THE ECONOMIC RESEARCH INSTITUTE

Demand Relationships for Ireland

by

C. E. V. LESER

April, 1962 Paper No. 4.

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1. *Introduction.*

The household budget enquiry undertaken in 1951–52 by the Central Statistics Office (1954) yields a considerable amount of information on the distribution of household expenditure over various commodity groups and commodities, and the extent to which this distribution is affected by various factors such as income, household size etc. Although the published data have been utilised in various studies involving international comparisons, notably those made by Houthakker (1957) and by Goreux (1959), a detailed and comprehensive analysis does not appear to have been made yet.

It still seems worthwhile to undertake this task, in spite of the time that has elapsed since the publication of the report. Whilst figures showing the average amount of money spent on various goods a decade ago may be of more historical than topical interest, experience tends to show that relationships between those amounts and other economic variables remain at least approximately valid for a long time.

Income-expenditure relationships, often called Engel functions after a German statistician of that name, are of particular interest. Among other things, one might ideally expect them to indicate the effect of changes in national income upon the national consumption pattern. In practice, Engel functions derived from family budgets do not, for various reasons, lend themselves to immediate application to time series; nevertheless, they do afford a valuable help towards a study of changes in demand over time.

The information contained in the Engel functions may to some extent be summarised in the form of income elasticities of demand, which indicate the sensitivity of demand for various commodities to changes in income. A great deal of empirical work has been done on income elasticities for various commodities and commodity groups in a number of countries and parts of countries, and certain regularities have been observed; but fresh information still remains of theoretical and practical interest. Demand elasticities with regard to household size may similarly be computed; they summarise variations in expenditure patterns between households of different size, which have not been studied to the same extent as variations with income.

The analysis has, in the first instance, been carried out for the five commodity groups " Food ", " Clothing ", " Fuel and Light ", " Housing ", and " Sundries ". Furthermore, the first of these groups has been broken down into 20, and the last of them into 11 subgroups.

In the present paper, the data and methods used will be described, and the numerical results presented will be discussed with regard to both their meaning and limitations.

2. *The data used.*

An analysis of household budget data involves a comparison between averages of amounts spent on various goods, derived for suitably chosen groups. To this purpose, households are usually classified according to income or total expenditure, and according to household composition. Where income-expenditure relations are of predominant interest, the latter classification may be dispensed with if the households are homogeneous with regard to type, say containing 2 adults and 2 children each, or if each income group contained a representative cross-section of all household types; but this is rarely the case.

If data for individual households are available, they may be grouped in the most advantageous manner. For example, data for households of 2 adults, of 2 adults and 1 child, of 2 adults and 2 children etc. would permit a study of the effect that the addition of a child has upon the household's expenditure pattern; analyses on these lines was made for Great Britain by Nicholson (1949) and by Forsyth (1960).

In this instance, the original records are no longer available; and of course, even if they were, the labour in extracting the data would have been very considerable. Recourse was therefore made to the published information, which, though not ideal, proved quite adequate.

Fortunately, a double classification by household size and income per head is available in tables 6 and 6A of the official publication; and these tabulations form the main basic material for the present study. The households have been grouped according to whether they contain 1–2, 3–4, 5–6 or 7 and more persons; and according to whether stated regular income was under 30/-, 30/- to 50/-, 50/- to 80/-, or 80/- and over per person. The double classification thus provides 16 observations from which a comparison may be made; or, in statistical terminology, there are 13 degrees of freedom available for estimating 2 partial regression coefficients on income and household size.

It would have been of some interest to study the effects of variations in income and household size for at least two different social classes separately, thus obtaining at the same time social group differences in expenditure patterns, other things being equal. Similarly, a geographical distinction at least between Dublin and Dun Laoghaire on the one hand, and other cities, towns and villages on the other might appear desirable. This, however, cannot be satisfactorily done, for although various double classifications including social or geographical grouping are available, the published data do not give a triple classification.

Since the proportions of metropolitan households do not seem to vary appreciably between the various income and size of household groups, the results are not likely to be seriously affected by this factor. The social class effect is another matter; since naturally enough the high income groups contain a larger proportion of households in the upper social groups than the low income groups, the effect of variations in income is to some extent confounded with social class differences in expenditure patterns. This fact does not necessarily render the comparisons any less meaningful—in many instances, a rise in income will in fact be associated with a rise in social status and consequent changes in consumer's behaviour—but it must be borne in mind when interpreting the results.

For each commodity or commodity group studied, the data represent the mean weekly expenditure per household in each group. Thus, variations in outlay rather than in quantities purchased are considered. The distinction is a valid one, since a higher outlay on a commodity may partly represent a higher quality, rather than a greater quantity, of the goods bought; some indication of the importance of the quality effect will be given.

It is known, and indeed has been pointed out in the published report, that the amounts shown to be spent on alcoholic drinks are considerably understated. If the understatement is, on the average, proportionate to total outlay or, which comes to the same, to the true amount spent on drink and tobacco combined, it does not produce any noticable bias in the results for the demand elasticities other than that for "sundries" as a whole. Comparison with national consumption data indicates that the true amount spent on drink and tobacco might be about twice the recorded figure; in this case the greater weight given to this subgroup would bring the estimated average income elasticity of demand for all sundries down from 1·50 to about 1·41.

However, if the incidence of the unrecorded outlays varies over the various size and income groups, there may be a bias in the results derived for "Tobacco" and, to a lesser extent, in the remaining results. No correction to the data has been made, and this limitation should be borne in mind when interpreting the results.

As expenditure on the various items is to be related to income and household size, there remains the problem of choosing data indicating these concepts. There is little choice with regard to the former, for although data on income were collected and average stated regular income was used for grouping the returns, figures for average income have not been published for the 16 groups on which the analysis is based. Total expenditure was therefore used instead. This solution is frequently adopted by economic statisticians, even in cases when they could opt for income data, since the concept of total household expenditure lends itself to more clear-cut definition than total household income and is generally more accurately measured. In this enquiry, stated income is known to be lower than the true figure.

In arriving at the figure for total weekly expenditure per household, the procedure adopted in the publication by which small outlays not allocated to any commodity group have been excluded has been followed here. Thus, the expenditure figures for the five main commodity groups distinguished add up to total expenditure.

Strictly speaking, the words "total expenditure" or "total outlay" should thus be used in the following discussion in place of "income"; and the derived demand elasticities should really be denoted as "total expenditure elasticities". To use the words synonymously may, however, be justified if we think in terms of an income concept such as "permanent income" as used by Friedman (1957) rather than in terms of total household income. We may assume that on the average for each household group, total expenditure bears a constant proportion to, or even equals, permanent income. Since the households have been grouped not by observed total outlay but by stated regular income, this assumption is not implausible.

The choice of the indicator of household size is less obvious. The average number of persons is given for each size/income group and is broken down into male and female earners, other male and female adults, children, and domestic servants. The distinction between adults—strictly adolescents and adults—and children under 14 years appears to be the most important one. It would be interesting to show separately the effect of adding an adult and that of adding a child to a household. A preliminary analysis showed that the data did not provide a reliable basis for doing so, but that on the other hand, it would not be realistic to lump adults and children together as persons, since the influence of children on the distribution of expenditure appeared much smaller than that of adults.

It was therefore decided to count each child as half an adult, and to indicate household size by number of equivalent adults, i.e. adults plus half the number of children. For example, a household size of 3·5 could indicate 2 adults and 3 children, or 3 adults and 1 child. Thus, all results for a given household size represent averages for various types of households with a given number of equivalent adults.

