# *Chapter 2*

# *Corner Solutions and Market Shortages*

A study of consumption behaviour under widespread rationing can best be started with an analysis of the particular type of influence rationing exerts on expenditure decisions. A major issue is the extent to which behaviour directed at fulfilling desired consumption can avoid the hurdle that quantity rationing puts in its way. If rationing forces consumption to be at the fixed level determined by the state, then analysis of consumption demand would require a quantity constrained conditional demand function. If, on the other hand, free market purchases are common despite rationing, enabling those who can afford to bridge their desired consumption gap, this will undermine the influence of ration constraints on expenditure since they will no longer be binding, and an unconditional function will be a more relevant tool of analysing household consumption behaviour.

Section 2.1 deals with the theoretical issue of the prevalence of corner solutions under rationing. I present evidence in section 2.2 to support the conclusion that rationing was, by and large, not binding on Iranian consumers during 1984-85, and examine market purchases for evidence of free market excess demand, especially among the rich. In section 2.3 I propose two measures of market shortages based on prices and frequency of purchase. Section 2.4 deals with the construction of price and frequency-based shortage indicators and examines their distribution. Finally, section 2.5 discusses how a parametric method of estimation of shortages by the price gap indicator can be developed.

## 2.1 Corner Solutions

### 2.1.1 Corner Solutions in Relation to the Rich and the Poor.

It may be thought that corner solutions are a common outcome of consumption under the conditions of war-time rationing. However, there are two important cases where the restriction will not be binding : when less than the restricted level is voluntarily chosen; and, more importantly, when higher levels can be achieved at higher free market prices. When ration levels are not binding, the former approximately describes the behaviour of the poor and the latter approximates that of the rich.

Fig. 2.1 shows various possible outcomes for the poor consumer. The commodity 'Food' is rationed and available to all at quantities $q_1$ at the fixed price of $p_0$ up to a maximum amount $\bar{q}_1$ beyond which it can only be bought at free market prices higher than $p_0$ , such as $p_1$ ,see also Deaton (1984) and (1986) for consumption at dual prices for the single consumer case. 'Non-food', representing all other commodities, is freely available at market prices $p_2$ in quantities $q_2$ .If the ration quota is full taken up, his indifference curve $u_0$ would go through A reflecting a corner solution. This case would be represented by a budget line, which would result in a conditional demand function and can be written in a general form as

(2.a) $z = p_0 q_1 + p_2 q_2 \; ; \; q_1 \leq \bar{q}_1$ where z is total expenditure (or income) of the poor.

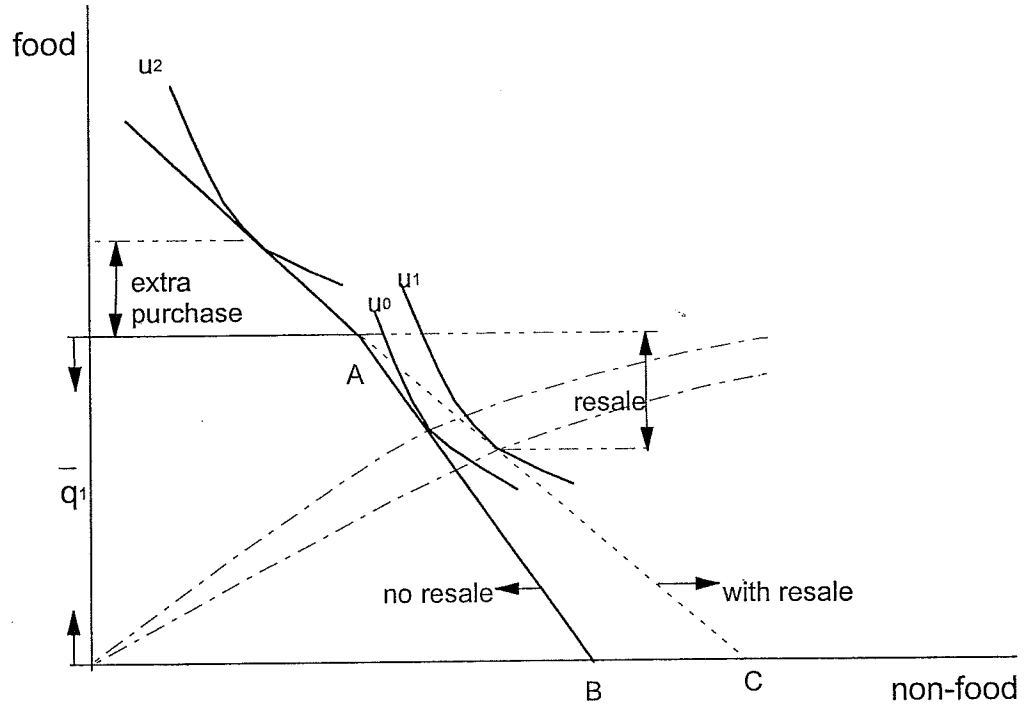


**Fig. 2.1-corner solution and behaviour of the poor**

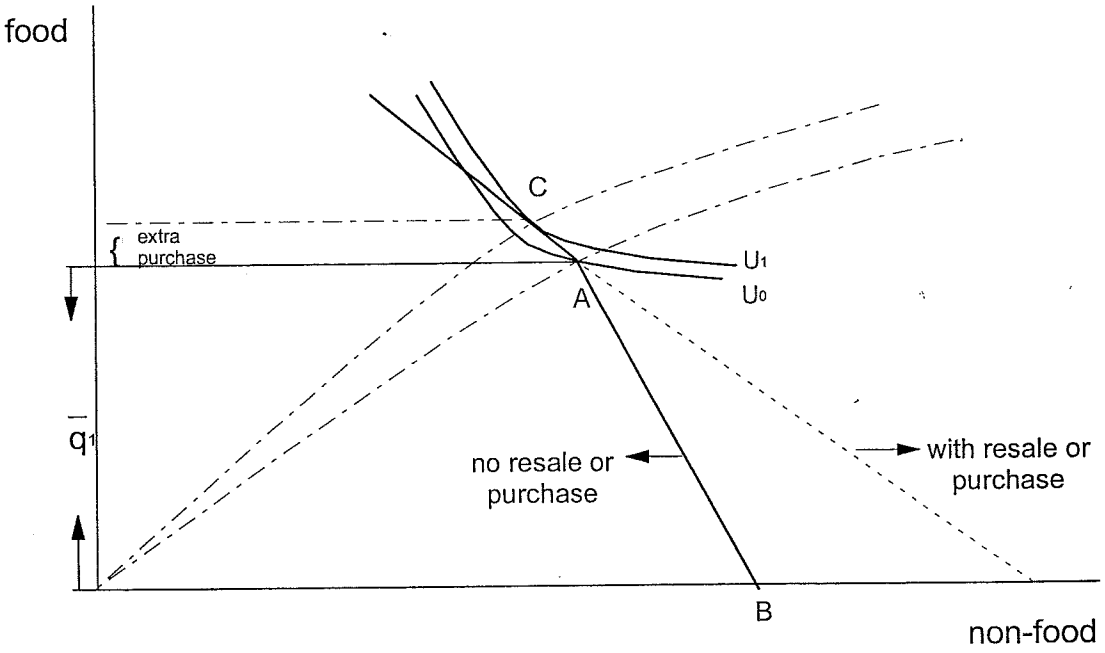


**Fig. 2.2-corner solution and behaviour of the rich**

Since the rationed good is not free, a more common position is for $u_0$ to be tangent to his budget line BA somewhere below A ,with $q_1 < \bar{q}_1$ , indicating partial rather than full take-up of the rationed quota $\bar{q}_1$ .

However, if the resale of rationed goods is legal or even semi-legal, then a 'parallel' market for the sale of the rationed good will develop. But even if resale were to be made illegal, it cannot be seriously enforced since barter among households cannot be prevented. Thus, there will always be at least some scope for resale. With resale possible, the unused ration $(\bar{q}_1 - q_1)$ will be offered for sale at the new relative price given by the slope of CA, and the poor moves onto a higher indifference curve $u_1$ . When there is some market purchase because the ration is too small , then the ration constraint cannot be binding on the poor, and a corner solution will be absent from his consumption choice with or without resale, that is, the point of tangency of the indifference curve $u_2$ with CA being above rather than below A. In this case too the ration constraint is superseded. Thus corner solutions will be irrelevant to consumption choice of the poor represented by all the three points of tangency of $u_0$ , $u_1$ ; $u_2$ .

When the ration constraint is not binding on the poor, then the relevant type of demand

function to employ would be an unconditional one which assumes the absence of a corner solution. The budget constraint for such a demand function can, in general terms, be written as

$$(2.b) \qquad z = p_0\bar{q}_1 + p_1(q_1 - \bar{q}_1) + p_2 q_2 \quad \text{or} \quad z + (p_1 - p_0)\bar{q}_1 = p_1 q_1 + p_2 q_2 \ .$$

Unlike (2.a), under (2.b) the definition of income is inclusive of ration subsidy.

The rich, shown in Fig. 2.2, are far more likely to have full ration take-up , and when resale is not allowed, this full take-up will result in the ration being binding; the indifference curve $u_0$ will pass through A. As with the poor, with no market purchase of food, the budget constraint for the conditional demand function of the rich can be written in general terms as (2.a) above.

