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Population Change and the Demand for Food

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WHILE a large number of factors affect family food consumption, the present paper is concerned with only five of these: income—clearly the most important single influence, family size, age of head, race, and location of family (whether in a metropolitan area or not, whether in the northern, southern, or western part of the United States), all of which may be considered demographic variables.

Intercorrelations among these variables make it difficult to isolate their separate influences. For example, any measure of the income effect is distorted by the other four variables, unless some way is found of holding these constant in the statistical analysis. Large families spend more for food than small at the same income, but they also tend to have higher incomes. Thus, only part of the higher consumption of large, high income families is properly attributable to income effects, but all will be so attributed unless family size is in some way introduced into the analysis. Furthermore, white families (particularly at low incomes,) spend more on food than Negroes with the same income and family size, perhaps in part because a very low current income is less likely to be considered "normal" by white families than by Negro families. Families with middle-aged heads spend more on food than either young families or old families with the same income and family size, and at the same time tend to have higher incomes. These families include a relatively high proportion of adolescents and fairly active adults, who may be expected to eat more heavily than either the small children characteristic of the younger families or the less physically active adults characteristic of the oldest families. Finally, white families in metropolitan areas in the north spend more on food than in other regions for the same income and family size, and also tend to have higher incomes. These families are faced with higher food prices than in other areas and, as compared with families in small cities, are more inclined to eat meals away from home. Thus the

Note: This paper is based on research undertaken in connection with the Wharton School Study of Consumer Expenditures, Incomes and Savings. The study is based largely on the 1950 survey by the Bureau of Labor Statistics of some 12,500 families in 91 representative cities, and is being carried out in cooperation with that agency. It is financed by a grant from the Ford Foundation.

higher income brackets contain a disproportionately large number of large families, white families, families with middle-aged heads, and families living in metropolitan areas in the north, all of which have unusually large food expenditures, not only because of their higher incomes but also because of their demographic characteristics. The result will be an overstatement of the influence of income unless the demographic factors are effectively held constant when this influence is measured.

An intermixture of the effect of income with that of other variables might not be undesirable if the intercorrelations could be counted on to remain unchanged. But this, unfortunately, is not true. In particular, where cross-sectional and time series information are to be combined we run into trouble on this score. A rise in average income over time is not in general accompanied by the same sort of shift in the age, regional, racial, and family size distribution that we find as we move from lower to higher income groups at a point of time. In fact, we expect a rising income over the next few years to be accompanied by a lower incidence (relative frequency) of middle-aged families and a higher incidence of Negroes.

Since the integration of time series and cross-sectional information is highly useful in demand studies, it becomes a major purpose of cross-sectional analysis to approximate a "pure" or "net" income elasticity for consumption items. A second major purpose is to isolate the effects on consumption of other major variables, including the four demographic factors considered here, so that the impact of distributional shifts in these variables over time may be estimated.[1] Because of the previously mentioned intercorrelations with income it is impossible to approach the effects of the demographic variables without first allowing for the primary effect of income. But even after this is done, correlations exist among the four demographic variables—for example, tendencies toward smaller family size among older people and larger family size among Negroes and in nonmetropolitan areas—making it desirable to hold constant, as far as possible, all of these variables except the one whose effect is being studied.

It is the purpose of this paper to develop procedures for estimating the effects on consumption behavior of shifts in the distribution of families among demographic groups, under the assumption that cross-sectional differences among these groups—holding other variables constant—are

[1] This involves the assumption of a reasonable degree of stability over time in the effects of these variables. Only by comparison of successive cross sections can we be sure that such stability exists.

reasonably stable over time. These procedures are applied to the case of food expenditures in the period 1950–1970, with particular reference to expected changes in the age and race-area distributions.

Regressions Computed from 1950 Data for Age and Race-Area Groups

In pursuit of the major aims mentioned above, two types of cross-sectional regressions have been computed for food expenditures from the 1950 BLS data on urban families.[2] The first is based on grouped data[3] and in most cases excludes families with incomes under $1,000. The model used is

$$F = aY^b n^c \text{ or } \log F = \log a + b \log Y + c \log n$$

where F is average family food expenditure (excluding alcoholic beverages), Y is average family money income after taxes, and n is average family size. Regressions of this type are available for various race-area groups, for various age groups, and for various occupational groups.[4]

The second type of regression is part of a larger analysis involving all major categories and some subcategories of consumption and saving. It is based on individual family data and excludes Negro families, the self-employed or not gainfully employed, and families with incomes under $1,000 or over $10,000. The model used is

$$F = a + bY + c_j,\ j = 1, 2, 3, 4$$

where F and Y are family food expenditures and money income after taxes respectively, and j represents family size. For family size four and over, $j = 4$. Regressions of this type are available for various age-tenure-assets-income change-income expectation groups.[5] Separate studies are

[2] The term "family" throughout this paper is understood to include unrelated individuals as one-person families.

[3] Cross-tabulations published in *Study of Consumer Expenditures, Incomes and Savings*, Vols. III and XVIII, University of Pennsylvania, 1956–1957.