3. *The Engel functions.*

The problem now arises of finding an appropriate form of mathematical relationship between expenditure on a commodity on the one hand, income and household size on the other. This problem has received considerable attention on the part of econometricians, particularly as far as the income-expenditure relation is concerned. The discussion may therefore suitably start with this aspect, and consideration of the treatment of household size may be deferred.

The simplest form of Engel functions are the linear ones advocated and used extensively by Allen and Bowley (1935). Their use offers many advantages: they allow easy and efficient computation, and they fulfil the additivity criterion, i.e. the computed outlays on the various commodity groups or commodities add up to total expenditure; furthermore, they would readily lend themselves to incorporation in a linear model of the economy. Where income varies within only a comparatively narrow range, as in a time series analysis or in a budget collection from households of a certain occupational or social group, these advantages may be considered as decisive.

It appears, however, that taken over a wide range of incomes, linear Engel functions do not adequately describe consumers' behaviour. Moreover, some theoretical values of outlays may become negative for incomes within a range that comes into the scope of the investigation. The addition of a quadratic term may meet the former but not the latter objection.

Various other forms of Engel functions which yield positive outlays for all positive incomes have been suggested and used. The simplest of these is the double-logarithmic function in which expenditures are proportionate to a power of income, and the relations between logarithms of income and outlay are linear. It does not satisfy the requirement of additivity, but can be made to do so by the introduction of a correction factor. In this form, it has been used by Leser (1941) and recently by Houthakker (1960) who used the term "additive logarithmic function".

About the most appropriate form of relationship between outlays and household size there is little direct evidence, and the choice of formula is usually governed by practical considerations in conjunction with the foregoing ones; that is to say, an additional additive or multiplicative term is introduced according to whether a linear or a logarithmic model is adopted.

With the set of data described here, both linear and additive logarithmic functions have been computed. The linear functions were found to be adequate for the broad commodity groups and for the food subgroups, but not very suitable for the sundries subgroups, where they indicated theoretical negative values in the case of several subgroups at realistic income and household size levels. Also, as shown in Appendix C the additive logarithmic function gave the better fit to the data in most cases, and the quoted results were derived on this basis.

The mathematical form of the expenditure function is as follows, when applied to commodity groups:

$$v_{i(c)} = \alpha_i M^{\beta_i} H^{\gamma_i} C \qquad (i = 1, \ldots, 5) \qquad (1)$$

$$C = 1 \Big/ \sum_{j=1}^{5} \alpha_j M^{\beta_j - 1} H^{\gamma_j}$$

where v_i indicates outlay on the ith commodity group

$v_{i(c)}$ its calculated or theoretical value

M total expenditure (in place of income)

H number of equivalent adults (household size)

α_i, β_i, γ_i constants.

We also write

$w_i = v_i / M$ for the proportion of commodity group outlay to total expenditure.

$\overline{M}$, $\overline{H}$ for average values of M and H (here the geometric means of the 16 observations)

$\overline{v_i}$, $\overline{w_i}$ for the values that $v_{i(c)}$ and $w_{i(c)}$ assume when M and H are at their average level, i.e. the geometric means of the observations adjusted for additivity.

It is clear that equations (1) remain unchanged, if the same number is added to all constants β_i or to all constants γ_i, or if all constants α_i are multiplied by the same number. These constants are thus not fully determinate. A suitable specification which fixes them is as follows

$$\begin{aligned} &\sum_{j=1}^{5} w_j \beta_j = 1 \\ &\sum_{j=1}^{5} w_j \gamma_j = 0 \qquad\qquad (2) \\ &\sum_{j=1}^{5} \alpha_j \overline{M}^{\beta_j - 1} \overline{H}^{\gamma_j} = 1 \end{aligned}$$

In this case, we have the simple relation

$$v_{i(c)} = \alpha_i \overline{M}^{\beta_i} \overline{H}^{\gamma_i}$$

Furthermore, if we adopt this specification, the constants β_i and γ_i can be given a simple interpretation in terms of demand elasticities.

The income elasticity of demand is the percentage increase or decrease in outlay on a commodity group (or commodity per unit percentage increase in income (or total expenditure) with which it is associated, other things being equal. It is usually positive, but negative values may occur with "inferior goods", the consumption of which is curtailed when more money becomes available to purchase more highly regarded goods. If the income elasticity lies between 0 and 1, the demand is said to be inelastic with regard to income; it means that with increased spending, outlay on the good expands but not in proportion to total outlay. A good with an income elasticity above 1 is said to have an elastic demand with regard to income: here expenditure grows more rapidly than income or total outlay, pointing to the relative luxury character of the commodity.

Similarly, we can speak of an elasticity of demand with regard to household size, representing the percentage increase or decrease in spending on the commodity associated with a percentage increase in household size. As total household income is considered as unchanged, additional outlay on one commodity must be accompanied by reduced outlay on another one; and while some of these elasticities will thus be positive, others will be negative.

It can be readily shown that when relations (2) hold, the constants β_i and γ_i represent the elasticities of demand with regard to income and household size respectively at average level of M and H ($M=\overline{M}$, $H=\overline{H}$), or briefly the average elasticities of demand.

With different values of H, the demand elasticities are not constant, though in this mathematical model they vary very slowly and the differences between them remain constant. It can also be shown that the general expressions

$$\beta_i - \sum_{j=1}^{5} w_j \beta_j + 1 \quad \text{and} \quad \gamma_i - \sum_{j=1}^{5} w_j \gamma_j$$

represent the elasticities of demand at any level of income and household size.

It goes without saying that the constants α_i, β_i and γ_i are not known; but estimates, which will be denoted by a_i, b_i and c_i, can be readily derived by least square methods. The computational procedure consists in constructing multiple regressions for each log v_i (or log w_i) on log M and log H; from the results, the ratios between pairs of a_i, and the differences between pairs of b_i and pairs of c_i, are obtained. The specifications (2) are then applied to fix their values b_i and c_i then serve as estimates for the average elasticities of demand.

From the theoretical point of view, this is not a perfect minimising procedure. It is quite plausible to assume random variations in commodity group expenditure to be proportionate to income; thus ideally we should have

$$\Sigma(w_i - w_{i(c)})^2 = \text{Min.} \qquad (i=1, \ldots, 5)$$

where $\qquad w_{i(c)} = C a_i M^{b_i - 1} H^{c_i}$

and the summation is taken over the 16 observations.

It is not possible to choose one set of coefficients $a_1, b_1, c_1, \ldots, a_5, b_5, c_5$ in such a way that all expressions are simultaneously minimised. However, it is possible to adjust the constants by iteration in such a way that some of the normal equations derived from the above condition, viz.

$$\Sigma(w_i - w_{i(c)}) w_{i(c)} (1 - w_{i(c)}) = 0$$

are satisfied or nearly so. This will improve the fit. In fact the adjustments required appear to be small here, the order of magnitude being ·01 for b_i and c_i, and thus of no practical importance.

Another possible improvement would consist in weighting the observations in proportion to number of households in each group. It is not difficult to reconstruct an approximate set of appropriate weights from the data but as they do not, with one exception, differ very much from each other, this refinement has been sacrificed for the sake of computational ease, and unweighted regressions have been constructed.

When it is desired to derive demand functions for commodities (or subgroups) as well as for commodity groups, a slight difficulty arises in this model, which is absent when a linear relationship is assumed. If formulae (1) are applied to individual commodities and the results for commodity groups are obtained by aggregation, the demand function for the group will not follow furmula (1), and the results for the group will depend on the classification adopted within the group. If, on the other hand, formulae (1) are applied to individual commodities as well as to groups, then the figures for commodities within the group do not necessarily add up to the group total.