With resale allowed, the rich can purchase an additional quantity of the rationed good to bridge his excess demand for food at a higher free market price $p_1 > p_0$ , allowing him to move onto a higher indifference curve $u_1$ . However, it would be rather extreme to assume that the only source of market consumption of the rationed good for the rich is the sale of the unused ration quota of the poor, if the main supply of a commodity comes from outside the coupon system. If the poor were to be at the tangency point of $u_2$ in Fig. 2.1, market purchase of food from resale by the poor is ruled out[13]. With positive market consumption, the relevant budget line

[13]- An additional, and potentially more important, reason for not assuming resale to be the sole source of market purchase of the rich is that even when purchase from this source is available, the rich in search of quality may forgo part of their own ration quota, and avoid market purchase from the pool

would be (2.b) again.

### 2.1.2 Evidence on Corner Solutions

The Iranian system of war rationing broadly tolerated the free market for resale of coupons , although this had never been officially acknowledged. Though the market for trading in coupons has some features in common with a black market, it would be seriously misleading to describe it as one, since coupon market prices are unaffected by information or risk costs due to illegality[14],and driven almost purely by the extent of shortages. This market was less active during 1984-85 compared to subsequent years, but it was lively even then. The importance of corner solutions cannot be assessed without considering the evidence on coupon resale. Table 2.1 presents annual per capita rationed averages for some key food commodities[15], commonly obtained by coupon, in order to find out how prevalent corner solutions are. Since my main interest is in comparison of the changing rationed quantity averages of the poor and the rich, I define these averages separately for each total expenditure quintile, all values in table 2.1 are relative to those for the third quintile in Tehran.

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of unused rations altogether, because they consider the rationed good to be of poor quality. As we shall see, at the top of the distribution market, purchase from non-resale sources is very important.

[14]-Such costs might be thought to be a major component of the Iranian foreign currency black market rates, see Pesaran (1992).Dealing on this market is illegal in Iran and ,especially in recent years, carries severe punishment, but the risk applies to buyers and sellers alike. However, one would expect black market prices to rise if the risk is borne by the buyers, and to fall if borne by the sellers, Boulding (1948), and DasGupta (1965). Presumably price effects from each party cancel out, leaving a price shortage gap relatively free from costs of illegality.

[15]-As discussed in Chapter 1, and shown in table 1.1, there are also non-food rationed goods, but food commodities constitute the main rationed goods most of which are distributed in per capita terms. The most important rationed good distributed on a per household basis are the cigarettes, excluded from table 2.1 due to difficulty of interpreting the changes in its rationed quantity averages, see note 4 below.

Attention must be drawn to a feature of the rationing system in Iran crucial to the interpretation of changing quantity averages in table 2.1. All goods listed have their own commodity-specific coupon 'currency' and resale of coupon goods is, in fact, in terms of purchase of these coupon currencies on the parallel market, not the goods themselves. For the poor, the interpretation of reported purchases as exclusive of resold rationed coupons seems to be straightforward, that is, the poor just report portions of rationed goods they have paid for according to the amount of coupons they hand over. For the rich, however, the additional ration purchases from the poor can appear as fix-price purchases if so reported. Since the 1984-85 CBIHBS does not ask questions on coupon resale or purchase, there is no legal compulsion for the rich to report extra ration purchases as fix-price ones when they must have been obtained at near free market prices. There are two issues here. If fix-price purchases are repriced at their free market rate, then the required adjustment to the income of the rich is fully taken into account whether or not the rich report extra ration purchases as fix-price type. The rational for this will be discussed in chapter 4. As to the interpretation here of quantity averages for the rich in relation to corner solutions , since resale data is unavailable, there is no way of verifying the validity of the assumption that the extra coupon purchases of the rich are reported as the fix-price type, other than observing that this would be consistent with the pattern in table 2.1 of lower coupon quantities for the poor compared to the rich. Moreover, though such a reading of table 2.1 is based on trade in coupons rather than goods, direct barter cannot be ruled out. But its scope must be negligible, otherwise it would be hard to explain the presence of an active market trade in coupons [16]. However, with flat distribution of per capita rations, inferences regarding prevalence

[16]-Direct barter is important for fix-price goods that do not have coupon currencies. There are few items obtained by identity cards for which no coupons are issued and resale is normally in terms of goods rather than their coupons. The quantity averages for this group would be difficult to interpret in the way suggested above, and are therefore excluded from table 2.1. Of the rationed food commodities, only milk falls into this group. The most important non-food omission from this group are cigarettes. Cigarette resale is mainly from smokers to non-smokers rather than from the poor to the rich. Moreover, as

of corner solutions would require the examination of ration quantities in combination with free market averages, for example, to find out if the poor have full ration take-up plus some market purchase. These free market quantity averages are also reported to facilitate interpretation.

The rise of quantity averages with income, at least up to the fourth expenditure quintile, is the dominant pattern in table 2.1 [17]. Note that with resale allowed, it is more plausible to regard the often lowest first quintile averages as indicating that the very poor sell more of their quotas than other less well-off quintiles, rather than as evidence of partial take-up due to poverty. On the whole, the dominant pattern appears to suggest a general absence of corner solutions. However, there are two exceptions, with approximately flat distributions, namely sugar and, except in small cities, rice. Free market averages for these two rationed goods will be examined in table 2.2.

There is one other common feature of table 2.1 worth noting as it is indicative of partial ration take-up by the rich due to poor quality: an increase up to the fourth quintile, followed by a fall for the fifth quintile. This reflects the fact that the richest are least dependent on the coupon system and can afford to go directly to the market for the bulk of their consumption, suggesting that the source of this market consumption is not likely to be the resold coupon goods, but rather the better quality non-resale market supply of similar goods[18].

Table 2.2 provides additional support for the minor role of corner solutions for goods

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cigarette rations are obtained by identity cards, the suggested interpretation would be even less appropriate in this case.

[17]-Beef, of the imported frozen type, was the main type of rationed meat distributed in Tehran, while in large and in small cities it was fresh lamb, which is relatively more expensive. Had we taken the same type of meat in all city groups, there would have been too many missing values, which explains why (MEAT) averages in Tehran are larger.

[18]-Thus in arguing in favour of the general absence of corner solutions, the emphasis should really be put on market consumption satisfying excess demand of the rich, the source of which may or may not be the resale of rationed goods.

listed in table 2.1. Some missing observations for quintile **market** averages are to be expected. With one exception for the base value of (SUGR), all missing values have been retained since their pattern is relevant to the assessment of market purchases, and their presence does not alter much the pattern of positive quantity averages in table 2.2. In addition to the market consumption of the type of rice available on coupon (RICE), domestically produced quality rice (QRICE), never available by coupon, has been added to table 2.2 to allow comparison of the two close rice substitutes.

First, free market quantity averages for sugar display a clear pattern of increase with income; therefore, the evidence would appear to rule out the corner solution interpretation for this good. Free market rice averages, for the imported variety (RICE), however, decline in Tehran for the top two quintiles, even though their rise with income is quite drastic in large and small cities. That this decline is, very probably, due to poor quality rather than the prevalence of corner solutions is supported by free market averages for quality rice (QRICE), which rise with income throughout the country, particularly for the fifth quintile[19].

Note that, of the seven instances of missing values, five are accounted for by the bottom two quintiles, suggesting greater abstention from market-price consumption among the poor than the rich, a point taken up in some detail in table 2.4 below. Note also the clear pattern of increasing quantity averages for all goods in all city groups, the only exceptions being in Tehran for imported rice. More specifically, there is not a single instance, apart from the above exception, of a fall in the average values for the 5th quintile. On the contrary, in many instances the increase is pronounced and consistent with a corresponding fall in table 2.1. Moreover, while evidence of flat distributions for 'SUGL' in all city groups, and for 'RICE' in large cities, given

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[19]-Compared to the export variety, this type of rice is a relative luxury which has never been available through the coupon system. Though among the most frequently purchased goods, it is mainly consumed by the rich.

in table 2.1 may be interpreted as binding rations and the general prevalence of corner solutions, the same evidence, when taken together with table 2.2 for market quantities, would seem to suggest a different story ; even the poor have **some** market consumption of these two goods, making a corner solution a misleading guide to the consumption choice of the poor in these cases.

Finally, in order to throw some light on the barter aspect of resale, table 2.3 examines milk 'coupon' quantities. This is one of the few goods obtained by identity card, and thus resale has to be in terms of the good itself since no coupon is issued for this commodity[20]. Rationed milk consumption shows an increasing pattern with rising income (3rd col). Market averages are in **per capita** terms, their average value over the entire sample is in fact very small, indicating a commodity in great shortage. The main source of the market supply of milk during 1984-85 was probably resale by the poor. The evidence of greater consumption for the fifth expenditure quintile suggests **some** role for resale. Taken together, the three above tables point to the relative absence of corner solutions[21].

The preceding suggests that the poor are far more likely to abstain from market consumption. Further evidence for this hypothesis comes from the examination of data on non-purchase. However, the sample reported non-purchase can also be a result of measurement error

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[20]-Milk distribution is restricted to those households with children under 2 of adults over 60 years of age. The reported averages for milk are thus defined over total of these two age groups, excluding families with no members in these age categories. It should be borne in mind that since probably much of the excess consumption through resale are by households with no member in these age groups, averages in table 2.3 underestimate the scope for resale. Since 'coupon' milk had limited distribution outside Tehran, they are reported for Tehran only.