[4] For further discussion, see Jean Crockett, "Demand Relationships for Food," forthcoming in *Proceedings of the Conference on Consumption and Saving*, University of Pennsylvania, 1960.

[5] Since the analysis in this paper of the effects of demographic shifts is based on these two sets of regressions and since both relate to food expenditures, the conclusions derived must also refer to food expenditures rather than caloric intake or some other concept of food consumption. It appears from Mr. Fox's comments that this point has not been clear to him.

Mr. Fox also appears to be laboring under the rather common delusion that an expenditure elasticity, as obtained from cross-section data, is not the relevant cross-section parameter for comparison with an income elasticity of quantity derived from the usual time series data. Price effects in a cross-section study largely reflect quality differences and not differences in prices paid for the same quality by different income groups, so that expenditure figures—but not quantity figures—incorporate quality shifts. Similarly a shift from lower to higher quality over time is reflected by an increase in the price weighted quantity index ordinarily used as the dependent variable in time series analysis.

planned which will cover Negroes, the self-employed, and those not gainfully employed.[6]

Regressions of the first type have an advantage in that, (1) the double log regression (exponential regression) provides a somewhat better fit for food than the linear, (2) the family size effect is handled more precisely than in the second set of regressions, (3) a finer age break is available, and (4) a larger portion of the total population is covered. On the other hand, it is not possible to hold race constant in the age regressions or age constant in the race-area regressions. The effects of area are not in fact held constant in the age regressions presented here, though they will be in work now in progress.

Regressions of the second type make use of the additional information provided by individual observations and hold constant many more variables. For example, the tenure of dwelling unit, the income change-income expectation pattern, and the debt-asset position are all likely to be correlated with age of head, and it is not clear that the cross-sectional correlations will be maintained over time. Thus, the net effect of age is measured more accurately from the second set of regressions. On the other hand, area is not held constant and this is a fairly significant factor in food expenditure. Furthermore, fairly large sectors of the population are excluded and a number of regressions must be combined to obtain an average age effect for that portion which is covered.

In the double log regressions the income elasticity is found to be roughly the same for all age groups, for all area groups among the white families, and for all area groups among the Negroes. Some differences were found in family size elasticities, which were relatively low among the youngest families, relatively high among the oldest families, and a little higher for northern than for southern and western families. Since the differences were in most cases well within the range of sampling error, each elasticity was averaged over age groups, over area groups for white families, and over area groups for Negro families, and a single figure used within each of these three groups. There were significant differences in the elasticities between white and Negro families in the same area; and substantial differences in level occur among age groups and among area groups within both the white and the Negro categories.

The regressions obtained, using average values of the elasticities in the double log regressions, are given on pp. 461–462.

[6] For further discussion, see Jean Crockett and Irwin Friend, "A Complete Set of Consumer Demand Relationships," forthcoming in *Proceedings of the Conference on Consumption and Saving*, University of Pennsylvania, 1960.

AGE GROUPS

Double log regressions (excluding families with incomes under $1,000)

(1)	Under 25:	$F = 10.2\ Y^{0.522} n^{0.317}$
(2)	25–34:	$F = 10.6\ Y^{0.522} n^{0.317}$
(3)	35–44:	$F = 11.2\ Y^{0.522} n^{0.317}$
(4)	45–54:	$F = 11.6\ Y^{0.522} n^{0.317}$
(5)	55–64:	$F = 11.6\ Y^{0.522} n^{0.317}$
(6)	65–74:	$F = 11.1\ Y^{0.522} n^{0.317}$
(7)	75 and over:	$F = 10.4\ Y^{0.522} n^{0.317}$

Linear regressions for white employee families with income between $1,000 and $10,000 and cash assets less than $500

(8) Renters under 35

a. 1 person family:	$F = 255 + 0.192Y - 110$
b. 2 person family:	$F = 255 + .192Y$
c. 3 person family:	$F = 255 + .192Y + 142$
d. 4 or more person family:	$F = 255 + .192Y + 313$

(9) Renters 35–54

a. 1 person family:	$F = 357 + .192Y - 110$
b. 2 person family:	$F = 357 + .192Y$
c. 3 person family:	$F = 357 + .192Y + 142$
d. 4 or more person family:	$F = 357 + .192Y + 313$

(10) Renters 55 and over

a. 1 person family:	$F = 369 + .192Y - 110$
b. 2 person family:	$F = 369 + .192Y$
c. 3 person family:	$F = 369 + .192Y + 142$
d. 4 or more person family:	$F = 369 + .192Y + 313$

(11) Homeowners under 35

a. 1 person family:	$F = 264 + .153Y - 175$
b. 2 person family:	$F = 264 + .153Y$
c. 3 person family:	$F = 264 + .153Y + 176$
d. 4 or more person family:	$F = 264 + .153Y + 372$

(12) Homeowners 35–54

a. 1 person family:	$F = 391 + .153Y - 175$
b. 2 person family:	$F = 391 + .153Y$
c. 3 person family:	$F = 391 + .153Y + 176$
d. 4 or more person family:	$F = 391 + .153Y + 372$