The difficulty may be overcome by showing the expenditure on each commodity as a function not of total expenditure but of total expenditure on the commodity group. As in this instance, commodity group 1 (Food) has been divided into 20 subgroups, we have

$$v_{1,i(c)} = a_{1,i}\, v_{1(c)}^{\beta_{1,i}}\, H^{\gamma_{1,i}}\, C_1 \qquad (i=1, \ldots 20)$$

$$C_1 = 1 / \sum_{j=1}^{20} a_{1,j} v_{1(c)}^{\beta_{1,j}-1} H^{\gamma_{1,j}}$$

and similarly for the 11 subgroups of group 5 (Sundries)

$$v_{5,i(c)} = a_{5,i} v_{5(c)}^{\beta_{5,i}} H^{\gamma_{5,i}} C_5$$

$$C_5 = 1 / \sum_{j=1}^{11} a_{5,j} v_{5(c)}^{\beta_{5,j}-1} H^{\gamma_{5,j}}$$

The constants are estimated by linear regressions of log $v_{1,i}$ on log v_1 and log H, or of log $v_{5,i}$ on log v_5 and log H respectively. In relations corresponding to (2) symbols corresponding to w_i, referring to proportions of total food or sundries outlay, will appear.

It should be noted that the constants $\beta_{1,i}$, $\gamma_{1,i}$ and $\beta_{5,i}$, $\gamma_{5,i}$ or their estimates do not in themselves represent elasticities of demand with regard to income or household size. $b_{1,i}$ represents the estimated average percentage increase in outlay on some foodstuffs associated with a 1% increase in total food expenditure; the increase associated with a 1% increase in total expenditure is therefore given by the product $b_1\, b_{1,i}$. The coefficient $c_{1,i}$ moreover indicates the estimated average percentage increase in outlay on the foodstuffs in question, associated with a 1% increase in household size, total food expenditure remaining unchanged; but as total food expenditure does not remain unchanged when the household size varied, the elasticity sought is given as the sum $c_1 b_{1,i} + c_{1,i}$. For sundries, the position is similar.

4. *Results for commodity groups.*

For the 5 main commodity groups, the most important results are shown in the following table. An indication of accuracy is provided in the form of standard errors; broadly speaking, we can reasonably expect the true figures to lie within a range of 2–3 times the standard error from the estimates.

The first column of figures indicates that an increase in total outlay by, say, 10%—probably brought about by a correspondingly higher income—implies generally an increase of about 5% in outlay on food and on fuel and light, a 10% increase in housing expenditure, and a 15% increase in expenditure on clothing and on sundries. The demand for food, and that for fuel and light can thus be said to be inelastic, the demand for clothing and for sundries to be elastic with regard to income, whilst housing appears to be a border line case.

The results are in agreement with those previously obtained for other countries and places. In 22 family budget enquiries analysed and quoted by Allen and Bowley (1935) the demand elasticities given range from 0·3 to 0·9 for food, from 0·9 to 1·9 for clothing, from 0·2 to 1·2 for fuel and light, from 0·5 to 1·2 for rent, and from 1·1 to 2·3 for other items. Similarly, in 35 surveys analysed by Houthakker (1957), mostly referring to the post-war period, the elasticities lie between 0·344 and 0·731 for food, between 0·918 and 1·784 for clothing, between 0·346 and 1·122 for housing (including fuel and light), and between 1·081 and 1·879 for miscellaneous items; and a value of 0·6 for food, 1·2 for clothing, 0·8 for housing and 1·6 for other items is considered a reasonable estimate for a country for which no expenditure data are available.

TABLE 1. AVERAGE ELASTICITIES OF DEMAND FOR COMMODITY GROUPS

i	Commodity group	Average elasticity of demand with regard to	
		total outlay (income) b_i	household size c_i
1	Food	0·553±0·026	0·401±0·037
2	Clothing	1·540±0·075	−0·202±0·109
3	Fuel and light	0·499±0·038	−0·071±0·055
4	Housing	0·967±0·025	−0·532±0·036
5	Sundries	1·499±0·025	−0·297±0·037
	All groups ..	1	0

The fact that food expenditure tends to increase less than total expenditure was already familiar to Engel and is known as Engel's law.

The most interesting result is that for housing, where the estimated demand elasticity lies a little below 1, but the difference from 1 is too small to be statistically significant. The view sometimes expressed as Schwabe's law—that housing demand, like food demand, is inelastic—has been widely held, but is not universally accepted. It has been challenged for example by Muth (1960), who suggests that an income elasticity of 1 or higher for housing demand is realistic. The Irish data would seem to support his view on the whole.

The conclusion must, however, be qualified in the light of further analysis. The Engel functions for commodity groups, the results of which have been summarised and which are given in full in Appendix B, have been applied to average total outlay and household size in each of the five social groups distinguished, and the actual expenditure pattern has been compared with this computed one. Some of the differences fall into a clear pattern: housing expenditure rises more than expected on the basis of the Engel function, expenditure on sundries less than expected as we go up the social scale. This indicates that a social class effect has operated in the direction of raising the income elasticity of demand for housing and of lowering that for sundries. In other words, with a rise in income but not in social status, the percentage increase in housing expenditure would not be as large, and the percentage increase in sundry expenditure more than $1\frac{1}{2}$ times as large, as the percentage increase in income or total outlay.

The second set of figures in Table 1 refers to variations in household composition and suggests that a larger household spends more on food and less on all other expenditure groups than a small household, assuming that the same amount of spending power is available. As one illustration, consider households with the same income of 2 and $2\frac{1}{2}$ equivalent adults—2 adults, and 2 adults with a child—or alternatively, households of 4 and 5 equivalent adults. As defined here, the size of the larger exceeds that of the smaller household by 25%. On the average, the larger household will tend to spend 10% more on food, but 5% less on clothing, 2% less on fuel and light, $13\frac{1}{2}$% less on housing, and $7\frac{1}{2}$% less on sundry items.

The figures for clothing and for fuel and light are small and not statistically significant; that is to say, there is insufficient evidence to show that larger households do, in fact, cut down on clothing or on fuel and light. The additional outlay demanded on food, and the consequent reduced spending on housing and on sundries seems, however, clearly established.

The combined effect of an increase in household size and an increase in income in the same proportion can be gauged by adding the two elasticities together. The sum is seen to be slightly below 1 for food, substantially below 1 for fuel and light and for housing, but well above 1 for clothing and sundries. This suggests that the larger household, given a proportionately higher income, is substantially better off: the members benefit from economies of scale as far as housing and fuel outlay is concerned (though not appreciably from economies with food) and there is more money available for comparative luxury spending.

These results, strictly speaking, only hold exactly at the average level of total outlay and household size, that is to say, in the neighbourhood of a total outlay of 204·44s. per week, and a household size of 3·492 equivalent adults. These averages have been derived as geometric means of the 16 observations; the averages published or available in the report, representing weighted arithmetic means, are 216·86s. and 3·48 equivalent adults (2·81 adults and 1·34 children). At the average level of the present analysis, the expenditure pattern is as follows:

TABLE 2. AVERAGE EXPENDITURE ON EACH COMMODITY GROUP

i	Commodity group	Average expenditure on group: per household per week (s.) $\bar{v}_i$	as proportion of total outlay (%) $100\,\bar{w}_i$
1	Food	83·56	40·87
2	Clothing	23·39	11·44
3	Fuel and light	16·13	7·89
4	Housing	14·70	7·19
5	Sundries	66·66	32·61
	All groups ..	204·44	100·00

The Engel functions, shown in Appendix B, allow the computation of the theoretical expenditure pattern in absolute or relative terms at any level of total outlay and household size. In the first instance, this has been done for the values of M and H assumed in the 16 groups of households on which the analysis is based. This permits a comparison to be made between actual and theoretical expenditures, and thus to judge the goodness of the fit for the Engel function to the data.