[21]-The public sector employees with access to additional consumption of goods on the coupon list through work co-operatives, discussed in section 1.3.2, are mostly to be found in the higher quintiles, suggesting their exclusion would be a check on the above pattern. First, the fifth quintile contained the largest number of this group, and yet table 2.1 indicates a general fall in its quintile averages. The exclusion is more likely to distort the pattern than correct it because there is no means of identifying those from lower quintiles with similar access to additional purchase. In this regard, note the reference to consumption 'in access of the household's quota' in the survey's definition of a fix-price purchase, (see p. 16). This is an allusion to the privileges of families more directly involved in the war effort, mostly from low income groups and not codified in any distinct manner.

in the data arising from sample recall periods significantly shorter for some goods than their cycle of purchase, which can be made less likely with annual averages. For the current survey, the adopted food group recall periods are one month for some categories, such as oil, and two-day for others , such as milk. The sample values for goods in the latter category will undoubtedly be contaminated by measurement error, since with a longer recall period, many false zeroes would be replaced by positive purchases. The question is which is the dominant influence on market purchases, genuine non-purchase or measurement error. Zero expenditures for market purchases are informative in this regard.

Table 2.4 shows the number of zeroes out of fifty-five (eleven months by five quintiles) for the most frequently purchased goods . Food items selected are based on those purchased by at least 10% of the sample households, regardless of whether the mode of purchase has been fix-price or market price, to ensure the inclusion of key coupon and non-coupon goods. Zeroes have been "aggregated" to quintile levels without the monthly dimension of the observations in order to show more clearly that the pattern of zero market purchases are income-related and unlikely to be, in the main, the result of measurement error. Since measurement error affects the observations on the rich and poor alike, the 2-day recall period group (top part of table 2.4) should display a more random pattern of zeroes compared to the bottom part of the table.

The general pattern evident in the table is different from the above. It indicates that positive purchase ('none' means no zero) are mainly accounted for by the rich, and zeroes mainly by the poor. Not only is this the case in the bottom part, but also in the top part. Among the six items of the two-day group, there are very few missing observations for the rich and no case where the number of zeroes is greater for the rich than it is for the poor; the only exception being onions in Tehran (four zeroes for the poor as against five for the rich). Taking the non-coupon group first, note that fresh mixed herbs('f. herb'), an important item in the Iranian diet, and the

only good of this table with no zero observation, is not, as one would expect, from the one-month, but from the two-day group. Exactly an identical type of distribution of zeroes characterizes the one-month non-coupon group in the lower part of table 2.4 ; whenever one encounters a zero value, with only a single exception, the number is always greater for the poor than it is for the rich. This pattern of zeroes concentrated on the bottom income groups, regardless of the length of the survey recall period, is not what one would expect if zeroes were arising from measurement error, but it is consistent with the non-purchase interpretation.

The same pattern, more or less, applies to the coupon group, though here the number of zeroes are typically larger since most consumption is satisfied through fix-price purchase. Looking at the three items for the two-day part of table 2.4, this is reasonably clear for meat and quality cigarettes, but the pattern is reversed for cheap cigarettes where the rich have a higher or approximately equal number of zeroes compared to the poor, suggesting shortages are quality related.

For the one-month coupon group, the two types of sugar show more zeroes for the rich in Tehran and large cities, but the number of zeroes in these cases is too many to allow a clear picture. However, zeroes for oil and rice are mostly accounted for by the poor, for instance, for domestically produced rice, we have eleven out of fourteen zeroes in Tehran, seven out of eight in large cities, and four out of five in small cities. Further support on the relative absence of corner solutions obtained from changes in monthly average quintiles and from frequency distribution of fix-price and market purchases are examined in Appendix A2.1. Hence the assumption that zero observations on **market** purchases must be genuine non-purchase is approximately valid for the above nine items.

It must be warned that this evidence is not meant to underestimate the importance of the question of measurement error. There is every evidence that coupon purchases recorded with a

two-day recall period contains very substantial degree of error. We must deal with this problem effectively. The point is, in analysing free market behaviour, shortages are the main influence on observed data in the sense that without capturing its influence on behaviour, no statistical remedy for measurement error is likely, on its own, to produce sensible results.

To sum up, food consumption of the poor is mostly confined to those obtainable by coupon; their market consumption could be regarded as negligible. Only the non-poor can be said to have significant market purchases.

The preceding suggests that the rich are more likely to be affected by market shortages. To examine whether this is so, two issues have to be dealt with. First is how to measure shortage. Once this is decided, then a second issue is whether the behaviour of measured shortage estimates are consistent with the pattern of market purchases of the poor and the rich as documented above. The next two sections take up in turn each of these issues.

## 2.2 Measurement of Shortage by Price Gap and by Frequency of Purchase

The aim of this section is to suggest measures of shortage applicable in the absence of corner solutions in consumption. I shall also propose a hypothesis on price behaviour to which one of the measures can be applied. The question of whether the application results confirms the hypothesis will then be examined in Section 2.3. My main proposed measure of shortage is based on the assumption of flexible market prices and one way of introducing the indicator is to point out that the most important alternative, based on the notion of the 'virtual' price first suggested by Rothbarth (1941), lacks some basic features necessary to the measurement of shortage in the **absence** of corner solutions in consumption. A virtual price vector for a group of rationed goods is that which, if it prevailed, would induce a consumer to choose voluntarily **exactly** the same

quantities as would be consumed under rationing. Virtual prices are hypothetical shadow prices reflecting consumer preferences, and applicable when ration levels are precisely are chosen, either actually or, more often, by assumption[22]. The concept is useful for hypothetical welfare comparison when, by assumption, a fixed level is chosen in two different price positions. Its relevance to non-hypothetical consumption behaviour depends crucially on the extent to which the ration levels are chosen. However, in an influential modern re-statement by Neary and Roberts (1980), the approach was applied to actual behaviour in markets in disequilibrium, covering both consumption goods and labour[23]. Its application would appear to less objectionable with regard to the consumption of public goods. When there is a private market for a rationed good, and ration levels are not binding because consumers may go to the market for part, or all, of their consumption, then the approach loses much of its relevance. Note that even with no private market for a rationed, or public, good the behaviour of those voluntarily choosing to consume less than the ration level will pose a challenge to the validity of the fundamental assumption in this approach.

In this approach, shortages and the presence of corner solutions are intimately linked in that the former is defined relative to the latter Putny (1989). Moreover, estimation of shortages by the virtual price method is very complicated, requiring a good deal of assumptions and such as the functional form employed being invertible in virtual prices, and estimation of a 'matched' pair of conditional and ordinary demand functions, see esp. Deaton (1981a), also Charezma (1990).

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[22]-A similar approach to the measurement, under rationing, of an income equivalence of a move from one indifference curve to another, was also suggested by Kaldor (1941) for the special case of one rationed good only.

[23]-In one of the earliest attempts to measure disequilibrium by virtual prices, Deaton (1981a) assumed that **all** consumers in the housing market are rationed in the short run. This may perhaps not be unreasonable for housing, but the point is that one has to rely on such an assumption in order to apply the method.

The alternative proposed in this chapter employs observable prices, that is, uniform prices at which all consumers as price-takers would participate in market consumption, provided goods are sufficiently homogenous. It is simple, both in its informational requirement and in application. It is based on the simple idea that when the price of a rationed commodity is fixed then the extent of a unique market price consumers pay over and above this fixed base price tends to be greater the larger the shortage for the good in question, and hence the gap measures the **degree of shortage** on that market. In each micro market, the distance of each flexible market price from its corresponding fixed value is **a measure of unsatisfied demand at the official, fixed prices.** This notion is implicit in both Figures 2.1 and 2.2. The intersections of the budget lines (rotating around A from AB to AC) with the non-food axis define two sets of relative prices, or the exchange rate, of non-food and food . Taking the non-food as the numeraire good with $p_2$ as unit price, $(p_1 - p_0)$ measures the degree of shortage in the food market. I prefer to use the term shortage for this measure because excess demand is determined with reference to supply, whereas the point of my proposed measure is that it only requires information from the demand side, contained in a budget survey[24]. Moreover, the emphasis should be on the distance between a pair of fixed/flexible prices whether or not accompanied by a fix- quantity ration. It is applicable when fix-price consumption consists of a uniform ration universally distributed to all, and the rest of the supply distributed by the market to those willing and able to pay the necessary price. When price is fixed but not quantity, one alternative is to distribute supply purely through a non-price mechanism, usually by queueing. Consumers pay a margin over the fixed price by their willingness to wait, and this can be approximately measured by

[24]-The basic indices of shortage presented in this work presuppose the availability of price and frequency of purchase information that are distinguished by the mode of purchase as free market or fix-price types.

wage rates, thus a giving a pair of fix and variable prices for the good. The other is to distribute it through a combination of the queue and market allocations, allowing payment by time as well as by money, in various combinations. In this case too, there are a pair of prices to measure the degree of shortage for the good, see Nichols, Smolensky and Tidemane (1971).

Note that such market prices reflect equilibrium in the sense of leading to a set of micro, free market purchases and sales consistent with each other, but they are **not** market clearing prices in the sense of reflecting equality of micro market supplies and demands. Furthermore, the same basic index can be applied to cases where the market price of a commodity may be below its corresponding ration price; the price gap here is a measure of slack.