(13) Homeowners 55 and over

a. 1 person family:	$F = 414 + .153Y - 175$
b. 2 person family:	$F = 414 + .153Y$
c. 3 person family:	$F = 414 + .153Y + 176$
d. 4 or more person family:	$F = 414 + .153Y + 372$

RACE-AREA GROUPS

Double log regressions (excluding white families with incomes under $1,000)

(14) White northern metropolitan:	$F = 14.9\ Y^{0.488}n^{0.335}$
(15) Total northern nonmetropolitan:	$F = 13.4\ Y^{0.488}n^{0.335}$
(16) White southern metropolitan:	$F = 13.9\ Y^{0.488}n^{0.335}$
(17) White southern nonmetropolitan:	$F = 13.0\ Y^{0.488}n^{0.335}$
(18) Total western metropolitan:	$F = 13.7\ Y^{0.488}n^{0.335}$
(19) Total western nonmetropolitan:	$F = 13.8\ Y^{0.488}n^{0.335}$
(20) Negro northern metropolitan:	$F = 6.78\ Y^{0.591}n^{0.219}$
(21) Negro southern metropolitan:	$F = 6.25\ Y^{0.591}n^{0.219}$
(22) Negro southern nonmetropolitan:	$F = 6.23\ Y^{0.591}n^{0.219}$

Effect of Distributional Changes on Aggregate Food Consumption

The change in aggregate demand for food between, say, 1950 and 1970 may be separated into several elements: (1) the effect of growth in the total number of families and of change in average family size; (2) the effect of growth in average income (or changes in the shape of the income distribution) within demographic groups; (3) the effect of distributional changes in the population, which would, of course, imply some income and family size changes even if the income and family size distributions within groups remained entirely unchanged; and (4) the effect of shifts in consumption behavior within the demographic subgroups, reflecting not only such factors as changes in relative prices or in tastes, which might affect all population groups more or less uniformly, but also factors causing differential shifts, such as the more complete assimilation of Negroes in the metropolitan North.

This paper is confined to considerations of type (3)—the effect of shifts among various demographic groups, assuming that the characteristics of each group as to food consumption remain unchanged. The interesting problems of type (4), involving either time series analysis or a comparison among successive cross-sectional studies, are beyond our present scope.

INTEGRATION OF DISTRIBUTIONAL EFFECTS INTO AN ESTIMATE OF TOTAL CHANGE IN FOOD CONSUMPTION[7]

The changes in food expenditure arising from demographic shifts, as estimated in this paper, may be integrated into an estimate of the total change in food expenditure (in constant dollars) between two points of time in the following way. We consider a number of population groups, differing in their food consumption patterns, and express aggregate food expenditure as the sum of the expenditures of these groups

$$M\sum_i p_i x_i$$

where M is the total number of families, p_i is the proportion of families falling in the ith group, and x_i is the average expenditure per family in the ith group. If the number of families changes by ΔM, the proportion of families in the ith group by Δp_i, and the average expenditure in the ith group by Δx_i then the change in aggregate food expenditure is given by

$$(23) \qquad (M + \Delta M)\sum_i (p_i + \Delta p_i)(x_i + \Delta x_i) - M\sum p_i x_i$$

$$(\text{A}) \qquad = \Delta M \sum_i p_i x_i$$

$$(\text{B}) \qquad + (M + \Delta M)\sum_i p_i \Delta x_i$$

$$(\text{C}) \qquad + (M + \Delta M)\sum_i \Delta p_i (x_i + \Delta x_i)$$

If we assume that the family size distributions within demographic groups remain unchanged and that the relationship of expenditure to income and family size within each demographic group is stable over time (no changes in relative prices or in tastes), then changes in average

[7] This section incorporates and further develops remarks made at the Conference in response to the comments of Mr. Fox. The expository approach used is suggested by Robert Ferber's paper in this volume.

expenditure within groups result from changes in income only. In this case (A) may be considered a crude first approximation to the change in aggregate expenditure, reflecting only the change in number of families, while (A) + (B) is a second approximation reflecting changes both in the number of families and in (real) income, but neglecting demographic shifts. (A) + (B) + (C) is then a third approximation, incorporating the effects of demographic shifts.

The first approximation (A) requires no expectational information except the change in number of families. The second approximation requires, in addition, only knowledge of the change in average income, say Δy, if this is assumed to be the same for all groups and if the expenditure-income relationship is linear. In this case the term (B) reduces to

$$(M + \Delta M)b\Delta y$$

where b is a weighted average of the marginal propensities to consume food for the various groups, using frequency weights. If income movements are expected to differ significantly among the groups, then the change in average income for each group must be known.

If the expenditure-income relationship is linear in the logarithms and if the income elasticity (though not the level of expenditure) is the same for all groups, then under the restrictive assumption that each family experiences the same per cent change in income, (B) reduces to

$$(M + \Delta M)\left[\left(1 + \frac{\Delta y}{y}\right)^b - 1\right]\sum_i p_i x_i$$

where b is now the income elasticity (assumed constant for all groups) and $\Delta y/y$ is the relative change in average income. Again the only expectational information required is the change in number of families and in average income. Under less restrictive assumptions, the expected income distributions for each group must be known.

