which is expected to reduce the burden of a disaster.

In the model above it was assumed that the individual maximizes a utility function of the quantities of food he will consume in the states N and D, respectively, and of the probability he assigns to the occurrence of D (see expression 1, section 2). Now, we will assume that the individual maximizes a utility function of: 1) the quantity of food he consumes during the state N, x_N, 2) the amount of money, m, he saves to be able to support his purchasing capacity or consumption possibilities in the state D and 3) the probability he assigns to the occurrence of D.*) That is, the individual, instead of purchasing an insurance contract to assure his consumption during a state of disaster, chooses to bear the risk by himself by way of saving. In addition, assuming the individual has no other motive for saving that influences his decisions, the amount of current income saved is taken to be equal to the price of food he expects for the state D, p_D^e, times the amount of food he wants to consume in that state, x_D (see expression 10).

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*) This utility function for the individual may be written in the form:

(8) $U(x_N, m; \Pi)$

The individual will then maximize (8) subject to

(9) $m + p_N \cdot x_N = \bar{m}$,

where $\bar{m}$ stands for the amount of initial endowments in the possession of the individual at the beginning of the current period, p_N is the price of food in state N and where

(10) $m = p_D^e \cdot x_D$

(x_D is a function of the expected prices (p_D^e) given $\bar{m}$ and Π).

It is most likely that the individual will have to confront a situation where $p_D^e \neq p_D$. That is, cash savings of m units of money will not provide the individual with the means to purchase a known bundle of consumption goods in D and therefore, cash savings will be an uncertain device for protection.

This uncertainty may be decreased if the individual chooses to invest his savings. For example, prior to the disaster the individual might purchase the bundle of goods he wants in case there is a catastrophe, e.g., food, cattle, medicine etc. Or, for instance, he might invest in building a house which is more likely to withstand the impact of a natural disaster (e.g. of an earthquake).

However, neither of the two types of individual solution mentioned above appear to be extensively used in disaster-prone LDCs. First, this may be owing to lack of information about the real consequences of a disaster. Secondly, it is difficult in practice to invest in earthquake-proof housing since the appropriate technologies for the construction of this kind of housing may be difficult to master. Finally, as in the case of insurance, all these types of solutions mean that normal consumption must be sacrificed for uncertain disaster consumption. In LDCs, where normal incomes are very low and where income may have been further reduced by previous disasters, this sacrifice will rarely be possible.

It should be pointed out here that savings in kind may turn out to be inappropriate as protection and therefore not sustained in the long run. Here are two examples.

In Sahel, a stock of animals was traditionally used by individuals as a form of insurance against situations

of reduced food accessibility. During the drought in the Sahel, however, the stocks of animals traditionally held by people turned out to be insufficient as a means of insurance. The reasons were that the political divisions of the dry Sahel region put arbitrary constraints on pastoral movements, that new obligations were imposed by a change in the tax system (requiring payments in monetary terms) and that the depressed markets during the drought made very few employment opportunities available. This forced people to sell more animals than expected in order to buy a certain quantity of food (Sen, 1981, pp. 121-127).

A similar case of "insufficient" savings in kind can be found in connection with the Guatemalan earthquake (see chapter 2, section 5c). There it has been observed that food stocks were sold by people in order to buy other necessities after the earthquake. Since the food market was already depressed this kind of protection turned out to be very expensive.

It may be mentioned in passing that in both of these cases, foreign disaster relief seems to have reinforced the state of disaster by providing food (in the Guatemalan case) or discriminating against people holding animals (forcing "nomads" to sell more animals in the case of Sahel) and hence depressing food prices even further. Thus, disaster relief schemes designed on the basis of assumed commodity shortages without consideration of all relevant aspects of the disaster situation may turn out to be irrelevant and wasteful or even conducive to a deterioration of existing forms of disaster protection.

6. The Role of Government in Disaster Mitigation

The results obtained so far lead us to conclude that the possibilities for individuals in LDCs to take adequate measures on their own to reduce the consequences of natural disasters are very limited. In this section we shall list, very briefly, the possibilities a government has to increase disaster preparedness.

The major ways in which the government may increase disaster preparedness are:

- insurance subsidies
- direct support in cash to individuals when a disaster has occurred
- information about the real costs of disasters
- village relocation
- commodity stocks to be used in the event of a natural disaster and
- international aid agreements or international insurance at the governmental level.

a) Insurance subsidies. When individual insurance is available governments have in some cases, e.g. in the USA (see Kunreuther, 1973), offered to subsidize insurance premiums. In terms of our discussion of the institutional prerequisites for this kind of contract, such a measure may provide incentives to an increase in the volume of insurance and thus to an improvement of disaster preparedness.

However, in spite of subsidies directed to increase insurance protection, individual purchases of insurance appear to be negligible in practice. Kunreuther (p. 45, op.cit.) points out: "Although evidence suggests that people do not voluntarily purchase insurance even if it is subsidized, it is not currently known what factors are responsible for this behavior".

