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I. Introduction

The problem of quality effects on consumer behavior is considered in a model for demand which is somewhat different from traditional approaches. Some empirical results on food consumption patterns indicate that as income rises in most instances people spend a portion of the increase on larger quantities but much of the increase goes on higher priced varieties. The implications of these phenomena are discussed for programs aimed at improvement in nutritional status.

II. Consumer Behavior

The conventional theory of consumer behavior is

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often based on assuming (or deriving from a set of assumptions) that individual consumers have a utility function $U(x)$, $U_1 > 0$ with appropriate second order conditions so that one may solve the problem

$$\begin{array}{ll} \text{Max } U(x) & \\ x \geq 0 & 1 \\ \text{s.t. } p'x \leq Y & \end{array}$$

where x is the bundle of goods at prices p and Y is income. One of the difficulties with this type of formulation is that it is extremely difficult to incorporate many empirically observed phenomena. Among these are the theory of conspicuous consumption as expounded by Thorstein Veblen, or John Rae at an even earlier date.¹

Veblenite prophecies of the triumph of technocracy may not yet be fulfilled but there is considerable evidence that tastes and consumer demand are to some degree conditioned by such things as advertising and a 'keeping up with the Joneses' syndrome. In many underdeveloped

¹ See Veblen(1899), Rae(1905) or Liebenstein's(1950) discussion of a number of these phenomena.

countries the demonstration effect referred to by Ragnar Nurkse is self-evident. One often observes the consumption of imported varieties of many goods because of some loosely defined snob appeal. In some developing regions of the world certain beverages are available when even a local water supply is lacking.

The present work is motivated by a study of food consumption patterns in Pakistan. The empirical work is largely based on the household surveys conducted by the Government of that country for the period 1968-1972. In particular these surveys give the quantity and expenditure for various foods by different income groups. Information is also available on total expenditure, household size, and urban-rural status. For a particular food, say wheat, the ratio of expenditure to quantity purchased by an average household in any one income group gives an imputed price. However this price varies by as much as a factor of two or three across groups for many food items. The reason for this variation may be considered a generalized quality effect. A naive analysis of the data would show price as an increasing function of quantity demanded, quite contrary to what

traditional economic theory would suggest.

III. Price Variations

There are many factors which account for price variations. It is convenient to consider two points of view. The first is to account for these different prices of the "same" intrinsic food and secondly, to develop an hypothesis for some households' willingness to pay these higher prices. There are, typically, aggregation problems. Thus food group one includes wheat and wheat flour. One would expect the consumption of higher income groups to be biased towards a higher proportion of flour and consequently a higher price. Secondly there is a multi-dimensional generalized quality of the commodity. For example many varieties of rice or meat cuts are consumed and again one would expect the consumption of higher priced varieties to rise with income. Third is the ratio of home to cash purchases. This in turn reflects the additional costs of packaging and service ranging from the individual attention of small shops to the less convenient but cheaper service at outlets which specialize in bulk sales. Fourth is

the question of regional and seasonal variations. In urban areas one tends to have more ration shops per capita but also a greater variety: The former would offer lower price opportunities for necessities while the latter would admit a wider range of prices. Seasonal variations are most pronounced where storage and transport facilities are least developed. Finally there are the problems of price discrimination sometimes arising from discriminating monopolistic behavior but often being rooted in social status.

The imputed price p for any food group i may be viewed as a function of an intrinsic price p_i^* and these generalized quality traits of that food group q_{i1} $i=1, \dots, n$

$$p_i = \pi(p_i^*; q_{i1}, q_{i2}, \dots, q_{in})$$

A variation in the imputed price p_i reflects the net effects of changes in the intrinsic price and in the quality measures. As economies develop it is observed that the nonprimary component of consumption expenditures particularly for food tends to increase. This means that the part largely received by agriculture tends to decrease. Kuznets has recorded the phenomenon with some detail for Sweden.²

In this study a somewhat simplified view is taken, namely that relative price is a measure of the quality of a food.

$$p_i = p_i^* q_i \quad 3$$

where p_i is the imputed price, p_i^* is price paid by the lowest income group and q_i is the associated quality.