This paper is concerned with the estimation of (C), which must be added to (A) + (B) to obtain the third approximation mentioned above. Estimates of average expenditures within groups are obtained from equations (1)–(22) and the effects of projected changes in the p_i are computed on the basis of these estimates.

In a linear model if marginal propensities (though not levels) are constant among groups and if the change in average income is assumed to be the same for all groups, (C) reduces to

$$(M + \Delta M)\sum_i x_i \Delta p_i$$

requiring only knowledge of the expected change in the number of families and in the proportion of families within each group. In a double log model with constant income elasticity among groups and the same per cent change in income assumed for each family, the only further knowledge required is the expected change in average income. Under less restrictive assumptions, the expected income distribution for each group is required.

The differences among the demographic groups studied are not large in the case of total food expenditures, and thus the value of (C) will ordinarily be small compared to (A) or (B). However (C) is likely to be relatively much larger for certain food subgroups and for certain non-food expenditures, and the estimation procedures developed here are equally applicable to such items. Furthermore the changes in expenditures for individual groups, as estimated below, are sometimes found to be large, both in relation to (C) and in relation to the initial expenditures of these groups (for example, Negroes in large cities in the north), and may therefore be of some interest to the suppliers of these groups.

Still further refinements may be made if some information is available as to expected shifts in the family size distribution, or in relative prices, or in tastes. If the parameters of the expenditure-income-family size relationships for individual groups show persistent time trends, then a comparison of successive cross-sections might lead to improved estimates of future expenditures. Such time trends might occur if, for example, the observed cross-sectional differences among age groups are only partially age specific and in part cohort specific, or if Negroes become more completely assimilated over time.

MEASUREMENT OF DISTRIBUTIONAL EFFECTS

If by 1970 we have a much larger proportion than in 1950 of families with heads under 25 or over 65, this should have three consequences, all of which may be expected to lower food consumption.

(a) An age effect—these families tend to eat less for the same income and family size than families with middle-aged heads.

(b) An income effect—these families tend to have lower incomes than middle-aged families.

(c) A family size effect—these families tend to have smaller families than the middle-aged.

Similarly, if by 1970 Negroes in small cities in the south constitute a smaller proportion of population than in 1950 and Negroes in metropolitan areas in the north a larger proportion, we may expect (a) larger food consumption for given income and family size, (b) higher incomes, and (c) smaller families. Thus the family size effect, though relatively small for Negroes, partially offsets the other two.

The effect on aggregate food expenditures of shifts among demographic groups is somewhat simpler to estimate from the linear than from the double log model. Let us assume that for families in the *i*th age (or other demographic) group with family size *j*:

$$F = a_i + bY + c_j.^8$$

Then the average expenditure of families of this type is

$$\bar{F}_{ij} = a_i + b\bar{Y}_{ij} + c_j;$$

and the average expenditure of families in the *i*th age group, without regard to family size, is

$$\bar{F}_i = a_i + b\bar{Y}_i + \sum_j w_{ij}c_j,$$

where w_{ij} is the relative frequency of family size j in the *i*th age group.

If the number of families is N,[9] then the effect on food consumption of a shift of r_i per cent of these families into ($r_i > 0$) or out of ($r_i < 0$) the *i*th age group is given by

$$0.01 r_i N(a_i + b\bar{Y}_i + \sum_j w_{ij}c_j).^{10}$$

The aggregate effect of the total of such shifts is

$$0.01 N \sum_i r_i(a_i + b\bar{Y}_i + \sum_j w_{ij}c_j), \tag{24}$$

where $\sum_i r_i = 0$. Note that the three terms in the above expression correspond, respectively, to the age effect, the income effect, and the family size effect of the distributional shift.

If we are interested in the effect of such a shift on 1970 food consumption, 1970 values should be used for the number of families, the average income within age groups, and the family size distribution within age groups. If the change in average income from 1950 to 1970 is approximately constant over age groups, however, the 1950 value of average income may be used, since

$$\sum_i r_i b(\bar{Y}_{i(1950)} + K) = \sum_i r_i b\bar{Y}_{i(1950)}.$$

[8] This implies not only linearity of the food-income relationship but the absence of any sizable interactions among the income, family size, and age effects. On the basis of pretests, such interactions appear to be fairly small.

[9] Including one-person families.

[10] In terms of the notation of equation (23), N corresponds to $M + \Delta M$ and $0.01r_i$ to Δp_i.

We may also ignore changes in the family size distribution of the several age groups if these changes cause the average family size effect, $\sum_j w_{ij}c_j$, to vary by the same amount for each age group. If such simplifying assumptions are accepted as to the nature of the changes in average income and family size distribution for the various age groups, only the number of families N and the percentage points of shift among age groups r_i need be estimated for 1970.