A glance through Table 3 shows that the agreement between actual and theoretical figures is on the whole close; especially for food and housing and also for sundries when the size of the group is taken into account, the fit may well be described as excellent. It is least satisfactory for clothing expenditure; this, however, is an expenditure group in which considerable irregularities may be expected to be found and do in fact occur, unless budgets are kept over a long period of time. Numerical measures of closeness or goodness of fit are given in Appendix C.

The variations in expenditure pattern with different household size and income can more readily be gauged when the demand functions are applied to a few selected values of M and H, and

TABLE 3. ACTUAL AND CALCULATED EXPENDITURE ON EACH COMMODITY GROUP FOR 16 INCOME SIZE GROUPS

Equivalent adults	Total outlay (s.)		Actual (v_i) or calculated ($v_{i(c)}$) expenditure on—				
			Food	Clothing	Fuel and light	Housing	Sundries
H	M	i:	1	2	3	4	5
1·515	44·94	v_i	21·82	2·13	8·23	5·13	7·63
		$v_{i(c)}$	22·92	2·38	7·12	4·70	7·82
1·565	75·44	v_i	33·36	4·51	9·57	7·70	20·30
		$v_{i(c)}$	33·41	5·68	9·94	8·23	18·18
1·855	124·64	v_i	50·31	13·48	13·14	11·56	36·15
		$v_{i(c)}$	48·79	12·28	13·04	12·62	37·91
1·83	222·93	v_i	66·87	32·35	15·64	22·43	85·64
		$v_{i(c)}$	65·51	29·49	17·07	21·83	89·03
2·96	92·07	v_i	47·31	7·29	10·29	7·28	19·90
		$v_{i(c)}$	47·77	6·72	10·41	7·05	20·12
3·07	146·50	v_i	66·02	15·96	13·05	10·33	41·14
		$v_{i(c)}$	65·51	14·26	13·68	11·33	41·72
3·085	227·21	v_i	80·95	33·20	17·31	17·31	78·44
		$v_{i(c)}$	83·98	28·11	17·09	17·33	80·70
3·28	358·27	v_i	106·00	49·74	20·49	27·53	154·51
		$v_{i(c)}$	106·95	54·07	20·63	25·16	151·46
4·03	135·29	v_i	70·34	11·64	12·19	8·86	32·26
		$v_{i(c)}$	68·55	11·71	12·64	8·90	33·49
4·28	218·44	v_i	94·65	27·58	14·46	13·49	68·26
		$v_{i(c)}$	93·93	24·83	16·41	14·06	69·21
4·62	331·20	v_i	119·03	46·13	18·72	19·85	127·47
		$v_{i(c)}$	120·60	45·90	19·87	19·96	124·87
4·765	490·14	v_i	147·15	74·97	27·26	28·22	212·54
		$v_{i(c)}$	145·64	80·07	23·15	27·54	213·74
5·945	175·28	v_i	92·85	14·72	13·90	9·87	43·94
		$v_{i(c)}$	92·15	16·08	13·95	9·26	43·84
6·615	305·44	v_i	132·79	39·16	17·53	14·35	101·61
		$v_{i(c)}$	133·75	37·84	18·69	15·31	99·85
6·90	468·21	v_i	168·96	72·04	25·44	21·99	179·78
		$v_{i(c)}$	168·95	71·03	22·62	22·20	183·41
6·41	749·08	v_i	196·94	120·23	27·11	34·72	370·08
		$v_{i(c)}$	197·83	138·21	26·73	33·81	352·50

when figures are given for $w_{i(c)}$ instead of $v_{i(c)}$, that is to say they are expressed as proportions of total outlay. This is done in Table 4 for households of 2, 4 and 6 equivalent adults, with a total outlay of £5, £10 or £15. For each commodity group, one can read off the effect of an increase total outlay by going from left to right, and the effect of an increase in household size by going downwards. The figures in the diagonals from the top left hand to the bottom right hand corner refer to households with the same total outlay per equivalent adult, viz. £2 10s. The bottom left hand corner refers to households on the extreme poverty line with only 16s./8d. per adult and half that per child to spend; whilst the household in the top right corner, with an expenditure of £7 10s. per adult are comfortably off.

Variations in elasticities of demand are also shown: the validity of this comparison, of course, stands or falls with the appropriateness of the mathematical model.

The figures in the left-hand part of the table illustrate the extreme variability of expenditure patterns and need little comment. The variations are more marked between income than between size groups for clothing and for fuel and light, whilst the opposite applies to housing; this fact is implied in the results obtained for average elasticities of demand. The differences in expenditure patterns between small and large households with total outlay proportionate to size are also worth noting.

The set of figures on the right hand side shows that income elasticities of demand tend to decrease with rising income, and to increase with rising household size (and thus declining income per head). This is on the whole plausible; and the theoretical problems involved have recently been discussed by Houthakker (1960) who used the model to explain differences in demand elasticities at widely differing income levels.

The numerical values of the demand elasticities become less accurately determined the further household size and total outlay are removed from their average values, and they should therefore be interpreted with caution. Nevertheless, the tabul-

TABLE 4. EXPENDITURE PATTERNS AND INCOME ELASTICITIES OF DEMAND FOR HOUSEHOLDS OF DIFFERENT SIZES AND DIFFERENT INCOMES

	Expenditure as % of total outlay: $100\,w_i$			Income-elasticity of demand: $b_i - \Sigma w_j b_j + 1$		
	$M=100$	$M=200$	$M=300$	$M=100$	$M=200$	$M=300$
Food:						
$H=2$ ..	43·99	32·46	25·94	0·633	0·489	0·405
$H=4$ ..	55·56	43·52	36·00	0·716	0·576	0·488
$H=6$ ..	62·03	50·30	42·53	0·761	0·630	0·542
Clothing:						
$H=2$ ..	8·51	12·44	14·83	1·620	1·475	1·392
$H=4$ ..	7·08	10·98	13·55	1·702	1·562	1·474
$H=6$ ..	6·18	9·94	12·54	1·747	1·616	1·528
Fuel and light:						
$H=2$ ..	11·48	8·16	6·38	0·579	0·434	0·351
$H=4$ ..	10·45	7·89	6·38	0·661	0·522	0·434
$H=6$ ..	9·64	7·53	6·23	0·707	0·575	0·488
Housing:						
$H=2$ ..	9·69	9·52	9·00	1·047	0·902	0·819
$H=4$ ..	6·41	6·68	6·54	1·129	0·990	0·902
$H=6$ ..	4·90	5·30	5·29	1·175	1·043	0·956
Sundries:						
$H=2$ ..	26·33	37·42	43·85	1·579	1·434	1·351
$H=4$ ..	20·50	30·93	37·53	1·661	1·521	1·433
$H=6$ ..	17·25	26·93	33·41	1·706	1·575	1·487

ation serves as a salutary reminder of the fact that income elasticities of demand cannot be taken as constant, and it is an over-simplification to speak of the income-elasticity of demand even for a given time, place and social group. In particular, the demand for housing may well be, as it is here, elastic with regard to income for some households and inelastic for others.

The elasticities with regard to household size which are not shown in the tables are likewise subject to variation. For example, for $M=100$ and $H=6$, the elasticities should be 0·152 below those shown in Table 1, i.e. 0·249, −0·354, etc.; for $M=300$ and $H=2$, they are about 0·109 above the values in table 1 (so that the figure for fuel and light becomes positive). In the three groups for which $M/H=50$, the elasticities in table 1 apply when a minor correction, in form of deducting 0·013 to 0·021 has been made. The general remarks made about variations in income elasticities of demand equally apply in this case.