To model some of these phenomena one would like to include quality effects in the utility function.

Houthakker (1951-52) drew attention to the possible

² Kuznets analyzed the PTD component (processing, transportation and distribution) for food expenditures in Sweden and the United States. For Sweden, PTD as a fraction of food expenditure went from .36 (1891-1900) to .47 (1921-1930) while for the United States it went from .32 (1909) to .56 (1949-1957).

bias caused by using only one representative price for each commodity. By extending the classical problem to include quality effects he proposed the maximum problem

$$u(x_1, \dots, x_n, v_1, \dots, v_n) \max$$

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if

$$\sum_{i=1}^n x_i (a_i + b_i v_i) = M$$

where he called constants a_i and b_i the quantity price and quality price respectively. Within this framework he deduced many rather interesting properties which result when both quality and quantity effects are considered. The non-convexity of the constraint does impose some difficulties which does not appear to have been considered in his analysis. There have been some attempts at estimating quality effects, see for instance Griliches (1971), for in general it has proved rather difficult.

Interpersonal effects would suggest including purchases of others in each person's utility function. Thus the price (or relative price) one pays might of itself have some utility.³ The inclusion of a price in the

³ One might also consider the Pigou effect or indeed any one of the consumption functions where real wealth enters as an argument being indicative of price parameters in the utility function; see Ando, A.K., and Modigliani, F. (1963) and Pigou (1943). Gabor and Granger (1966) also analyze price as an indicator of quality.

utility function leads to some technical problems.⁴ Kalman introduced a price in his utility function formulation and established some theories to extend the traditional theory. In a more recent paper Chichilnisky and Kalman (1975) study the "local" properties of equilibria--without the convexity assumptions--for "less neoclassical" agents.

⁴ Consider the problem $\text{Max } U(x,p,Y), p'x \leq Y$. One loses

$$x \geq 0, p \geq p^*$$

convexity so that without imposing further unrealistic assumptions one cannot obtain a solution.

IV. The Model

The approach proposed here seeks to resolve some of these difficulties by considering consumer behavior to be essentially a two-step process. For each good there is a base price p_i^* .⁵ The consumer can actually pay a price p_i which in general will be different from p_i^* . This difference reflects the various quality, PTD (Processing, Transportation and Distribution), or snob values mentioned earlier. For convenience here it is termed the non-primary content ratio or quality $q = \frac{p_i}{p_i^*}$.

Thus for each good i , ($i = 1, \dots, n$) consumer's expenditure is allocated to yield maximum satisfaction or utility by an appropriate quantity-quality mix.

⁵ The base price actually chosen in this model is p_i^* where p_i^* is the price paid by the lowest income group. Without loss of generality one could also choose some other basis for p_i^* . The consumer is however aware of the general price level for each good.

In the second stage (not necessarily time phased) a consumer allocates expenditure between goods so as to maximize his overall utility

$$\text{Max } U \left(f^1 \left(x_1, \frac{p_1}{p_1^*} \right), f^2 \left(x_2, \frac{p_2}{p_2^*} \right), \dots, f^n \left(x_n, \frac{p_n}{p_n^*} \right) \right)$$

$$x_i > 0$$

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$$p_i \geq p_i^*$$

$$\sum x_i p_i = Y$$

The constraint is not convex but one can obtain a solution if the f^i are sufficiently convex.

One may formalize this concept of sufficiently convex by defining a Lagrangian L where

$$L = U + \lambda (Y - \sum x_i p_i')$$

where:

p_i' is used for $\left(\frac{p_i}{p_i^*} \right)$ to simplify notation

denote $z = (x, p)$

and $g(z) = Y - \sum x_i p_i'$

Sufficient conditions of optimality are given by

$$\langle \bar{z}, (L_{zz}(\lambda, \hat{z}) - \rho g'_z(\hat{z})) \bar{z} \rangle < 0 \quad \forall \bar{z} \neq 0$$

where

$$\begin{bmatrix} L_{xx} & L_{px} \\ L_{xp} & L_{pp} \end{bmatrix} = L_{zz}$$

$$\rho \geq 0$$

and $\langle \cdot \rangle$ denotes outer product

This is essentially a technique for augmenting the Lagrangian to ensure a local optimum. For some choice of functional forms one can also have a global solution. Further details are given by Wierzbicki (1978).