Turning now to the double log model, we assume that for families in the ith age (or other demographic) group

$$F_i = a_i Y^b n^c.$$

For simplicity we may approximate this by writing, for families in the ith age group with family size j,

$$F \approx a_i Y^b j^c,\ j = 1, 2, 3, 4, 5, 6,$$

where $j = 6$ for family size 6 or more.

Let us now consider only those families in the ith age group which have exactly the income $\bar{Y}_{ik}$. The average food expenditure (averaging over family size) of such families is

$$F_{i(\bar{Y}_{ik})} \approx a_i \bar{Y}_{ik}{}^b \sum_j w_{ij(\bar{Y}_{ik})} j^c$$

where $w_{ij(\bar{Y}_{ik})}$ is the relative frequency of families of size j among families in the ith age group having income $\bar{Y}_{ik}$. If $\bar{Y}_{ik}$ is the mean income of families in the ith age and kth income group, if the kth income group has sufficiently narrow limits, and if the family size distribution is about the same for all incomes within the ikth age-income cell, then the average food expenditure of this cell may be roughly approximated by

$$\bar{F}_{ik} \approx a_i \bar{Y}_{ik}{}^b \sum_j w_{ijk} j^c,$$

where w_{ijk} is the relative frequency of family size j in the ikth age-income cell.

If the number of families (including one person families) is N, the effect on food consumption of a shift of r_{ik} per cent of these families into ($r_{ik} > 0$) or out of ($r_{ik} < 0$) the ikth age-income cell may then be approximated by

$$0.01 r_{ik} N (a_i \bar{Y}_{ik}{}^b \sum_j w_{ijk} j^c).$$

The aggregate effect of the total of such shifts is roughly equal to

$$(25) \qquad 0.01 N \sum_{i,k} r_{ik} a_i \bar{Y}_{ik}{}^b \sum w_{ijk} j^c,$$

where $\sum_{i,k} r_{ik} = 0$. The aggregation of individual age-income cells, rather than complete age groups, minimizes the distortion arising from the approximation procedure used.

Again the 1970 values should be used for total number of families, as well as mean income and family size distribution within age-income cells, in estimating the effect on 1970 food consumption of distributional changes between 1950 and 1970. However, mean income within income classes is not likely to vary greatly over time except in the highest class, which is open-ended. Note that, to determine the r_{ik}, some estimate of the 1970 income distribution within age groups is required.

Numerical Estimates of the Effect of Shifts Among Age and Race-Area Groups, 1950–1970

The following numerical estimates of the effects of distributional changes in the period 1950–1970 are subject to error from a number of sources, listed below, and are intended primarily for purposes of exposition.

1. The values of a_i, b, and c_j used in evaluating (24) in the age analysis are obtained from the linear relationships (8)–(13),[11] which are based on urban white employee families with incomes between \$1,000 and \$10,000 and cash assets under \$500; they are therefore not properly applicable to the population as a whole.

2. These linear relationships utilize rather broad age and family size groups and neglect rather substantial differences in behavior within these groups.

3. The values of $\bar{Y}_i$ and w_{ij} used in evaluating (24) are based on 1950 data. As indicated above this will lead to substantial error only if the changes between 1950 and 1970 in mean income and family size effect $(\sum_j w_{ij}c_j)$ differ considerably among age groups.

4. The values of a_i, b, and c used in evaluating (25) in the age analysis and the race-area analysis are obtained, respectively, from relationships (1)–(7) and (14)–(22), which exclude both non-urban families and white urban families with incomes under \$1,000 and are therefore not properly applicable to the population as a whole. However, an alternative estimate of (25) substitutes observed 1950 food expenditures in the lowest income class for expenditures as computed by combining the age (or race-area), income, and family size effects implied by the regressions. The resulting difference in (25) is very small.

[11] Regressions for renters and homeowners are combined, using weights based on frequencies and aggregate income of the two groups.

5. The values of c used in (25) are obtained as the exponents of a continuous family size variable but are applied to a discrete variable. In the computations they were applied to the mean family sizes of the various family size groups rather than simply the numbers 1, 2, 3, 4, 5, 6.

6. A straight line approximation to the double log relationship is used in estimating the mean food expenditure within each income class, and the assumption is made of a constant family size distribution within each age-income (or race-area-income) cell. In other words we neglect the quantity

$$a_i \bar{Y}_{ik}{}^b \sum_j w_{ijk} j^c - \frac{a_i}{N_{ik}} \Sigma Y^b j^c,$$

where the second summation runs over all families in the ikth cell and N_{ik} is the number of families in this cell. This difference, which might be very large if complete age groups were used instead of age-income cells, may still be substantial for the open-end income class.

7. The values of $\bar{Y}_{ik}$ and w_{ijk} used in evaluating (25) are based on 1950 data. While it is reasonable to assume little change in $\bar{Y}_{ik}$ for the closed-end income classes, we may expect some increase in the open-end class. Alternative estimates of (25), allowing for a 10 per cent rise in mean income for this class were insignificantly different. The assumption that the family size distribution remains unchanged within age-income (or race-area-income) cells is probably unrealistic and a source of some error.