The idea of fix-price/market-price gap as shortage indicator presented itself in the process of a search for variables that can effectively account for market consumption behaviour of Iranian households under rationing . Subsequent search in the literature revealed a surprising absence of this simple idea with the exception of a brief informal application by Holzman (1960) to determine the extent of 'excess demand' by the gap between the controlled prices offered by the state and the market prices offered by peasant co-operatives in the former Soviet Union[25]. This exception apart, when occasionally the price gap concept is employed it is usually to measure the distance from some hypothetical equilibrium position using hypothetical or 'virtual' prices, presupposing the prevalence of corner solution in consumption[26]. However, if we are concerned with an explanation of household behaviour under market disequilibrium and the binding ration levels are frequently violated, then it is not at all clear why hypothetical market prices provide a better explanation of behaviour than actual market prices on which consumers base their decisions . Whether they do depends on rations being, not hypothetically chosen but, actually

[25]-See also Appendix A2.2.

[26]-In modern disequilibrium analysis the fix-price/market-price gap plays a more prominent role in the literature on parallel markets , see Devarajan, Jones and Roemer (1998) , or Nguyen and Whalley (1986).

binding[27].

The second type of shortage index employed is based on a ratio frequency of market purchases to the total purchases of market and fix-price purchases. To see how this measures shortage, assume a rationed commodity is distributed to all consumers and all rationed goods are fully purchased, then, if rationing satisfies demand sufficiently, we would not expect much shortage, hence market purchase would be limited and the value of the ratio will be close to zero. At the other extreme, with small quantities of rationed goods there will be a great deal of purchase through free market to bridge the shortage gap over and above the ration base. With ration frequency very small in comparison with market frequency, the ratio will be close to one. Thus the absolute frequency ratio of shortage for a commodity will vary from zero for no shortage to one for intense shortage with values in between these extremes indicating degrees of shortage intensity for the commodity providing that there is a ration base from which to make the comparison [28]. As mentioned earlier, comparisons of changes in shortage requires expressing them relative to a fixed base if it is relative shortage which is of interest, that is when comparing shortages for the poor and the rich. In the present context, the base can be the middle expenditure quintile in comparing the poor and the rich, or a base month for changing monthly shortages, or a combination of both.

The microeconomic handling of aggregate shortage has been a refinement of the macroeconomic formulation of it, and it is best to start with the latter. We may begin by asking

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[27]-Even the distances from market prices prevailing in other market economies, as a sort of equivalent to virtual prices, have been employed to measure non-hypothetical disequilibria, Podkaminer (1982). It would not be totally out of place to question the relevance of such 'disequilibrium' estimates to an explanation of behaviour since households obviously do not make their expenditure decisions by basing them on such prices.

[28]- I am not aware of any measure of disequilibrium or shortage based on frequency of purchase. The idea suggested itself from the literature on the measurement of poverty, see Desai and Shah (1988).Their suggestion for defining a deprivation index linearly as the ratio of frequency of 'event' for an individual to its mode for the entire community has some affinity with the idea of a non-price, frequency index of shortage presented here.

what determines the shortfall in demand under formal or informal rationing. In a seminal paper Clower (1965) argued that observed exchanges are equal to the short-side of the market. This aggregate "min. condition" has been employed to separate time series observations into periods of excess demand and those of excess supply depending on Q= Min.(D;S).

However, if we have shortage of a good at the micro level, not everyone with an unfulfilled demand would opt out of the market; some would decide to substitute for it some other product available which they would not have **voluntarily** chosen[29] . An important consequence of this diversion of unfulfilled demand from a shortage market into another adjacent market is that if the new market cannot absorb the entire volume of this additional demand, it too develops into a shortage micro market[30]. This would make it hard to separate the observed aggregate data into its voluntary and forced components[31].

The concept of involuntary or 'forced substitution' is directly relevant to the price notion of shortage provided its context is clearly understood. At the macroeconomic level, the presence of shortages affect consumption through forced spending and forced saving. Theses macro effects of shortage have to be distinguished from its partial, microeconomic effects. Forced substitution is relevant to a micro context within a given broad category of goods. The emphasis on a broad group as a point of reference is important. In a war economy, as Olson (1963) pointed out, shortages induce all sorts of long-run substitution possibilities. It makes sense to define shortages in terms of distinct needs, satisfied by broad groups of goods, rather than specific commodities,

[29]-The aggregate min. condition ignores this type of micro spill-over, though not the macro type, for instance excess supply of labour appearing in the consumption demand function.

[30]Kornai (1980) has developed an interesting line of argument from this, namely that it is possible for shortages and expenditure to increase together, if the former spreads from market to market. Thus use of consumer saving as a measure of unfulfilled demand may well be a poor indicator of disequilibrium if shortages are persistent.

[31]-Thus Kornai (1980) concluded from this that "aggregate excess demand is not an operational concept"; partial shortage indices should be employed instead. See, however, Portes (1989).

for instance, by shortage of flour rather than of bread or cake[32]. This is the context in which I apply the notion of forced substitution. For example, food defines a closed group because no commodity outside the group can substitute for food shortage. Within the food group, there will be derivative shortages inducing forced substitution among narrow food items.

Each derivative commodity shortage, besides being a measure of shortage for its own micro market, is likely to be interrelated to shortages of other commodities, therefore an aggregate shortage indicator must also take into account all the interacting effects. At the micro level Kopitany et al (1989) suggested the use of market research data, containing consumer order of preference for a range of commodities as well as actual purchases recorded side by side. Unfortunately, such information is not available in a household budget survey[33]. However, aggregate budget shares of shortage goods can provide a simple alternative of expressing such spill-over effects and will be employed below.

In many ways the issues of micro market interdependence and the effects of forced substitution on consumption are quite central to the working of a shortage economy. What is needed is an aggregate shortage indicator dealing effectively with forced substitution. By far the most promising approach for this purpose is "smoothing by aggregation", Muellbauer (1978)[34]. To see how this approach can provide the basis, in a micro context, for the aggregation of the

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[32]-Similarly, Kornai (1976) argues that direct shortage is only applicable to a "closed need", defining a broad group whose price elasticity of demand , in aggregate, is zero or small when in shortage. Forced substitution occurs when, within the closed group, the internal structures of supply and demand leads to purchases different from the original demands. A somewhat similar notion is ,Lancaster (1966), 'intrinsic' commodity group defined on a shared characteristic.

[33]-Another alternative for measuring forced substitution effect is the employment of principal component analysis, see Kornai (1982), also Phlips (1983).

[34]-Smoothing by aggregation was first applied in a micro market rationing context by Malmquist (1948), but subsequent applications of it have been in macro contexts. Although it was originally discussed in relation to the Phillips curve by Hansen (1970), as an alternative to the short side of the market rule, the approach was first rehabilitated by Muellbauer (1978) , followed with a similar attempt by Malinvaud (1980). Further applications are by Muellbauer and Winter (1980) to employment; by Muellbauer (1984) to productivity, by Lambert(1988)to disequilibrium macro modelling, and by Burkett (1988) to forced saving.

price gap shortage indicators, it is useful to state briefly a few aspects of it particularly relevant to a cross-sectional context, disregarding all time series issues.

Taking the labour market example from the literature let us assume labour supply and demand in a sectoral labour market j is

$$l_j^s = l^s + \varepsilon_j \;;\; l_j^d = l^d + \eta_j$$

where $l_j^s$, $l_j^d$, $\varepsilon_j$; $\eta_j$ are labour supply, labour demand, and corresponding cross-sectional deviations in market **j** form the average value of labour supply and demand over all markets given by $l^s$ ; $l^d$ . Let $z = l^d - l^s$ ; $\theta_j = \varepsilon_j - \eta_j$ , then there will be excess supply of labour in market j if $\theta_j > z$ , and unemployment in this market will be equal to their difference. Now if we aggregate over all markets, and assume that the joint cumulative distribution of sectoral deviations can be approximated by a continuous cumulative distribution , we can use integration rather than summation for this aggregation, then aggregate unemployment can be written as

$$U = \int\int_{\theta \geq Z} (\theta - Z)\, dF$$

By the same method, similar equations can be obtained for aggregate vacancies, and total employment; these need not concern us here. However, in each case we have to adopt a suitable

cumulative distribution for the sectoral deviations in order to carry out the aggregation[35].

Much of the preceding assumes a time-series context. In cross-section models of demand, prices are assumed constant and are usually absent in estimation. By contrast, cross-sectional price change has a major role in this study. Two aspects of price change under market disequilibrium will prove useful in providing economic interpretations for the variation in the aggregate food shortages in section 2.3, and for market price behaviour in chapter 4. The first is the price change over a very short period, a family budget survey typically covering several such periods; and the second is its change across income group in a given time and location. The second, usually interpreted as reflecting quality variation, is by far the more important type of price effect encountered in this study, but I shall begin with examining the first. In each case, I contrast the outcome based on price adjustment to that based on quantity adjustment.

Whenever the consumption goods market is characterised by shortages, especially of food, rapid price rises can become a common phenomenon, even within a few months, and the main channel of restoring 'equilibrium', provided prices are flexible. In the main body of disequilibrium literature such price flexibility, partial or full, is only allowed over periods. Within each unit time, adjustment to equilibrium is by 'quantity' , that is, by queues, search, forced substitution, and price change is ruled out, for example, in Muellbauer and Portes (1978) fix-price model[36].