One indicative solution may be obtained by considering the class

$$f^i(x_i, \frac{p_i}{p_i^*}) = \mu_i (\log x_i)^{\alpha_i} \log \left(\frac{p_i}{p_i^* x} \right)^{\beta_i}, \quad i = 1, \dots, n$$

where $\alpha_i + \beta_i \geq 0$ 6

One may then view the subproblems as concave programming problems in $\log x_i - \log \frac{p_i}{p_i^*}$ space.

So for each good one obtains ⁶

$$x_i = r(k_i, p_i^*) \quad i = 1, \dots, n \quad 7$$

$$p_i = s(k_i, p_i^*)$$

Where $k_i = p_i x_i$

It is assumed that U is concave in $f^i()$.

If one defines a Lagrangian L where

$$L = U + \lambda(Y - \sum k_i) \quad 8$$

First-order condition for a constrained maximum is

$$\frac{\delta L}{\delta k_i} = 0 \quad i = 1, \dots, n \quad 9$$

$$\frac{\delta L}{\delta \lambda} = Y - \sum k_i = 0$$

Second-order condition is that d^2L be negative definite subject to the constraint

$$\sum dk_i = 0 \quad 10$$

The system (9) can be solved for k_i if the conditions of the implicit function theorem are satisfied. From 9 one obtains $n + 1$ equations

$$g^i(z_1, \dots, z_{n+2}) = 0 \quad i = 1, \dots, n+1 \quad 11$$

⁶ For instance sufficient second order conditions are $0 \leq \alpha_i \leq 1, 0 \leq \beta_i \leq 1, \mu_i \geq 0$.

where the $n+2$ arguments are $(k; Y, \lambda)$

Equation 11 can be solved for k_i in terms of Y if g^i and $\frac{\delta g^i}{\delta z_j}$ are continuous and the Jacobian, J , is non-zero, in the neighborhood of $\bar{k}, \bar{Y}, \bar{\lambda}$

$$J = \begin{vmatrix} g_1^1 & g_2^1 & \dots & g_{n+1}^1 \\ \vdots & \vdots & \ddots & \vdots \\ g_1^{n+1} & \dots & \dots & g_{n+1}^{n+1} \end{vmatrix} = 0 \quad 12$$

where g_j^i is $\frac{\delta g^i}{\delta z_j}$.

Hence one obtains a solution of the form

$$k_i = h^i(Y) \quad i = 1, \dots, n \quad 13$$

Combining equations 7 and 13 one obtains

$$x_i = d^i(Y, p_i^*) \quad 14$$

$$i = 1, \dots, n$$

$$q_i = w^i(Y, p_i^*)$$

where $q_i = \frac{p_i}{p_i^*}$. These equations may be interpreted as

follows. A typical consumer consumes a quantity x_i of good i with corresponding quality q_i when he has income Y

and is faced by a general price level p_i^* for that good. The development of this model is of course premised on a number of assumptions. The assumption of a non zero Jacobian implies linear independence among the columns. Economically this is likely to be satisfied if the choice of goods x_i and the corresponding f^i correspond to distinct categories. Thus the methodology would be least applicable to goods which are close substitutes. In particular the assumption of an "average" utility function is open to question. A practical solution requires some balance between a theory based on highly stylized assumptions and reality.

The choice of an appropriate functional form for $d'(\)$ has been discussed at length in the literature (Houthakker (1957), Prais and Houthakker (1971), Philips (1974)), and is typically limited to the linear, semi-logarithmic and double-logarithmic.