CHANGES IN THE AGE DISTRIBUTION

Census estimates are available for the age distribution of males in 1970. Table 1 shows the 1950 per cent distribution of males over 20, the estimated distribution for 1970, and the expected shifts into or out of each age group (expressed as a percentage of total population). These shifts may be used as the r_i of equation (24) on the assumption that *changes* in the age distribution of males over 20 are roughly the same as *changes* in the age distribution of family heads. By applying an appropriate income distribution for each age group, these r_i may be converted to the r_{ik} of equation (25). The 1950 income distributions as obtained from the BLS sample were used in this conversion and are, of course, a poor approximation to the expected 1970 distributions for the shifting families. Even if the assumption is made that each family's real income rises by a given per cent, the effects of this rise on the age groups suffering relative losses do not cancel the effects on the age groups with relative gains because of substantial differences in the initial income distributions.

TABLE 1

Effect on Food Consumption of Expected Shifts in Age Distribution, 1950–1970

Age Group	Per Cent Distribution of Males over 20: 1950[a]	1970[b] (estimated)	Difference (r_i)		Effect on Food Consumption: In terms of N[c]: Linear Model (1950 dollars)	Double log Model (1950 dollars)	Assuming $N = 65$ million[c]: Linear Model (millions of 1950 dollars)	Double log Model (millions of 1950 dollars)
Under 25	11.72	14.50	2.78	−0.33	− 3.482N	24.097N	− 226	1,566
25–34	23.81	20.70	−3.11			−34.578N		−2,248
35–44	21.58	18.46	−3.12	−2.24	−29.501N	−40.543N	−1,918	−2,635
45–54	17.58	18.46	0.88			11.179N		727
55–64	13.60	14.51	0.91	2.57	25.289N	9.982N	1,644	649
65–74	8.17	8.74	0.57			4.645N		302
75 and over	3.54	4.63	1.09			7.101N		462
Total	100.00	100.00	0.00		− 7.694N	−18.117N	− 500	−1,178

[a] Derived from Bureau of the Census, *Current Population Reports*, Series P-25, no. 170, Table 1.
[b] Derived from Bureau of the Census, *Current Population Reports*, Series P-25, no. 123, Table 2.
[c] N is number of families, including one person families, in 1970.
Source for last four columns: Tables A-1 and A-2.

This is perhaps the most important shortcoming of the estimated effects of age shifts on aggregate consumption as obtained from the double log model.

Table 1 further shows for both the linear and the double log model the estimated increase or decrease in the aggregate food consumption of each age group and of all groups combined, as compared with what might be expected on the basis of growth in population and income in the absence of shifts in the age distribution.

The computations on which the last four columns of Table 1 are based are shown in Appendix Tables A-1 (linear model) and A-2 (double log model). These tables present for each age or age-income group the age effect, the income effect (based on 1950 mean incomes), the family size effect (based on 1950 family size distributions), and—estimated from these three effects—the typical food expenditure of each age-income group. Also shown are the expected shifts into or out of each group and the resulting changes in food consumption as computed from (24) or (25).

It was indicated earlier that some problems arise from applying to the total population relationships based on a subgroup. This is a serious shortcoming for the linear model, but until further computations are completed, covering the omitted groups, little can be done to correct it. For the double log model, where the lowest income class is omitted, an alternative calculation substitutes the observed 1950 food expenditures of this class for expenditures as computed from equations (1)–(7). Actual expenditures tended to be considerably higher than computed expenditures particularly for families with middle-aged heads. (This may reflect a relatively large deviation of current from normal income for these families.)

It should also be noted that relatively poor fits are obtained in the highest income class, even though these families are included in computing the regressions. Here actual expenditures are systematically lower than computed expenditures. Because of low frequencies and large sampling variation in this income class, it was not desirable to replace computed with observed expenditures here. Instead, computed expenditures were lowered by an amount equal to the mean deviation of computed from observed expenditures. The result of these adjustments in the lowest and highest income classes was to decrease the estimated lowering of aggregate food consumption by 1.6 per cent. A further adjustment, allowing for a 10 per cent increase in the mean income of the highest income class between 1950 and 1970, increased the estimated effect by 0.25 per cent.

It will be noted from Table 1 that the linear model gives a much lower estimate than the log model of the negative effect on aggregate food consumption resulting from the expected shift in age distribution. Some difference might be expected because of the much lower coverage of population groups in the linear model. Negroes, self-employed, not gainfully employed, families with incomes under \$1,000 or over \$10,000, and families with cash assets over \$500 or not reporting cash assets, are all omitted in determining typical expenditure patterns. However, the major part of the discrepancy arises from the much broader age groupings used in the linear model, which conceal important intra-group shifts. While good agreement between the two models is obtained for the 35–54 age group, the lowering of expenditure in the under-35 group is much underestimated because the large shift from the 25–34 bracket to the under-25 bracket is entirely missed. The differences between these two brackets are considerable, however, in terms of average income and family size as well as expenditures for given income and family size. The rise in expenditure for the over-55 group is probably overstated in the linear model, since there is no allowance for the fact that about 40 per cent of the shift into this group goes to the over-75 bracket, which represents one-sixth or less of the total group and has much lower food expenditure than the rest of the group.