What can such a within period quantity adjustment mean in a war economy, itself already subject to a regime of fixed quantities ? The answer must clearly be that if there were imbalances

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[35]-In aggregating from micro to macro markets, the aggregate min. condition is replaced with a micro version of it in order to separate observations into the supply category or the demand category. However, due to simultaneous co-existence of job vacancies and unemployment, the macro markets in this approach are characterized by the Muellbauer min. condition, Q <= Min.(D,S), Lambert (1988).

[36]-It is this type of price change that is often employed to separate periods into excess demand or excess supply, Maddala (1988) for a discussion of the literature.

between the totals of supply and demand, it would be the quantity of the **market** portions of the supply and demand which would have to adjust within the unit-time to remove such imbalances. What shape would this quantity adjustment take ? Suppose after the distribution of coupon supplies to all consumers, the rest of the total supply is allocated not through the market, but through some non-price mechanism. If total supply cannot meet demand, a queue will develop to select those most willing to pay, in accordance with their waiting time. With fixed or sluggish prices, consumer's time would act as a price setting off a decentralised allocation mechanism, and the good in shortage would then be distributed according to the time spent in the queue. As shortage for a good increases, so does the length of the queue, and thus the time spent to obtain the good. This will force out of the queue those with high opportunity cost of time, hence bringing demand to the level of available supply, Barzel (1974), Frech and Lee (1987); Deacon and Sonstelie (1989a) ; (1989b).

The main issue of interest is whether market adjustment to equilibrium is by quantity because within period prices may be sluggish. Two sets of reasons are usually offered for this sluggishness: institutional control, and high cost of price adjustment. The former is more typical of a unionised labour market, while the latter seems to be more relevant to durable goods markets, particularly the housing market. However, there are a broad range of markets in which the short-run price response to market imbalance is swift. In particular, food markets do not usually have the impediment to price change of either the former or the latter type, and prices can be expected to change quickly to reflect quantity shortages [37]. However, it is not just the food market which displays within time-unit price flexibility. Price flexibility has an important role

[37]-A high speed of short-run price adjustment to market disequilibrium also explains why under the conditions of pronounced market disequilibrium characterising a famine situation, price change is so ferociously swift. Between February to May 1943, within just a four month period at the peak of the Bengal famine and prior to the introduction of price control in September, the price of rice increased by 214 %. A similar rapid price rise characterised the 1974 Bangladesh famine, see Sen (1981, tables 6.1, and 9.15).

even in the durables market, especially in economies with thriving trade in second-hand durables[38]. Thus for commodities with no price adjustment cost, the price gap index is a pretty accurate measure of shortage, providing there are no controls over market prices as was, by and large, the case in Iran during 1984-85.

The second, type of price change I wish to examine, is price change across income groups for a given time and place. This is usually interpreted as indicating quality variation. The individual categories of food commodities in budget surveys may conceal substantial quality variations for some commodities, for example, rice, so that prices paid by different households are not for a homogenous product. These prices are therefor likely to be closely related to quality changes. A product such as tea can be thought of as a composite good consisting of a range of distinct, strictly homogenous commodities, each with its own single, uniform, free market price. In their classic study of family budgets, Prais and Houthakker (1955, ch.8) suggested that since the price of a single homogenous good is constant across households, variations in quality will be systematically related to standard of living, that is to household's income; given its size and composition. Suppose we have a composite commodity consisting of j homogenous products such that $x_j = p_j * q_j \; ; \; X = \sum_j x_j \; ; \; Q = \sum_j q_j$ . This gives us a unit value for the composite commodity as $P = \sum_j \frac{q_j}{Q} * p_j$ . With all $p_i$ 's being constant across households, P can be given the natural interpretation of being a measure of quality for the group of distinct

[38]- Although the price changes of new durables are often sluggish due to various kinds of institutional controls, those of second-hand durables have highly flexible market prices, for example, motor cars, see Kapitany el at (1989). The changing price gap of a new to a used durable is a particularly effective indicator of short-run market imbalances as the two types are very close substitutes.

homogenous commodities which comprise the composite good. Change in quality over goods in this group then results in the positive variation of P with household income.

Since the most significant aspect of price change encountered in this study is of this income-related type, it would be natural to interpret free market price variation across income groups as unit values, and the increase in the price ratio of each good with income as a reflection of quality improvement. There are two problems with such an interpretation. The first, is that quality-related change in prices is a factor present, in various degrees, in all households expenditure surveys, and yet such cross-sectional surveys do not commonly display the type of significant price changes I report for Iran below. Indeed Deaton (1997), presenting evidence on quality change for a number of quite different developing countries, reaches the same conclusion in all cases : the effect of food quality variation on expenditure patterns is negligible essentially because all consumers tend to purchase a mixture of different varieties. Under shortages with sharply rising food prices, this option is not available to the poor, while the consumption of low quality coupon goods will insure that the market purchase of the rich will mainly consist of high quality goods. Hence the price paid for a good may rise with income, but the rise reflects the variation in the budget constraint not in taste. The problem is how to reconcile different prices paid for a good by different income groups with the notion of a single market price.

A possible hypothesis is that the degree of shortage relates, not to the heterogenous good in question but to its specific homogenous varieties. Put briefly, I suggest that shortages are more likely to raise the market prices of better rather than poor quality goods . Though all consumers pay the same price for a homogenous variety, the composite price rise with income will be quite sharp as the poor drop out of the high quality micro-markets. The advantage of this explanation is that it is consistent with the evidence in section 2.2.2 : a decrease in consumption of coupon goods by the top income quintile, and higher proportions of non-purchase through the market by

the bottom income quintiles. In chapter 4, I shall correct the highly significant market prices for quality variation and demonstrate the negligible effect of this correction on estimates obtained. Here, I merely state that the price-based indicator approximately measures the degree of shortage in a micro market, though this would be somewhat affected by quality variation. Since the above hypothesis on price behaviour suggests that shortages tend to increase with income, the question is whether the price-based measure of shortage is consistent with this. Section 2.3 constructs and applies such a shortage indicator to data in order to verify this.

If adjustment across income groups in a given time and location were to be by 'quantity' rather than price, the distributional outcome would appear to be fundamentally different. The distributional consequences of a rising price ratio with income is the result of a system of allocation based on ability to pay. If my suggested explanation is accepted, the better-off pay higher prices for their market purchases. From a distributional point of view, it is far from inconsequential whether adjustment to equilibrium is by quantity or price. This fundamental difference stems from the fact that time is distributed more equally than money. Suppose we measure the cost of time by some income-related index such as the wage rate. All households are guaranteed a basic uniform amount, but the rest of the available supply is distributed by queue. Since there is a high correlation between income and the opportunity cost of time, quantity rationing by queue would be more expensive to the rich, for them 'time is money'. One would expect to observe a greater number of abstentions among the high income group, while the low time price for the poor would ensure a greater degree of participation in the queue, and a greater share in the consumption of the shortage good. One would expect a reverse pattern of zeroes to that for market non-purchase given in table 2.4 above, with most of the zeroes concentrated at the top of the distribution. When the free market component of the total supply is also partly distributed through queues and partly by ability to pay, consumers are confronted with alternative

combinations of money and time prices. The rich would choose a combination of high money price and low time price for the shortage good, while the poor would choose the reverse, Nichols, Smolensky and Tideman (1971), Alderman (1987)[39].

## 2.3 Construction and Application of Shortage Indicators

I have chosen to base the shortage indicators on the difference in logarithmic values of the market price of a good from its fixed price. Two practical issues are important in the construction of such shortage indicators. First, one would have to avoid goods dominated by zero observations, both in order to allow a reasonable degree of interaction among shortage goods and to be able to take logarithm of price ratios. I define the shortage basket to consist of goods consumed by at least 10% of the sample, regardless of the mode of purchase. The last condition will insure that the basket is defined over both key non-coupon as well as coupon goods. As expected, the resulting shortage basket of most frequently purchased goods would be dominated by necessities. This is reinforced by an increasing budget share of necessities since, with a fall in income typical of a shortage war economy, expenditure on essentials fall less than on non-essentials[40]. Second, the values of such spill-over terms would have to be interdependent and one way of doing so is to define these spill-over terms as aggregate expenditure share in each micro market. To obtain these shares, total expenditure is taken as the aggregate expenditure on goods

[39]- Sah (1987)shows that if the entire supply of a shortage good is distributed by queuing rather than rationing, the poor is slightly worse off, since the outcome under queueing involves an additional (small) cost in waiting time. My concern, however, is with case when, subject to a uniform level of ownership of the rationed good, the non-rationed component of the supply is distributed under two alternative systems of decentralised allocations, namely the market and the queue. This case is more typical of a war economy.

[40]-This is supported by the available income elasticities for the goods of the shortage basket. There are only two goods from the shortage basket for which the pre-war 1971-72 elasticities are greater than 1, quality rice (1.28), apple (1.50), see central Bank of Iran (1971-72). More recent income elasticities for a limited range of coupon goods for 1991-92 contains no instance of a good with greater than 1 estimate, see Ministry of Economy and Finance (1991-92).

contained in the shortage basket only[41]. Third, I employ annual budget shares for which fix-price purchases are valued at free market prices. Although alternatives definitions of 'total' expenditure on either free market purchases or all actual purchases are possible, a definition inclusive of ration subsidies is in line with similar criteria employed in chapters 3 and 4 based on the relative absence of corner solutions. For each city-group, there will thus be 5 separate sets of aggregate 'budget' share, defined so that they will add up to 1 for each quintile.