5. *Results for food.*

The demand for food has been subjected to a further analysis, in which the whole group has been broken down into 20 components. The names of the food subgroups, which will be found in the tables, are largely self-explanatory, but some notes on the foodstuffs concerned are given in Appendix A.

The importance of the various food items in the average food budget and in the average total budget is shown in table 5; the figures refer to an average total outlay of 204·44s. and an average household size of 3·492 equivalent adults. It is seen that in this average budget, about 60% of total food outlay is accounted for by the following subgroups or combinations of them and about 10% by each: bread and flour; milk; butter; eggs, cheese and miscellaneous fats; beef; potatoes and vegetables. A further 20% goes on meat other than beef and fish, leaving 20% for various other foodstuffs.

The main results of the analysis are given in Table 6. As previously explained, the relation

TABLE 5. AVERAGE EXPENDITURE ON EACH FOOD SUBGROUP

i	Food subgroup	Average expenditure		
		per household per week (s.) $\overline{v}_{1,i}$	as percentage of	
			total food outlay $100\,\overline{w}_{1,i}/\overline{w}_1$	total outlay $100\,\overline{w}_{1,i}$
1	Bread and flour	7·79	9·32	3·81
2	Biscuits and cakes	2·79	3·33	1·36
3	Milk	8·99	10·76	4·40
4	Butter	8·21	9·83	4·02
5	Miscellaneous fats and cheese	1·59	1·90	0·78
6	Eggs	5·79	6·93	2·83
7	Beef	8·31	9·95	4·07
8	Mutton	3·46	4·14	1·69
9	Miscellaneous Meat	11·16	13·36	5·46
10	Fish	1·86	2·23	0·91
11	Potatoes	3·69	4·42	1·80
12	Vegetables	4·08	4·89	2·00
13	Fresh fruit	1·32	1·58	0·65
14	Tinned and dried fruit	0·70	0.84	0·34
15	Tea, etc.,	2·38	2·84	1·16
16	Sugar	1·93	2·31	0·94
17	Preserves	1·44	1·72	0·70
18	Cereals	1·29	1·54	0·63
19	Sweets, ice-cream, etc.,	1·39	1·66	0·68
20	Miscellaneous food	5·39	6·45	2·64
	All food	83·56	100·00	40·87

directly investigated is that which outlay on each food bears to total food expenditure and to household size. The partial regression coefficients on total food expenditure must therefore be interpreted as total food outlay elasticities of demand, whilst the regression coefficients on household size do not readily lend themselves to a direct interpretation. This is so because they only represent one of the effects which variation in household size has on expenditure for each kind of food; the other effect operates through the additional total food outlay which has been shown to go hand in hand with a larger household size, other things being equal. This set of figures is therefore not shown here—though it appears in the Engel function given in the appendix—but elasticities of demand with regard to income and household size can be easily derived; and they are shown together with the total food outlay elasticities.

If the food subgroups are classified according to the value of their elasticity of demand with regard to food outlay and total outlay, they may be divided into six categories. There are firstly those foods, consumption of which does not vary appreciably with income or total food outlay; they are bread and flour, butter, and potatoes (3 subgroups). For foodstuffs in the second category, expenditure increases with total food outlay but far more slowly, and total outlay elasticities are low; this applies to milk, tea, etc. and sugar (3). Thirdly, expenditure increases approximately in proportion with total food outlay, but still considerably less than total expenditure and income elasticities are about 0·5—0·6 in the case of miscellaneous fats and cheese, beef, miscellaneous meat, preserves and cereals (5). Fourthly, expenditure increases more than proportionately to total food outlay but still less than proportionately to income for eggs, and vegetables (2). The fifth category contains foods with total outlay elasticities of about 1; these are biscuits and cakes, mutton and fish (3). Finally, high income elasticities, in the neighbourhood of 1·5, are found

TABLE 6: ELASTICITIES OF DEMAND FOR FOOD.

i	Food subgroups	Average elasticity of demand with regard to		
		total food outlay $b_{1,i}$	total outlay (income) $b_1 b_{1,i}$	household size $c_1 b_{1,i} + c_{1,i}$
1	Bread and flour	—0·091±0·071	—0·050	1·000
2	Biscuits and cakes	2·120±0·078	1·173	—0.273
3	Milk	0·565±0·049	0·313	0·682
4	Butter	0·102±0·048	0·056	0·990
5	Misc. fats and cheese	0·837±0·062	0·463	0·523
6	Eggs	1.213±0·051	0·671	0·248
7	Beef	0·882±·0056	0·488	0·492
8	Mutton	2·080±0·125	1.151	—0.496
9	Miscellaneous meat	1·137±0·062	0·629	0·230
10	Fish	1.745±0·046	0·966	—0·071
11	Potatoes	0·016±0·098	0·009	0·913
12	Vegetables	1·277±0·050	0·707	0·211
13	Fresh fruit	2·906±0·093	1·608	—0·446
14	Tinned and dried fruit	2.629±0·114	1·455	—0·272
15	Tea, etc.	0·497±0·053	0·275	0·486
16	Sugar	0·338±0·025	0·187	0·750
17	Preserves	0·888±0·076	0·492	0·476
18	Cereals	0·834±0·097	0·462	0·632
19	Sweets and ice-cream, etc.	2·522±0·090	1.396	—0·174
20	Miscellaneous food	2·781±0·106	1.539	—0·404
	All food	1	0·553	0·401

for fresh fruit, tinned and dried fruit, sweets and ice-cream, etc., and miscellaneous food (4). Commodity classification in the foregoing categories is shown in Table 7.

The most surprising features are the low value of the income elasticity obtained for butter, and the high value obtained for mutton. The result for butter had already been obtained and commented upon by the F.A.O. (1957). Butter does not appear to be an inferior good, at least at average income levels, as the coefficient is almost significally positive at the 5% level; yet it makes a strange companion to the other foods in this category, viz. bread and flour, and potatoes. It is also notable that margarine which forms a textbook example of an inferior good, is not—or at any rate was not at the date of the enquiry—an inferior good in Ireland; it forms part of the "miscellaneous fats and cheese" subgroup and if the admittedly small figure for margarine was extracted, an even higher value would be obtained for the income elasticity than that of the subgroup. There is—or has been—no tendency to replace butter by margarine at low levels of household income. The high level of fat consumption at low income levels may be explained by the high consumption of bread and potatoes which it conventionally accompanies, but the adherence to butter would appear to be more traditional than rational.

There is no obvious explanation for the special position as a luxury food that mutton occupies, as compared with meat in general. Otherwise, the foods with an income elastic demand are more or less those one would intuitively classify as relative luxuries. None of them plays an important part in the average food budget.

There is generally more variation between results of different enquiries with regard to kinds of food than with regard to commodity groups. Allen and Bowley (1935) list elasticities for broad food groups in relation to total food outlay obtained from 26 enquiries with which the first column of figures in Table 7 is comparable. For cereals including bread, the figures are generally well below 1 and occasionally negative; for meat generally a little above 1; for dairy products around 1; for sugar well below 1; for miscellaneous foods well above 1 (for vegetables including potatoes as well as tea and coffee, the range of results is very wide). The results obtained here generally fit in to these patterns.

A comparison may be apposite with the results obtained by Prais and Houthakker (1955) from their analysis of the British working class household budget enquiry of 1937–38. Generally speaking, the result derived for Ireland indicates a wider dispersion between the income elasticities for different kinds of food than would appear to exist for Great Britain. It would appear that in Britain the demand for most foods was moderately inelastic, with a heavy concentration of results round the ·5 mark. It may, however, be mentioned that different results, generally showing wider dispersion and closer to the Irish experience, were given by Stone (1954) in his analysis of the same material in combination with other data.