The actual equations estimated for x_i and q_i are adapted to try and reflect some of the individual differences between consumers.⁷ The model is given by

$$\log x_i = \alpha_{0i} + \alpha_{1i} \log E + \alpha_{2i} \log H + \alpha_{3i}^D + \alpha_{4i}^J + \alpha_{5i} \log p_i^* + \epsilon_i$$

$i = 1, \dots, n$ 15

$$\log q_i = \beta_{0i} + \beta_{1i} \log E + \beta_{2i} \log H + \beta_{3i}^D + \beta_{4i}^J + \beta_{5i} \log p_i^* + \epsilon_i$$

where x_i is quantity of good i consumed, E is expenditure/capita, H household size, p_i^* is price paid for good i by lowest income group, D is a dummy variable for urban (1) or rural (0) status, J gives job status, 1 for self-

⁷ See Taylor and Weiserbs (1972) for a discussion of theoretically plausible dynamic demand functions.

employed otherwise 0, while q_i is the quality of good i .

V. Discussion of Empirical Results

The model given in equation 15 was first estimated for all income groups aggregated. A slightly modified⁸ version was used for low, medium and high income groups and finally for urban and rural populations separately. The separate income group regressions suffer from a lack of sufficient observations so the standard errors in many instances are perhaps on the high side. In interpreting the results one must also be mindful that Pakistan is a developing country so that the markets and degree of participation, particularly in rural areas, are far from perfect.⁹

The food groupings, F_i , $i = 1, \dots, 11$ are chosen because these are the foods which dominate the Pakistan diet for protein-calorie intake. One must make the

⁸ The modification for separate income groups was to omit the J variable to try and increase the statistical stability of the estimates where the dearth of data created some difficulty while for the urban and rural regressions the dummy variable D was of course omitted.

⁹ For a discussion of these and other imperfections see Eckaus(1955).

TABLE NO. 1 ALL INCOME GROUPS - QUANTITY

log-log regressions of quality of various food groups consumed

FOOD											
	wheat	rice	pulse	milk	butter	ghee	v. ghee	mutton	beef	vegetable	sugar
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
C (Con- strain)	.3.2 (.35)	-.57 (.55)	-.17 (.28)	1.5 (.59)	1.3 (2.3)	2.0 (.66)	-2.5 (2.7)	.89 (1.3)	-.86 (.57)	1.10 (.23)	1.96 (.31)
EL (Expend- iture)	.08 (.08)	.29 (.24)	.28 (.10)	.92 (.17)	1.6 (1.0)	1.3 (.21)	-.38 (.9)	2.6 (.47)	.41 (.22)	.38 (.09)	.74 (.12)
HL (House- hold size)	-.12 (.05)	.60 (.12)	.006 (.06)	.52 (.11)	.05 (.5)	.03 (.13)	.67 (.5)	.66 (.26)	.26 (.13)	-.05 (.05)	-.26 (.07)
D (Urban- rural status)	-.19 (.04)	-.15 (.05)	.009 (.03)	-.17 (.06)	-2.9 (.2)	-1.2 (.08)	1.2 (.3)	.48 (.12)	.42 (.05)	-.005 (.027)	-.28 (.03)
J (Job status)	.01 (.07)	.14 (.20)	.17 (.08)	.25 (.13)	-1.1 (.9)	-.4 (.16)	.08 (.66)	.29 (.37)	.31 (.18)	.04 (.07)	-.10 (.09)
P _i (Base Price)	.29 (.23)	-.24 (.10)	-.22 (.11)	-.67 (.27)	-.3 (.1)	-.85 (.37)	-1.6 (2.0)	-.07 (.58)	-.44 (.21)	.3 (.15)	-.13 (.02)

Source: Household Income and Expenditure Survey, 1968-1972.
Government of Pakistan.