CHANGES IN THE DISTRIBUTION OF POPULATION BY AREA AND RACE

Projections are not available, so far as I know, for the distribution of population among the race-area groups to which the 1950 regressions apply. However, the actual movements between 1940 and 1950 are available for roughly the appropriate categories, and estimates of the shifts between 1950 and 1970 have been obtained by simply continuing these trends. An easy correction is available if it is believed that the observed trends will continue at an accelerated or decelerated rate. For example, if the 1950–1970 shifts are expected to occur at half the 1940–1950 rates, the r_{ik}, and hence the final figures on change in aggregate consumption, should be multiplied by one-half.

The 1940–1950 shifts among race-area groups were obtained in the following way. First, the 1940 and 1950 populations in metropolitan and non-metropolitan regions were obtained for thirteen economic areas.[12] It was assumed that "metropolitan regions" corresponded approximately to a combination of the Bureau of Labor Statistics categories of "large

[12] Donald J. Bogue, *Components of Population Change, 1940–50*, published jointly by Scripps Foundation for Research in Population Problems and Population Research and Training Center, 1957, p. 18.

cities" and "suburbs." "Nonmetropolitan regions" differ from the BLS category of "small cities" in that they include both cities with population between 50,000 and 100,000 and rural areas. However, the regressions obtained for BLS "small cities" should give a reasonably satisfactory description of the food consumption behavior of these somewhat larger categories. Four of the economic areas distinguished were found to correspond roughly with the BLS category "north," three with the BLS category "south," and the remaining six with the BLS category "west."[13] The per cent distribution of population among the six regions—metropolitan north, nonmetropolitan north, metropolitan south, nonmetropolitan south, metropolitan west, and nonmetropolitan west—was calculated for 1940 and for 1950.

White population as a per cent of total was then calculated for the north and for the south, in 1940 and in 1950, from the Census table, "Population by Race by States."[14] Negro population as a per cent of total in 1950 was then obtained for urbanized and for nonurbanized areas in three regions: northeast, north central, and south.[15] On the basis of this computation it seemed reasonable to assume that in the south, white persons represented the same percentage of total population in metropolitan as in nonmetropolitan regions. The percentage for the south as obtained from the Census table "Population by Race by States" was therefore applied to both metropolitan and nonmetropolitan regions. (This was 73.1 per cent in 1940 and 75.4 per cent in 1950.) For nonmetropolitan areas in the north, the nonwhite population was taken to be 1.5 per cent of the total in such areas and the remainder of northern nonwhites were assumed to reside in metropolitan areas. On this assumption, white population in northern metropolitan areas was taken to be 94.8 per cent of the total in 1940 and 92.6 per cent in 1950.

Table 2 shows the resulting per cent distribution of population among nine race-area groups for 1940 and 1950, the shift into or out of each group (as a per cent of total population), the expected shift between 1950 and 1970, r_i, based on a continuation of the 1940–1950 trends, and the expected change in aggregate food consumption of each group and of all groups combined. The last was estimated from equation (25) by applying to nonmetropolitan regions the regressions obtained for BLS "small cities" and applying to nonwhite groups the regressions obtained for Negroes.

[13] Regions I, II, III, and V as defined by Bogue were assigned to the north; VII, VIII, and IX to the south; and IV, VI, X, XI, XII, and XIII to the west.

[14] Bureau of the Census, *Statistical Abstract of the United States, 1955*, p. 34.

[15] From Duncan, Otis Dudley, and Albert J. Reiss, Jr., *Social Characteristics of Urban and Rural Communities, 1950*, John Wiley and Sons, Inc., 1956, pp. 30, 60.

TABLE 2

Effect on Food Consumption of Expected Shifts Among Race-Area Groups, 1950–1970

	Percent Distribution			*Expected Shift 1950–1970*	*Effect on Food Consumption* (double log model)	
Race-Area Group	1940	1950	Difference	(r_i) (percent)	In terms of N[a] (1950 dollars)	Assuming $N = 65$ million[a] (millions of 1950 dollars)
North, metropolitan, white	34.54	33.77	−0.77	−1.54	−18.534N	−1,205
North, metropolitan, nonwhite	1.89	2.70	0.81	1.62	14.930N	970
North, nonmetropolitan, total	15.56	14.49	−1.07	−2.14	−21.736N	−1,413
South, metropolitan, white	5.85	6.84	0.99	1.98	21.980N	1,429
South, metropolitan, nonwhite	2.15	2.23	0.08	0.16	1.184N	77
South, nonmetropolitan, white	12.40	11.72	−0.68	−1.36	−13.434N	− 873
South, nonmetropolitan, nonwhite	4.56	3.82	−0.74	−1.48	− 9.672N	− 629
West, metropolitan, total	8.34	10.70	2.36	4.72	48.904N	3.179
West, nonmetropolitan, total	14.71	13.73	−0.98	−1.96	−20.834N	−1,354
Total	100.00	100.00	0.00	0.00	2.786N	181

[a] N is number of families, including one-person families, in 1970.
Source: Table A-3 and see text.