This, he adds, may be so "because of lack of information regarding its availability, lack of data on potential losses from future disaster, or a belief that free disaster relief will be available in the future as in the past." "Free" disaster relief refers to income support directed to compensate afflicted individuals for reductions in real incomes that the occurrence of a natural disaster have caused. In some cases, this type of relief will make the afflicted individuals better off, creating disincentives for insurance activities, i.e., reducing the effectiveness of insurance subsidies as a device for protection.

b) Spreading of information. In section 4 above, it was pointed out that the occurrence of a natural disaster will inform individuals about the existence and consequences of disasters. This may change the individuals' attitudes to the risk for as well as the consequences of natural disasters. So might providing people with information in a less drastic way.

In more developed countries where the transmission of information is easier, this solution may be effective. But in LDCs, information to poor and perhaps illiterate people living in risk zones can often be absorbed only to a limited degree. Thus, the effective spreading of information and individual actions to prevent future damages will be less likely. Furthermore, even if the spreading of information were possible, the low income level in LDCs would continue to be a constraint on measures at the individual level. If so, governmental intervention or disaster relief efforts would be required.

c) Planning for village relocation. Moving people away from risky areas will not only reduce the individual's burden from the occurrence of a natural disaster but that for the rest of the society as well. However, the

cost of moving people away from the risk zones has to be considered. First, they may lose by being moved from a productive region such as fertile land in a volcanic area. Moreover, the price of land may be lower in risk zones than in safer areas. Migration may involve substantial costs over and above material costs. If, in addition, the safer areas are already occupied by others we have to consider their losses or the effective political obstacle for immigration that this may imply.

d) Precautionary stores and international agreements. When analyzing real saving as an individual solution (see section 5 above) we were able to conclude that this type of solution is likely to be prohibitively expensive for individuals in LDCs. The two specific factors behind this conclusion are information difficulties and minimum subsistence level conditions. These two factors, however, may not be obstacles at the community or national level. Actually, some efforts in this direction have already been made by various disaster relief organizations. To help such efforts, the UN has established a list of food and health requirements relevant for different disaster-prone LDCs (see "Guide to Food and Health Relief Operations for Disasters", UN, 1977).

One example at the national level in Guatemala is the creation of the National Reconstruction Committee (CRN) after the earthquake of February 1976. In addition to its reconstruction tasks, this organization also has the task of preventing the same kind of devastating effects of a future natural disaster in that country. Since this type of solution appears to be one of the few remaining realistic alternatives in disaster mitigation in LDCs, it needs to be developed by the governments of the disaster-prone countries. However, retaining the risk of losses from catastrophes in the

exposed country itself by precautionary stores and internal income transfers will imply costs that may be difficult for an LDC to bear. This leads us to conclude that for this solution to work it may have to be combined with international insurance or agreements for the delivery of what the disaster-stricken country can not provide on its own.

7. Concluding Remarks

The analysis in this chapter has helped us to identify the main causes and implications of the non-existence of a disaster preparedness environment in many LDCs. We have seen that, in principle, there are three different ways for the society to meet this sort of risk. Two of them rest on individual actions, the third on governmental intervention or disaster relief efforts. At the individual level, one solution was to purchase insurance which assures the individual access to a given sum of money or bundle of goods in the future. However, we have seen that in LDCs the institutional prerequisites for such insurance policies often do not exist, or if they do, the policies are of limited coverage or too expensive to be bought by all those who need this kind of protection. Therefore this kind of individual solution may have limited relevance.

We have also seen that, although the experience of a disaster may be fresh on their minds, people do not increase their purchases of insurance against future catastrophes. This may in part be a consequence of the income reductions that natural disasters cause, reducing the demand for insurance and weakening the institutional prerequisites for a viable insurance market. Another reason may be the feeling that "free disaster relief will be obtained in the future as in the past", leading people to keep their purchases of insurance at a low level. But again the factor lying behind such

attitudes could be the low levels of income. The subsistence level conditions of individuals in those countries may, in other words, act as a kind of "income trap". Thus, the institutional prerequisites for insurance activities can hardly be improved by demand incentives and even strong governmental support to this end may not be effective.

On the basis of these results we may conclude that if insurance is to be used to improve disaster preparedness in LDCs, alternative forms have to be tried out. This could be some form of national or international insurance or other agreements among governments whereby the risks will be distributed among all members of the society or a group of nations.

A second solution at the individual level analyzed was that of saving a share of current income in money or real terms. But, again analysis showed that these forms of individual solutions may have a very limited relevance. Also, cash savings may fail to be an effective instrument due to the uncertainty of the prices and availability of commodities in a state of natural disaster.

Real saving could be an effective alternative in the sense that the individual invests in a bundle of goods necessary during disaster conditions or that he invests in building houses more likely to withstand the impact of a natural disaster. But the lack of information and the non-existence of appropriate construction techniques in LDCs may reduce the practical relevance of this solution. In addition, the costs of this type of solution for individuals will not always be easy to bear in LDCs. Hence, again more direct intervention from government or disaster relief organizations would be required.

The capacity of a government in a poor country to take

effective and expensive measures of disaster prevention and protection is very limited, of course. Hence, international assistance in one form or another may be the only significant instrument for improving the conditions in disaster-prone LDCs. And given that the institutions for international disaster relief already exist, this particular kind of assistance may continue to be the most important one.