Once adopted, one would expect the resulting budget shares to decline with income if the shortage basket consisted of necessities, as it should tend to do, since the basket is defined by the most frequently purchased goods. This is, in fact, the case for most items. However, it is worth pointing to the important exception of a small group of goods which display rising budget share with income : meat, cigarettes, and, less important, quality rice. The rising budget shares of these few goods are important to the increasing pattern of shortages with income.

Turning now to the actual formulation of the price-based shortage indicator, this is defined over some twenty food commodities, eleven months, and five income groups. To avoid any gap in the data, missing values have been filled by adjacent observations. This will inevitably impute positive values to some cases of genuine zero in the bottom two quintiles. However, such positive observations will receive a lower weight in their budget shares. Once aggregated over twenty commodities, the index will have fifty-five distinct non-zero observations for each of the three city groups. The shortage 'norm' is taken to be the value of the index for Tehran in quintile=3, and in month=1, shown by prefix 31j . Thus all observations in different city groups are assessed relative to this norm. Let i=1...5 income quintiles; t=1,...11 months, and j=1,...20 food commodities. $w_{ij}$ = budget share of each good for the ith quintile. The bars above price,

[41]-It does not seem right to use total expenditure on food, even less so on all commodities, food and non-food. If we did so the share of each of the 20 food items would be so small that once shortage observations are weighted by such budget shares, they would all have values close to zero.

quantity, or budget share indicate their mean values; m stands for market, and r for fix-price purchases. The price-based shortage indicator can be written, in logarithmic terms, as follows.

$$S_{it}^{p} = [\sum_{j=1}^{20} \ln(\frac{p_{itj}^{m}}{p_{itj}^{r}})\,\bar{w}_{ij} - \sum_{j=1}^{20} \ln(\frac{p_{31j}^{m}}{p_{31j}^{r}})\,\bar{w}_{3j}] \quad (2.1) \;;$$

$$\bar{w}_{ij} = \frac{\bar{p}_{ij}^{m}\,(\bar{q}_{ij}^{m} + \bar{q}_{ij}^{r})}{\sum_{j=1}^{20} \bar{p}_{ij}^{m}\,(\bar{q}_{ij}^{m} + \bar{q}_{ij}^{r})} \;; \quad \sum_{j=1}^{20} \bar{w}_{ij} = 1$$

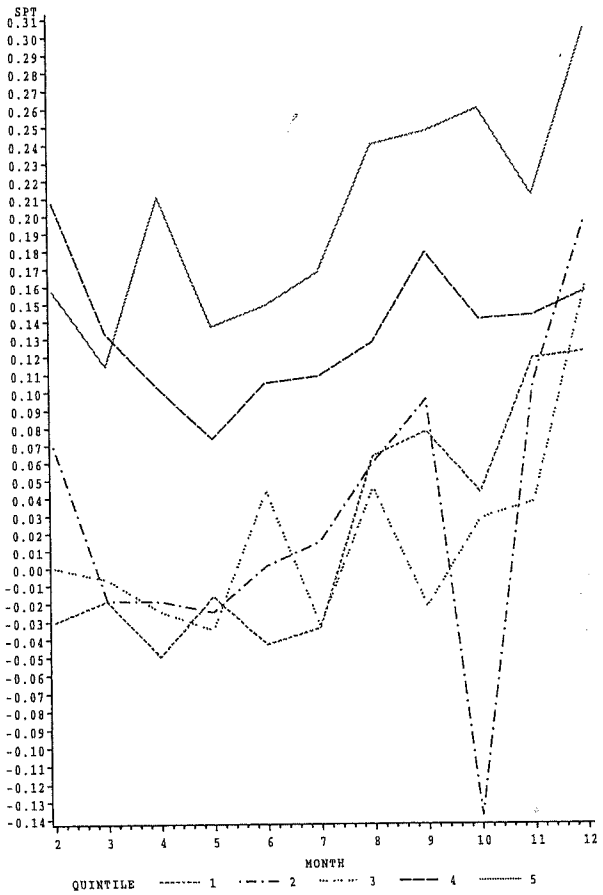
Plotted values obtained for (2.1) are given in graphs 2.1, 2.2, and 2.3 for Tehran, large cities, and small cities. There is a marked tendency for $S_{it}^{p}$ of the top two quintiles to be well above the bottom three quintiles. In particular, all shortage data for the top two quintiles are defined over positive observations. As can be seen from the accompanying plots, this trend is quite general, and applies as much in Tehran as in large and small city groups. Thus, the shortage indicator is much larger for the rich than it is for the poor. This is consistent with the suggested hypothesis on price behaviour across income groups, assuming for the time being that these values are marginally influenced by quality change.

Before turning to the non-food group, mention should be made of an alternative measure of food shortages. One could suggest a similar **quantity**-based shortage indicator using the gap between fix-price quantities and their corresponding market quantities. The idea would be that if ,for example, coupon consumption falls in a particular period, perhaps due to late arrival of

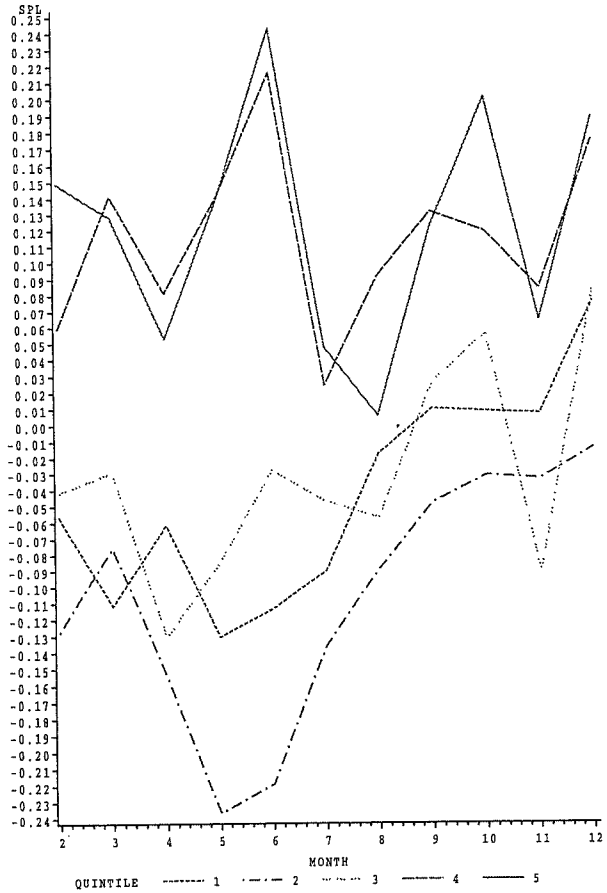
imported food, there would be a greater reliance on the market to satisfy consumption, thus widening the quantity gap. One can define such a quantity-based shortage indicator on exactly the same basis as I have done for a price-based indicator.

The interpretation of this quantity-based variable as a shortage indicator is not, however, as straightforward as (2.1). First, it is not clear that in markets with unfettered price adjustment, the 'equilibrium' mechanism works mainly through quantity rather than price, as discussed in section 2.2. Second, the shortage interpretation of quantity gap becomes somewhat confusing if a single meaning is attached to the group of goods for which rationed consumption is the rule (coupon goods), and that for which ration consumption is the exception (non-coupon goods). Consider first the coupon group of goods for which most household demand is met through rationing. In this case intense shortage for a good will raise the market/ration quantity ratio by reducing the amount of fixed-price relative to market price quantity when most purchases are of a market type. Now consider the second, non-coupon group. Here, in normal conditions, most purchases are made through the market with negligible ration purchases, and the ratio will be close to one. With intense shortages, availability of goods on the market fall, and the ratio will decrease. For this group of commodities therefore the index moves in the **opposite** direction. Since both groups of goods are very important, one cannot expect either one to dominate the other. This is a serious drawback for an index of shortage. By contrast, the interpretation of the price gap indicator of shortage is independent of the group of coupon or non-coupon goods to which it is applied. In both cases, shortage moves market prices in the same upward direction, thus widening the gap between fixed and market prices. Aggregating such micro shortages would provide an indicator with a clear interpretation, and this is lacking in the case of the quantity-based indicator. The quantity-based indicator would give correct signals only to the extent that one of the two groups of goods has a negligible position in the average consumption basket,

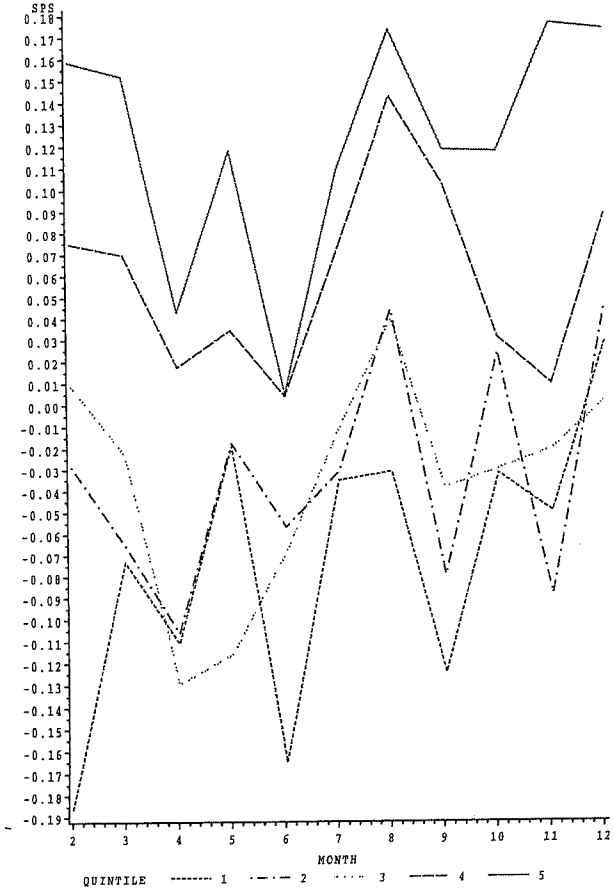
**Plot 2.1-Tehran Food Shortage by (2.1)**




**Plot 2.2-Large Cities Food Shortage by (2.1)**




**Plot 2.3-Small Cities Food Shortage by (2.1)**



and ,for the food group, this is unlikely. For this reason, I do not provide estimates based on such a quantity index.