To return to Table 6, the last column of figures shows the effect of variations in household size on food purchases. Broadly speaking, we can state that with additional consumers and no additional income in the household, much more is spent on food in the first two categories which have a very inelastic demand; somewhat more on the third and fourth categories of food for which demand is slightly inelastic; less is spent on goods in the fifth and sixth categories, which are relative luxuries.

Furthermore, the sum of the two elasticities shown in Table 6 is generally close to 1 but a little lower which means that a little less is generally spent on most foods in relation to total expenditure in large than in small households with the same income per equivalent adult. The most marked exceptions to this rule are fresh fruit, tinned and dried fruit, and sweets and ice-cream etc., which seem to command a greater share in the large households. The opposite extreme is afforded by the case of tea, possibly indicating substantial economies of scale in tea making. Of course, the higher proportion of children in the larger households may be partly responsible for these effects.

The fit of the Engel curves to the observations is generally good. Table 7 is designed to illustrate both the variations in food expenditure patterns between different household groups and the ability of the theoretical scheme to explain them. Here the foodstuffs have been arranged according to the value of their demand elasticities, and the distribution of outlay is shown for 4 of the 16 household groups on which the analysis is based, namely those giving extreme combinations of small or large household size and low or high income.

A comparison between the first and second, or between the third and fourth columns of figures shows the effect of differences in total outlay on food consumption; this is clearly seen to be very slight in the first and very substantial in the last category of foodstuffs. The agreement between the actual and theoretical values is close in every instance.

TABLE 7. ACTUAL AND THEORETICAL FOOD EXPENDITURE PATTERNS.

Foods	Actual and calculated food expenditure in household with:				
	Size (eq. ad.). Outlay (s.)	1·515 44·94	1·83 222·93	5·945 175·28	6·41 749·08
I Bread and flour, butter, potatoes	Actual	6·99	10·15	32·68	32·28
	Calculated	7·74	9·49	30·51	33·32
II Milk, tea, etc., sugar	Actual	4·27	8·45	16·70	27·22
	Calculated	4·29	8·13	16·68	25·85
III Miscellaneous fats and cheese, beef, miscellaneous meat, preserves, cereals.	Actual	5·89	17·77	24·07	53·16
	Calculated	6·22	17·88	24·86	53·24
IV Eggs, vegetables.	Actual	2·29	8·25	9·00	22·74
	Calculated	2·33	8·22	9·33	22·74
V Biscuits and cakes, mutton, fish	Actual	1·54	9·73	5·06	22·87
	Calculated	1·49	10·12	5·38	23·18
VI Fresh fruit, tinned and dried fruit, sweets and ice-cream, etc., miscellaneous food.	Actual	0·84	12·52	5·34	38·67
	Calculated	0·85	11·67	5·39	39·50
All food.	Actual	21·82	66·87	92·85	196·94
	Calculated	22·92	65·51	92·15	197·83

In the case of a number of foodstuffs, the additional outlay associated with an increase in income is attributed partly to a larger quantity purchased, and partly to a higher quality or higher price paid for the same quantity. The proportion of the additional expenditure accounted for by this quality factor appears to be about 80% in the case of tea, about 30% in the case of beef and fish, and about 10% in the case of butter, eggs, mutton and preserves. In the case of bread, a lower quantity consumed in the higher income groups is partly offset by a higher price paid per unit. There is, of course, no means of distinguishing between true quality differences and differentials in prices for identical goods.

6. *Results for Sundries*

The expenditure on sundries constitutes an important part of the total household budget, the proportion of total outlay devoted to it varying from about one-sixth to one-half. On the average, its share in the household budget is about one-third, and it is thus second in importance only to food with an average share of about two-fifths. A further study of the demand for the goods and services making up this group is therefore indicated.

The subgroups chosen have been those given in the published report, except that " Education " and " Medical expenses " which show a very small outlay or even no outlay at all for some household groups have been combined and that alcoholic drink has been included with miscellaneous goods instead of with tobacco. Eleven subgroups have thus been obtained; they are listed in Table 8, which at the same time indicates the relative importance of each at average levels of household size and income. Some explanatory notes are given in Appendix A.

The subgroups, or some of them, could also have been treated as individual commodity groups, since their combination does not make a natural group like food. However, it is not unreasonable to suppose that the consumer first decides on the distribution of his outlay over the five main commodity groups, and then decides how to spend the amount available for sundries. This assumption justifies the present treatment, in which expenditure on each sundries subgroup is treated as a function of expenditure on the whole group as well as household size. Results are presented here in a similar form to those given for food.

By and large, the expenditure data show greater irregularities for the sundries subgroups than for broad groups and foodstuffs; these are particularly marked for education and medical expenses, and for services. This implies that the regression coefficients which represent or enter into demand elasticities are less accurately estimated here—a fact which is partly reflected in larger standard errors—and the results must be interpreted with some caution.

Nevertheless, some results are brought out quite clearly. The one subgroup which stands out from the rest by virtue of its low income elasticity of demand is that of household non-durable goods, which includes household soap, soap powders, polishes, etc. This is, of course, quite plausible. Average outlay on these items amounted to about 2s./6d. per week for a medium-sized household; this tends to be somewhat lower for small households and low incomes, higher for large households and high incomes, but the variations are relatively small.

The elasticity of demand for tobacco is also shown to be not only much lower than that for the group as a whole, but also below 1, though not very much. A similar result has been obtained for Britain in 1937–38 by Prais and Houthakker (1955). The data for tobacco are believed to be far more reliable than those for alcoholic beverages; nevertheless, it is possible that they also contain some

TABLE 8. AVERAGE OUTLAY ON EACH SUNDRIES SUBGROUP

i	Sundries subgroup	Average expenditure		
		per household per week (s.) $\bar{v}_{5,i}$	as percentage of expenditure on: all sundries $100\,\bar{w}_{5,i}/\bar{w}_5$	all goods $100\,\bar{w}_{5,i}$
1	Tobacco	11·14	16·70	5·45
2	Household non-durable goods	2·60	3·90	1·27
3	Personal care	1·32	1·99	0·65
4	Household durable goods ..	4·32	6·47	2·11
5	Miscellaneous goods	6·15	9·23	3·01
6	Travel and holidays	7·29	10·94	3·57
7	Entertainment	4·71	7·07	2·31
8	Education and medical expenses	5·41	8·12	2·65
9	Social security	7·58	11·36	3·70
10	Services	9·55	14·33	4·67
11	Postage, subscriptions, etc. ..	6·59	9·89	3·22
	All sundries	66·66	100·00	32·61

TABLE 9. ELASTICITIES OF DEMAND FOR SUNDRIES

i	Sundries subgroup	Average elasticity of demand with regard to:		
		total sundries outlay $b_{5,i}$	total outlay $b_5 \cdot b_{5,i}$	household size $c_5 b_{5,i} + c_{5,i}$
1	Tobacco	0·554 ± 0·060	0·830	0·097
2	Household non-durable goods	0·287 ± 0·015	0·430	0·270
3	Personal care	0·941 ± 0·063	1·410	−0·223
4	Household durable goods ..	1·443 ± 0·093	2·162	−1·017
5	Miscellaneous goods	0·949 ± 0·043	1·422	−0·459
6	Travel and holidays	1·742 ± 0·076	2·611	−1·022
7	Entertainment	1·077 ± 0·089	1·614	0·136
8	Education and medical ..	1·102 ± 0·106	1·652	0·252
9	Social security	0·862 ± 0·058	1·292	0·020
10	Services	1·088 ± 0·108	1·630	−0·635
11	Postage, subscriptions, etc. ..	0·877 ± 0·058	1·314	−0·412
	All sundries	1	1·499	−0·297

errors in recording, Stone (1954) did not consider budget data for tobacco or drink sufficiently reliable to use and based his analysis for these commodities entirely on time series, thus obtaining estimates for the income elasticity of demand for tobacco in the neighbourhood of 0·2.