TABLE NO. 2 ALL INCOME GROUPS - QUALITY

log-log regressions of quality of various food groups consumed

	FOOD										
	wheat F1	rice F2	pulses F3	milk F4	butter F5	ghee F6	v. ghce F7	mutton F8	beef F9	vegetable F10	sugar F11
C Constant)	-.64 (.24)	.12 (.46)	.007 (.48)	-.1 (.43)	3.0 (1.5)	2.3 (.25)	3.0 (2.6)	.84 (.42)	.05 (.37)	-.71 (.40)	.05 (.31)
EI. Expen- diture)	.10 (.06)	.25 (.16)	-.04 (.15)	.22 (.13)	.99 (.69)	.25 (.11)	.89 (.8)	.11 (.14)	-.04 (.14)	.19 (.13)	.32 (.11)
HL house- hold size)	.004 (.04)	.12 (.10)	-.02 (1.0)	.01 (.08)	-.05 (.31)	-.057 (.06)	-.99 (.5)	.11 (.08)	.16 (.09)	.14 (.08)	.28 (.07)
D Urban- rural status)	.02 (.02)	.15 (.05)	.02 (.06)	.33 (.04)	.31 (.11)	.04 (.02)	-.13 (.3)	.11 (.05)	.06 (.04)	.29 (.06)	.21 (.04)
J Job status)	-.02 (.05)	.03 (.12)	-.2 (.11)	.05 (.11)	.86 (.60)	.11 (.09)	.05 (.6)	-.02 (.10)	-.09 (.11)	-.004 (.1)	.07 (.08)
P Price)	-.82 (.16)	-.57 (.13)	-.82 (.29)	-.68 (.18)	-.81 (.07)	-1.1 (.09)	.9 (1.9)	-.6 (.24)	-.5 (.17)	-2.0 (.37)	-.97 (.02)

Source: Household Income and Expenditure Survey, 1968-1972.
Government of Pakistan.

usual compromise between too much detail and overpowering volumes of data on the one hand and highly aggregated but less informative grouping on the other. The grouping chosen follows fairly closely that used by the Government of Pakistan in carrying out its household survey.

One can obtain an overall view of the situation from Tables 1 and 2. Here one notices the expenditure elasticities for most foods are positive which is not really too surprising. However, on examining Table 2 one finds a less obvious outcome; that as expenditure rises in many instances consumers are willing to pay more for the same quantity. What this says is that as income and hence expenditure rise households tend to buy higher priced varieties. The implication of this phenomenon is that if one is interested in improving nutritional intake as measured by food quantities, then one should be aware of significant "leakage" between the increase in income and the increase in nutrient intake.

The results are now discussed in more detail first for quantity and then quality of food.

Quantity Regressions

1. Expenditure Effect (EL)

As might be expected, expenditure, (and

hence income), is a significant determinant of the quantity of food entering the consumer's bundle. For ten of the food groups the expenditure elasticity, η_e , is positive. The exception, vegetable ghee (F7), is negative but not statistically significant at the 95% level. This may be attributed in part to severe shortages of that food. In recent years it has been subject to strict rationing.

To appreciate some of the variation across income groups the expenditure elasticities for two foods, wheat, F1 (a staple) and ghee, F6 (a luxury) are given in Table 3.

TABLE 3
EXPENDITURE ELASTICITY OF DEMAND BY INCOME GROUP

Food	Income Group			
	Low	Middle	High	All Groups
wheat	2.79	.37	-.65	.08
ghee	3.7	3.2	3.4	1.3

2. Household Size (HL)

The effect of household size on quantity consumed again follows a fairly distinct pattern, Table 1.

The general tendency is for larger households to have a consumption pattern higher in luxury goods content.

3. Urban-Rural Status (D)

The most significant differences between urban and rural household consumption occurs for butter, F5 and ghee F6 where the urban population consumes less and for vegetable ghee where it consumes more. The differences may in part be attributed to marketing problems and transportation costs; as butter and ghee are more readily available in rural areas while vegetable ghee, largely imported, is more readily available in urban areas.

4. Job Status (J)

The results for job-status are not particularly illuminating. The self-employed are largely farmers and even more so among low income groups. The results do not contribute much more than what might be

expected for farmers. The self-employed consume more pulses, milk and beef.

5. Price (p_1^*)

Nine price elasticities, η_p , were negative, Table 1, statistically significant for luxuries F5, F6 and also for milk, F4 and beef F9. In general it is noted that the quantity of these goods purchased by the higher income groups is not affected negatively by price.

Quality Regressions

1. Expenditure Effect (EL)

Once more the aggregate picture is conveyed by Table 2. The expenditure elasticity of demand for quality, μ_e , is either negligible or positive. The value of μ_e is positive for the luxuries F5 and F6 and also for the sugar group F11. This implies that as consumers income rises there is a strong tendency not only to buy more but also to buy higher priced varieties.