For non-food commodities where price/quantity information is not available, I have constructed a frequency-based indicator similar to the price-based indicator for the food group. This is given by (2.2) where f stands for frequency of purchase. Once again, I included only goods purchased by at least 10% of the sample households, regardless of the mode of purchase, and defined spill-over, budget share terms over the same 10% group of non-food commodities, as opposed to defining them over all non-food, or all goods, food and non-food.

$$S_{it}^{f} = [\sum_{j=1}^{20} \ln(\frac{f_{itj}^{m}}{f_{itj}^{r}})\,\bar{w}_{ij} - \sum_{j=1}^{20} \ln(\frac{f_{31j}^{m}}{f_{31j}^{r}})\,\bar{w}_{3j}] \quad (2.2) \;;$$

$$f_{itj}^{m} \;;\; f_{itj}^{r} > 0$$

The frequency-based indicator of shortage would have the same problem giving inconsistent signals if applied to food commodities as the quantity-based indicator since coupon frequencies dominate one group and market frequencies the other group. That is, the indicator will move from zero for no shortage to one for severe shortage for the coupon group, but for the non-coupon group the move is from one (for no shortage) to zero (for severe shortage). However, when applied to non-food the indicator should provide reasonably clear shortage signals because non-food coupon goods are very few, and more generally, fix-price purchases are the exception rather than the rule for non-food commodities. (2.2) would thus be estimated on purchase frequencies dominated by market purchases[42].

[42]-It should be borne in mind that 'frequency' data employed here should really be termed positive purchases since the CBIHBS of 1984-85 survey recorded multiple purchases of a good by a household as a single expenditure entry, unless they differed in their mode of purchase.

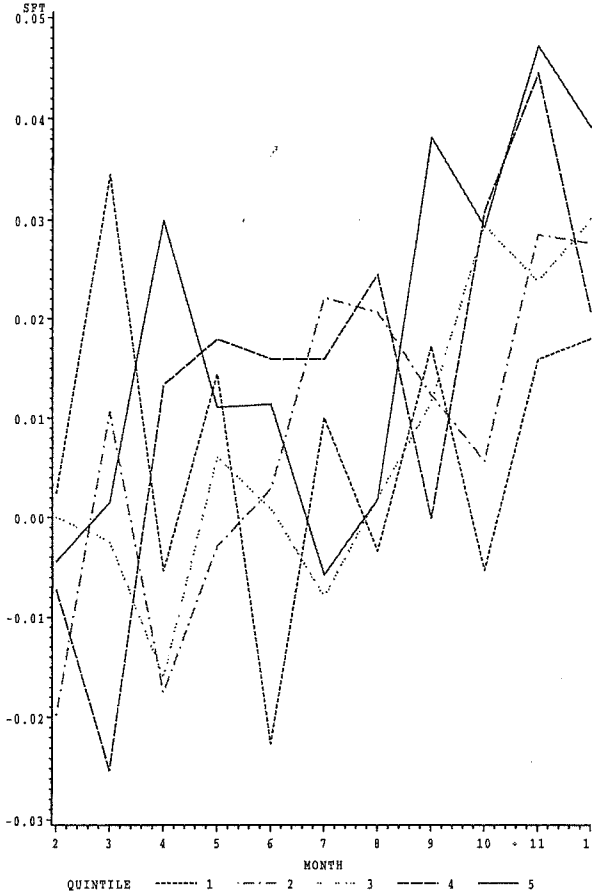
Graphs 2.4, 2.5, and 2.6 plot these observations against time for Tehran, large cities, and small cities respectively. Although the clear tendency of shortages to rise with income for the food group is not very evident here, the observations on the bottom 2 quintiles tend to be below those for the other quintiles for most months. This is perhaps more evident in graph 2.4 for Tehran where the 4th and 5th quintile observations are usually above those for lower quintiles, than it is elsewhere. For large cities two large observations in month 8 and 11 for the 5th and 4th quintiles are prominent, and another in month 5 is approximately equal for the 1st and the 3rd quintiles. For small cities, it is the 3rd quintile which appears to have larger shortage observations than the 1st and the 2nd quintiles.

Food shortages and their price increases are thus related to the high purchasing power of the rich, even though one may expect the opposite, given the availability of a wide range of coupon goods to the poor, see Malthus (1800).

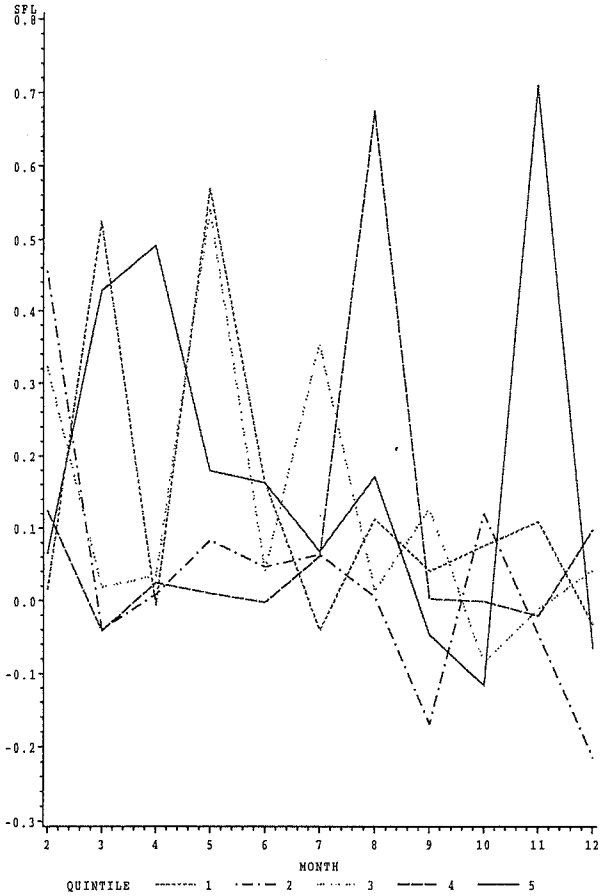
## 2.4 Parametric Shortage Indicators

(2.1) and (2.2) are aggregated by a simple summing up of shortages of all goods for a given month/income quintile. As mentioned in section 2.2, the 'smoothing by aggregation' approach raises important issues of relevance to the formulation of shortage indicators, namely their interdependence and distribution. Its application requires substituting a distribution function for the simple adding up of the micro-market commodity shortages adopted for (2.1) and (2.2). Using a general functional form, take, as an example,(2.1) without the summation over micro-markets. Observations for a given good j are expressed as deviations from the norm (third quintile)

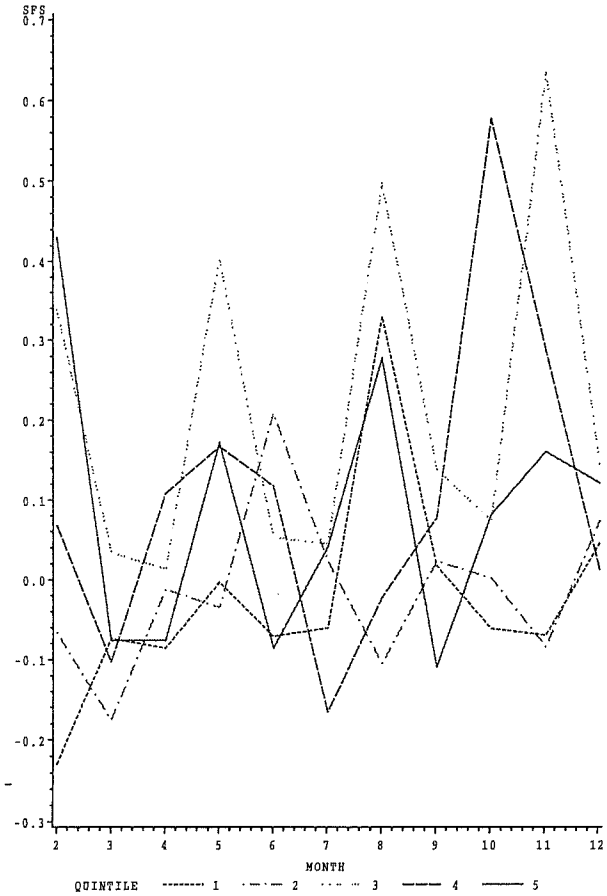
**Plot 2.4-Tehran Nonfood Shortage by (2.2)**