At the other end of the scale are the subgroups "household durable goods" and "travel and holidays" (which includes motoring). The income elasticity of demand for these subgroups are greater than 2 and well above the figure for the whole sundries group; they are also higher than the figure for clothing. At the same time expenditure falls sharply with increasing household size but unchanged total household income. These two items thus form the main outlay for luxury spending.

The remaining subgroups are characterised by elasticities of demand with regard to total outlay and household size which are not substantially and, generally speaking, not significantly different from the corresponding figure for all sundries; they can thus be regarded as moderate luxuries. The sum of the two elasticities is, however, much in excess of 1 with regard to entertainment, as well as education and medical expenses. This implies that large households with the same income per equivalent adult devote a far greater proportion of their resources to these two kinds of services than small households. With regard to education and medical expenses, the explanation may lie partly in the higher proportion of children in the large households and partly in social class variations in expenditure habits. The result with regard to entertainment may be associated with variations in the age structure of households, and in the varying adequacy of the ordinary dwelling unit to the needs of smaller or larger households; this is a problem which may well be of interest to the sociologist.

7. *Summary and implications*

An attempt has been made to derive statistical relationships between total expenditure and household size on one hand, and the amounts spent on various goods and services on the other hand. These expenditure functions permit the assessment, for any given household size, of the effects that variations in total available spending money have on the pattern of household expenditure; they also permit comparisons in expenditure patterns for households of different size. In particular, numerical values for income-elasticities of demand may be estimated.

Perfect accuracy cannot be claimed for the results, which contain errors in the original records, errors due to the use of grouped data as well as those due to the shortcomings of the methods employed. Although the results are thus open to revision in the light of fresh information that may come to hand, they nevertheless provide a set of mutually consistent figures. The main results may be summarised as follows:—

(*a*) Demand is inelastic with regard to income, i.e. it tends to rise less than in proportion to total outlay, for the majority of foodstuffs, for fuel and light, and for non-durable household goods like washing and cleaning materials. In particular, the demand for bread and flour, butter and potatoes hardly increases at all with rising income or, in the case of bread, even tends to decline.

(*b*) Demand is elastic with regard to income, or rises more than in proportion to total outlay, for fruit, sweets and various minor food items including meals away from home, for clothing, personal care, durable consumer goods, reading material, etc., as well as for most services. The highest demand elasticities, amounting to more than 2, are found for household durable goods, and for travel and holidays.

(*c*) Borderline cases are formed by a few foodstuffs like biscuits and cakes, mutton and fish, as well as housing, and tobacco. In these cases, expenditure increases approximately in proportion to total expenditure, and the proportion of money devoted to them remains approximately unaffected by the income level.

(*d*) Given the same amount of household income, large households as compared with small ones spend a high proportion of it on food, particularly bulk foodstuffs, on non-durable household goods, and on education and medical expenses. Conversely, they spend low proportions on other goods and services, notably housing, consumer durables, travel and other services.

(*e*) Given the same amount of income per equivalent adult, a relatively high proportion is spent by large households on travel, entertainment, education and medical services, and on clothing; by small households on fuel and light and on housing.

The findings apply to some extent to the changes in consumption expenditure which may be expected to accompany a rise in disposable real national income. Other things being equal, demand can be expected to grow most rapidly in respect of the goods and services with a highly income-elastic demand, and least or not at all for those items for which demand is very inelastic ; the implications on, say, the market for butter are obvious. This effect would be to a minor extent counteracted by a more even distribution of income which would stimulate the demand for goods with moderately low income elasticities.

This conclusion is subject to stringent qualifications. In the first instance, it cannot be taken for granted that income elasticities of demand derived for the years 1951–52 will apply without modification in present-day conditions or indeed to any change over time at all. Secondly, price variations which cannot be studied in a static analysis play an important role in demand variations over time ; the effect may be expressible in comparatively simple terms of price-elasticities in some instances, but may be very complex in the case of durable consumer goods. Finally, the introduction of new goods and services, the development of hire-purchase, and other factors bring about changes in tastes and habits of consumption which are often so large as to be decisive.

There are still wide gaps in our knowledge of consumers' behaviour even for countries like Britain and the United States in which much research has been done in this field. The present study does not pretend to close this gap in our knowledge for the Irish economy ; it merely attempts to make it a little narrower.

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Appendix A : The food and sundries subgroups

Food or sundries subgroup		Code Nos. in C.S.O. report	Remarks
No.	Name		
1	Bread and flour	1–9	
2	Biscuits and cakes	10–11	
3	Milk	12–16	Includes cream
4	Butter	17	
5	Miscellaneous fats and cheese	18–22	
6	Eggs	23	
7	Beef	24–25	Includes veal and corned beef
8	Mutton	26	
9	Miscellaneous meat	27–40	Includes bacon, meat products
10	Fish	41–54	
11	Potatoes	55	
12	Vegetables	56–74	
13	Fresh Fruit	75–82	
14	Tinned and dried fruit	83–89	Includes bottled fruit
15	Tea, etc.	90–93	Includes coffee and cocoa
16	Sugar	94	
17	Preserves	95	Jam and marmalade
18	Cereals	96–104	Oatmeal, breakfast cereals, rice, sago, etc.
19	Sweets, ice-cream, etc.	115–116	Includes chocolates, soft drinks and cider.
20	Miscellaneous food	105–114 117–119	Includes meals away from home.
1	Tobacco	224–225	
2	Household non-durable goods	226–232	
3	Personal care	233–238	
4	Household durable goods	239–261	Includes semi-durable goods
4	Miscellaneous goods	223,262–270	Alcoholic drink, newspapers, books, etc.
6	Travel and holidays	271–278	Includes all expenditure on motor cars.
7	Entertainment	279–283	
8	Education and medical	284–289	
9	Social security	290–292	Insurance and trade union subscriptions.
10	Services	293–298	Haircuts, shoe repairs, laundry, cleaning, domestic service, etc.
11	Postage, subscriptions, etc.	299–305	Includes licences, pocket-money for children, etc.

Appendix B : The expenditure functions

Since computations, is by means of logarithms in practice, the multiplicative constants in the expenditure functions are best given as powers of 10. We then have, for commodity groups :

$v_{1(c)}=10^{0.42561}\,M^{0.55343}\,H^{0.40078}\,C$
$v_{2(c)}=10^{-2.07927}\,M^{1.53996}\,H^{-0.20234}\,C$
$v_{3(c)}=10^{0.09260}\,M^{0.49924}\,H^{-0.07094}\,C$
$v_{4(c)}=10^{-0.77854}\,M^{0.96719}\,H^{-0.53172}\,C$
$v_{5(c)}=10^{-1.47789}\,M^{1.49876}\,H^{-0.29695}\,C$
with the correction factor C chosen so that

$$\sum_{i=1}^{5} v_{i(c)}=M$$

In practice the logarithms of the expressions excluding C are calculated for given M and H, then converted into antilogs, summed and divided by M which yields C. Incidentally, $C<1$ (this also applies to C_1 and C_5)