2. Household Effect (HL)

The effect of household size is rather mixed.

For most food groups the household size coefficient is positive; the exceptions being F3, F5 and F6 and vegetable ghee F7. The latter is probably due to the strong role played by the government in maintaining a uniform price. Thus one is led to believe that as household size increases members tend to alter their consumption toward higher priced varieties of some foods.

3. Urban-Rural Status (D)

The results indicate what one might expect intuitively. For ten of the eleven food groups positive coefficients. This one might attribute to the more numerous varieties available in urban areas. Also one expects a broader spectrum of P.T.D. or non-primary components in urban areas. However, advertising media such as television, which is particularly popular in Pakistan among the urban populace wealthy enough to afford it, and radio, exert their greatest efforts in urban areas.

4. Job Status (D)

Again the results are not too brilliant for this variable. The self-employed again reflecting their

bucolic content show preference for the dairy products F5 and F6.

5. Price (p_i^*)

The price elasticities of the demand for quality, μ_p , display an intuitively reassuring pattern. This is helped to some extent by the manner in which quality is defined. In ten instances these are negative and statistically significant. The exception once more is vegetable ghee due to limited variety availability. The price elasticities for quality do not show a uniform pattern for all foods across income groups but for a number of them one may observe that as income rises the μ_p becomes first more negative and then less so. This would indicate that as the general price for these food groups rises the middle class tends to change more than other income groups toward varieties at lower prices than it customarily consumes.

TABLE 4
PRICE ELASTICITY FOR DEMAND FOR QUALITY
IN VARIOUS FOODS ACROSS INCOME GROUPS

Food	Income Group			
	Low	Middle	High	All Groups
Rice(F2)	-.56 (.42)	-1.05 (.14)	-.72 (.46)	-.57 (.13)
Beef(F9)	-.68 (.18)	-1.3 (.1)	-.9 (.8)	-.68 (.18)

Conclusions and Possible Strategies

The primary conclusion of this analysis of the demand for food is that quality matters. Failure to do so will tend to give lower values for price elasticities as quality changes tend to absorb part of the response to prices. Not only should one analyze the quantity of various foods which enter a consumer's bundle but also the quality combination chosen. The general pattern that emerges is

- (i) as income increases people consume more but much of the increase goes to buying higher priced varieties;
- (ii) as household size increases consumption of higher priced varieties increases;
- (iii) urban dwellers are more prone to purchase higher priced varieties;
- (iv) as price levels rise the quantity consumed falls, but an even stronger effect is the degree to which people switch to lower priced varieties.

The issue then arises of what policy implications are suggested. At one extreme (very extreme) a nutritionally aware benevolent dictator looking at these results could conclude that significant improvement in nutritional status may be achieved by using the country's resources to providing only the lower priced varieties. In many centrally planned

economies¹⁰ the government limits the available range of qualities of various foods to ensure that the broad mass of the population is first adequately nourished before catering to those tastes which may involve a mis-allocation of resources.

Where funds are not readily available to supplement incomes or better still food intake, (to avoid leakage effect as indicated by positive quality expenditure elasticities) a government should consider programs to modify tastes. In most mixed economies this could best be done by tax incentives related to nutrient content. This could be done by an advalorem tax rising from zero for the low cost varieties. The rate would vary according to the quality elasticity.

An alternative is to apply some form of price controls to the lower qualities. This has the advantage that much of the cost of such a program may be defrayed by permitting price increase for higher qualities, provided the spread is not too great. Some estimates of the costs of such programs for foodstuffs in Pakistan are given by McCarthy (1977).

Modifying tastes does seem to offer some opportunity to policy makers for improving nutritional status in countries with limited resources. The problem is of course an extremely difficult one. Some strong centrally controlled governments have had some success but in a mixed economy a realistic program should probably rely more heavily on a suitably designed tax incentives in trying to change deeply imbedded traditions. The approach advocated here might be fruitful in that one is not trying to introduce radical taste changes from one food to another but rather changes "within foods" from one variety to another.

¹⁰ For an interesting report of how some of these issues were addressed by one centrally planned economy see Wray(1974).

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