**Plot 2.5-Large Cities Nonfood Shortage by (2.2)**




**Plot 2.6-Small Cities Nonfood Shortage by (2.2)**



$$\theta_{itj} = \ln\left(\frac{p^{m}_{itj}}{p^{r}_{itj}}\right)\bar{w}_{ij} - \ln\left(\frac{p^{m}_{31j}}{p^{r}_{31j}}\right)\bar{w}_{3j} \qquad (2.3)$$

In this case $\theta_{itj}$ will have fifty five observations for each city group, or one hundred sixty five over the entire sample, and j= 1,...,20; t= 1, ..., 11; and i=1,...,5. If we adopt a suitable joint distribution for all j variables representing these deviations for each commodity, then their joint cumulative distribution over all j commodities provides a vector of time/quintile specific observations. Ignoring location for simplicity, this can be represented as

$$F_{it}(\theta) = \int_{j=1}^{n} f_{itj}\left[g_{it1}(\theta_{it1}), g_{it2}(\theta_{it2}), \ldots, g_{itn}(\theta_{itn})\right] df_{itj} \qquad (2.4)$$

where each $g_{itj}(\theta_{itj})$ function shows the distribution of fifty five shortage observations of a single commodity j. The joint distribution of $g_{itj}(\theta_{itj})$ functions over commodity j is then defined by $f_{itj}(.)$ in (2.4), producing j vectors; each element of each vector corresponding to one time/quintile observation. Thus $f_{itj}(.)$ function is also distributed over such observations, and its cumulative distribution will offer a method of aggregating shortages of each commodity over j=20 commodities. Therefore (2.4) produces a single vector of observations,

each observation will be an aggregate measure of shortage, over all j commodities, specific to a given time/quintile. The issue of whether $f_{itj}(.)$ in (2.4) is defined by adding individual commodity shortage functions $g_{itj}(\theta_{itj})$ or combining them according to another non-linear function, is left open, although a weighted average seems the obvious combination. The same method can employed for the frequency-based (2.3). However, the issue of market purchases of the poor and the rich would have to be handled with care, and the choice of a function should be sensitive to the skewedness in the distribution of shortages [43].

[43]-For example, Malmquist (1948) and Lambert (1988). Both employ a log-normal distribution in their application of this method since their original sets of observations have a skewed pattern of distribution.

**Table 2.1**-Per Capita Ration Quantities of Key Coupon Goods
(Base : City=1, Quintile=3)

| CTY | QUINT | MEAT | EGG | CHICK | RICE | OIL | SUGL | SUGR |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.56 | 0.30 | 0.12 | 1.07 | 0.95 | 0.95 | 1.03 |
| 1 | 2 | 0.91 | 0.60 | 0.90 | 0.98 | 1.02 | 0.99 | 1.05 |
| 1 | 3 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1 | 4 | 1.11 | 1.02 | 1.09 | 1.00 | 1.10 | 1.00 | 1.05 |
| 1 | 5 | 0.74 | 0 .98 | 0.94 | 0.84 | 1.14 | 0.98 | 1.15 |
| 2 | 1 | 0.18 | 0.65 | 0.21 | 1.01 | 0.88 | 1.11 | 0.82 |
| 2 | 2 | 0.37 | 1.02 | 0.41 | 1.00 | 0.95 | 1.03 | 0.85 |
| 2 | 3 | 0.45 | 0.61 | 0.72 | 1.03 | 0.98 | 1.11 | 0.96 |
| 2 | 4 | 0.43 | 1.10 | 1.02 | 1.00 | 1.02 | 1.06 | 1.05 |
| 2 | 5 | 0.44 | 1.45 | 1.22 | 0.94 | 1.15 | 1.07 | 1.02 |
| 3 | 1 | 0.06 | 0.41 | 0.21 | 0.79 | 1.00 | 1.25 | 0.58 |
| 3 | 2 | 0.18 | 0.75 | 0.67 | 0.84 | 0.98 | 1.15 | 0.71 |
| 3 | 3 | 0.26 | 0.98 | 0.91 | 0.84 | 1.01 | 1.19 | 0.81 |
| 3 | 4 | 0.24 | 1.08 | 0.93 | 0.93 | 1.06 | 1.22 | 0.81 |
| 3 | 5 | 0.29 | 1.39 | 1.74 | 0.87 | 1.07 | 1.17 | 0.81 |

**Table 2.2**-Per Capita Free Market Quantities of Key Coupon Goods
(Base : City=1, Quintile=3)

| CTY | QUINT | MEAT | EGG | CHICK | QRICE | RICE | OIL | SUGL | SUGR |
|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 1.00 | 0.11 | 0.73 | - | 0.17 | 0.34 | 0.69 | 0.98 | 1.55 |
| 1.00 | 2.00 | 0.58 | - | 0.39 | 0.39 | 1.63 | 0.61 | 1.99 | 0.95 |
| 1.00 | 3.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00* |
| 1.00 | 4.00 | 2.20 | - | 2.20 | 1.82 | 0.77 | 3.07 | 1.84 | 1.26 |
| 1.00 | 5.00 | 3.92 | 2.39 | 12.46 | 2.51 | 0.96 | 4.67 | 3.71 | 7.92 |
| 2.00 | 1.00 | 0.93 | 0.49 | 1.91 | 0.14 | 0.38 | 0.36 | 0.72 | 0.38 |
| 2.00 | 2.00 | 1.87 | 0.97 | 1.21 | 0.43 | 0.32 | 0.76 | 1.44 | 1.08 |
| 2.00 | 3.00 | 2.83 | 1.01 | 3.13 | 0.37 | 2.28 | 2.44 | 1.77 | 0.58 |
| 2.00 | 4.00 | 4.11 | 0.75 | 2.55 | 1.05 | 1.13 | 2.77 | 1.42 | 2.03 |
| 2.00 | 5.00 | 7.77 | 3.45 | 3.68 | 2.21 | 2.78 | 6.47 | 4.60 | 14.75 |
| 3.00 | 1.00 | 0.66 | 0.91 | - | 0.17 | 0.05 | 0.29 | 0.85 | - |
| 3.00 | 2.00 | 1.82 | 0.94 | - | 0.48 | 0.34 | 0.94 | 1.98 | 0.93 |
| 3.00 | 3.00 | 2.52 | 1.35 | 0.34 | 1.23 | 1.57 | 1.24 | 2.70 | 2.06 |
| 3.00 | 4.00 | 4.94 | 1.60 | 1.03 | 1.46 | 2.14 | 1.54 | 1.34 | 2.74 |
| 3.00 | 5.00 | 7.10 | 2.73 | 6.43 | 2.42 | 3.33 | 4.11 | 3.25 | 12.57 |

missing * : imputed using adjacent cells

**Table 2.3**-Average Milk Quantities In Tehran (Per No. of Infants Plus Old Members)-(Base : 3rd Quintile)

| CITY | QUINT | COUPON | MARKET |
|---|---|---|---|
| 1 | 1 | 0.70 | 1.00 |
| 1 | 2 | 0.97 | 1.00 |
| 1 | 3 | 1.00 | 1.00* |
| 1 | 4 | 1.22 | 1.00 |
| 1 | 5 | 1.14 | 2.00 |

* : imputed from adjacent cells

**Table 2.4**-Frequency of Market Non-purchase out of 55 for each Good of the Food Shortage 'Basket'

| recall | Goods | Tehran | | | | Large Cities | | | | Small Cities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | coupon* | | non-coup# | | coupon* | | non-coup# | | coupon* | | non-coup# | |
| priod | | Poor | Rich | Poor | Rich | Poor | Rich | Poor | Rich | Poor | Rich | Poor | Rich |
| two | 1 | 12 | 12 | 6 | 1 | 13 | 9 | none | none | 5 | 6 | none | none |
| | 2 | - | - | 4 | none | - | - | 3 | none | - | - | 5 | 1 |
| days | 3 | 17 | 23 | none | none | none | 5 | none | none | 3 | 2 | none | none |
| | 4 | 11 | 3 | 5 | none | 7 | 1 | 4 | 2 | 4 | 1 | 2 | none |
| | 5 | - | - | 3 | 1 | - | - | 1 | none | - | - | none | none |
| | 6 | - | - | 4 | 5 | - | - | 1 | 1 | - | - | 1 | none |
| one | 7 | 5 | 1 | none | none | 10 | 3 | 1 | 1 | 6 | none | none | none |
| | 8 | 14 | 4 | 2 | none | 12 | 4 | 2 | none | 11 | 6 | 1 | none |
| mont | 9 | 9 | 13 | 6 | 1 | 9 | 9 | 8 | none | 8 | 6 | 5 | none |
| | 10 | 18 | 25 | 1 | none | 13 | 20 | 3 | none | 19 | 15 | none | none |
| | 11 | - | - | 10 | 4 | - | - | 8 | 1 | - | - | 1 | none |

*-'Coupon Goods': 1=meat, 2=milk, 3=cigarette, 4=quality cigarette,7=quality rice, 8=oil, 9=lump sugar,10=sugar;
#-'Non-Coupon Goods' :1=yogurt, 2=apples, 3=fresh herbs, 4=tomatoes, 5=potatoes, 6=onions, 7=chick beans,8=dals, 9=kidney beans, 10=lentils, 11=tea.
|-'Poor'=Quintiles 1+2; 'Rich'=Quintiles 3+4+5.