For food subgroups, $v_{1(c)}$ is first computed, then entered, together with H, into the relations
$v_{1,1(c)}=10^{0.50351}\,v_{1(c)}^{-0.09117}\,H^{1.03637}\,C_1$
$v_{1,2(c)}=10^{-3.01765}\,v_{1(c)}^{2.12002}\,H^{-1.12730}\,C_1$
$v_{1,3(c)}=10^{-0.37976}\,v_{1(c)}^{0.56527}\,H^{0.45514}\,C_1$
$v_{1,4(c)}=10^{0.20331}\,v_{1(c)}^{0.10171}\,H^{0.94960}\,C_1$
$v_{1,5(c)}=10^{-1.50901}\,v_{1(c)}^{0.83674}\,H^{0.18766}\,C_1$
$v_{1,6(c)}=10^{-1.43956}\,v_{1(c)}^{1.21304}\,H^{-0.23782}\,C_1$
$v_{1,7(c)}=10^{-0.85133}\,v_{1(c)}^{0.88244}\,H^{0.13827}\,C_1$
$v_{1,8(c)}=10^{-2.73731}\,v_{1(c)}^{2.08035}\,H^{-1.33025}\,C_1$
$v_{1,9(c)}=10^{-1.01433}\,v_{1(c)}^{1.13661}\,H^{-0.22571}\,C_1$
$v_{1,10(c)}=10^{-2.87492}\,v_{1(c)}^{1.74514}\,H^{-0.77050}\,C_1$
$v_{1,11(c)}=10^{0.04365}\,v_{1(c)}^{0.01625}\,H^{0.90601}\,C_1$
$v_{1,12(c)}=10^{-1.67969}\,v_{1(c)}^{1.27694}\,H^{-0.30107}\,C_1$
$v_{1,13(c)}=10^{-4.58967}\,v_{1(c)}^{2.90566}\,H^{-1.61018}\,C_1$
$v_{1,14(c)}=10^{-4.48760}\,v_{1(c)}^{2.62856}\,H^{-1.32582}\,C_1$
$v_{1,15(c)}=10^{-0.73544}\,v_{1(c)}^{0.49724}\,H^{0.28684}\,C_1$
$v_{1,16(c)}=10^{-0.69701}\,v_{1(c)}^{0.33785}\,H^{0.61442}\,C_1$
$v_{1,17(c)}=10^{-1.61458}\,v_{1(c)}^{0.88827}\,H^{0.12039}\,C_1$
$v_{1,18(c)}=10^{-1.65430}\,v_{1(c)}^{0.83425}\,H^{0.29731}\,C_1$
$v_{1,19(c)}=10^{-4.06172}\,v_{1(c)}^{2.52180}\,H^{-1.18420}\,C_1$
$v_{1,20(c)}=10^{-3.78903}\,v_{1(c)}^{2.78121}\,H^{-1.51875}\,C_1$
with the correction factor C_1 such that

$$\sum_{v=1}^{20} v_{1,i(c)}=v_{1(c)}$$

Similarly for the sundries subgroups, $v_{5(c)}$ is computed and with its aid
$v_{5,1(c)}=10^{-0.10511}\,v_{5(c)}^{0.55368}\,H^{0.26138}\,C_5$
$v_{5,2(c)}=10^{-0.30177}\,v_{5(c)}^{.28703}\,H^{0.35522}\,C_5$
$v_{5,3(c)}=10^{-1.62558}\,v_{5(c)}^{.94121}\,H^{0.05682}\,C_5$
$v_{5,4(c)}=10^{-1.67707}\,v_{5(c)}^{1.44277}\,H^{-0.58820}\,C_5$
$v_{5,5(c)}=10^{-0.84534}\,v_{5(c)}^{0.94904}\,H^{-0.17764}\,C_5$
$v_{5,6(c)}=10^{-2.04046}\,v_{5(c)}^{1.74204}\,H^{-0.50457}\,C_5$
$v_{5,7(c)}=10^{-1.53813}\,v_{5(c)}^{1.07668}\,H^{0.45618}\,C_5$
$v_{5,8(c)}=10^{-1.59194}\,v_{5(c)}^{1.10232}\,H^{0.57975}\,C_5$
$v_{5,9(c)}=10^{-0.84243}\,v_{5(c)}^{0.86181}\,H^{0.27613}\,C_5$
$v_{5,10(c)}=10^{-0.83426}\,v_{5(c)}^{1.08768}\,H^{-0.31202}\,C_5$
$v_{5,11(c)}=10^{0.69783}\,v_{5(c)}^{0.87678}\,H^{-0.15146}\,C_5$
with C_5 such that

$$\sum_{i=1}^{11} v_{5,i(c)}=v_{5(c)}$$

Computation procedure is analogous to that described for commodity groups.

Appendix C : Goodness of fit measurement

The discrepancies between actual and theoretical figures may be measured in the proportionate outlays to total expenditure and thus summarised by the expressions

$$\Sigma(w_i-w^i{}_{(c)})^2=16\,S_i^2$$

They may be related either to w_i or to $\Sigma(w_i-\overline{w}_i)^2$, where $\overline{w}_i$ here represents the simple arithmetic mean of the 16 observations for w_i.

The coefficient of variation

$$V_i=100S_i/\overline{w}_i$$

gives a descriptive measure of what might be called the "closeness of fit" a low value indicating close agreement and a high value greater discrepancies.

The coefficient of determination

$$R_i'^2=1-16S_i^2/\Sigma(w_i-\overline{w}_i)^2$$

shows the proportion of the original sum of squares (or variance) which is explained by the regression. In the case of the subgroups, it represents the combined effect of the double regression. A high value of R'^2 indicates good fit. R' cannot, of course, be interpreted as a correlation coefficient in the ordinary sense.

These measures are given here, together with comparable figures for $R_i'^2$ obtained by the regression equation

$$w_{i(c)}=a_i+b_i/M+c_iH/M$$

which corresponds to the linear function

$$v_{i(c)}=b_i+a_iM+c_iH$$

The method used in the present study gives in many instances substantially higher values for R'^2 and hardly ever substantially lower ones, which justifies its acceptance in preference to the linear model.

i	Group or subgroup	Additive logarithmic functions		Linear functions
		V_i	$R_i'^2$	R_i^2
1	Food	2·2	·989	·919
2	Clothing	10·2	·881	·906
3	Fuel and light	9·2	·953	·977
4	Housing	6·5	·947	·792
5	Sundries	3·6	·981	·891
1	Bread and flour	7·5	·976	·986
2	Biscuits and cakes	8·1	·761	·321
3	Milk	5·3	·972	·948
4	Butter	4·5	·989	·983
5	Miscellaneous fats and cheese	5·6	·951	·861
6	Eggs	3·6	·947	·701
7	Beef	4·7	·962	·833
8	Mutton	10·8	·692	·728
9	Miscellaneous meat	4·5	·942	·698
10	Fish	6·1	·636	·000
11	Potatoes	10·3	·949	·947
12	Vegetables	5·2	·895	·589
13	Fresh fruit	8·9	·918	·904
14	Tinned and dried fruit	14·0	·735	·773
15	Tea, etc.	6·4	·969	·968
16	Sugar	3·8	·990	·987
17	Preserves	7·4	·908	·886
18	Cereals	9·4	·864	·817
19	Sweets, ice cream, etc.	6·7	·917	·920
20	Miscellaneous food	10·4	·876	·865
1	Tobacco	10·0	·635	·222
2	Household non-durable goods	8·0	·930	·961
3	Personal care	10·2	·844	·809
4	Household durable goods	26·2	·791	·742
5	Miscellaneous goods	9·7	·839	·728
6	Travel and holidays	20·5	·915	·788
7	Entertainment	15·6	·855	·775
8	Education and medical	26·7	·832	·485
9	Social security	12·3	·774	·719
10	Services	41·3	·183	·352
11	Postage, subscriptions, etc.	18·2	·244	·533

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