The computations on which the last two columns of Table 2 are based are shown in Appendix Table A-3. The latter presents for each race-area-income group the race-area effect, the income effect (based on 1950 average incomes), the family size effect (based on 1950 family size distributions), and—estimated from these three effects—the typical food expenditure of each race-area-income group. Also shown are the expected shifts into or out of each group, obtained by applying the 1950 income distribution for each race-area group to the r_i of Table 2, and the expected change in aggregate food consumption as computed from equation (25). The use of 1950 income distributions causes less concern in this case than in the analysis of age shifts; for while the real income of each race-area group may be expected to rise by 1970, the income distribution of the shifting families is likely to be lower than the distribution of the group to which they shift. This is true whether we consider white families moving from nonmetropolitan to metropolitan regions in the south and west or Negroes moving from nonmetropolitan regions in the south to metropolitan regions in the north.

Since white families with incomes under $1,000 were not included in computing regressions (14)–(22) and since the observed expenditures of these families were systematically higher than the computed expenditures based on these regressions, an alternative calculation was made, substituting observed 1950 expenditures for the computed expenditures of these families. This resulted in less than a 5 per cent increase in the relatively small effect on aggregate food consumption. There was no systematic tendency for Negroes in the lowest income class to exceed expenditures as computed from the regressions or for the race-area groups to fall short of computed expenditures in the highest income class. A further adjustment, allowing for a 10 per cent increase in the mean income of the highest income class by 1970, leads to an insignificant decrease in the effect on aggregate food consumption.

It should be noted that the increase in food expenditures for Negroes alone is more than twice as large as that for white and Negro families combined. The partially offsetting decrease for white families is largely due to the shift of these families out of the highest expenditure area, metropolitan regions in the north. Much of this apparent shift may simply represent the movement of urban families out beyond the currently recognized metropolitan limits. If these families retain urban habits of food expenditure, then the effect is to overstate the shift from metropolitan areas in the north and understate the shift from nonmetropolitan areas in the north, which are characterized by much lower levels of food expenditure. For this reason, it is entirely possible that in fact no change or even a small increase should be expected in the food consumption of white families as a result of regional shifts.

In summary, it appears that shifts among race-area groups largely cancel in their effects on aggregate food consumption, though the distributional shifts in consumption are of considerable interest for some purposes. On the other hand, shifts in the age distribution may have effects which require a significant adjustment of the change in food expenditure (in 1950 dollars) which might be expected between 1950 and 1970 on the basis of growth in population and real income.

Appendix

TABLE A-1

Computation of the Effect on Food Consumption of Expected Shifts in the Age Distribution 1950–1970 (linear model)

Age Group	*Expected Shift 1950–1970* r_i (per cent)	*Age Effect* a_i	*Income Effect*[a] $b\bar{Y}_i$	*Family Size Effect* $\sum_j w_{ij}c_j$	*Typical Food Expenditure* $a_i + b\bar{Y}_i + \sum_j w_{ij}c_j$	*Expected Effect on Aggregate Expenditure* $0.01r_i(a_i + b\bar{Y}_i + \sum_j w_{ij}c_j)N$
						(1950 dollars)
Under 35	−0.33	259	649	147	1,055	− 3.482N[b]
35–54	−2.24	372	775	171	1,317	−29.501N
55 and over	2.57	389	559	36	984	25.289N
Total	0.00					− 7.694N

[a] Based on 1950 mean incomes.
[b] N is number of families, including one-person families, in 1970.

TABLE A-2

Computation of the Effect on Food Consumption of Expected Shifts in the Age Distribution 1950–1970 (double log model)

Age Group	*Income Group*	*Expected Shift 1950–1970* r_{ik}	*Age Effect* a_i	*Income Effect*[a] $\hat{Y}_k^b$	*Family Size Effect*[b] $\sum_j w_{ijk} j^c$	*Typical Food Expenditure* $a_i \hat{Y}_k^b \sum_j w_{ijk} j^c$	*Expected Effect on Aggregate Expenditure* $0.01 r_{ik}(a_i \hat{Y}_k^b \sum_j w_{ijk} j^c)N$
		(per cent)					(1950 dollars)
Under 25	All	2.78	10.23	—	—	—	24.097N[c]
	Under–$1,000	0.0211		28.5	1.245	363	
	$ 1,000–$1,999	.5196		45.9	1.245	585	
	$ 2,000–$2,999	.9196		59.7	1.298	793	
	$ 3,000–$3,999	.8073		70.5	1.324	955	
	$ 4,000–$4,999	.3439		80.2	1.300	1,067	
	$ 5,000–$5,999	.0984		89.0	1.338	1,218	
	$ 6,000–$7,499	.0281		98.5	1.388	1,399	
	$ 7,500–$9,999	.0281		111.9	1.388	1,589	
	$10,000–over	.0142		134.3	1.388	1,907	
25–34	All	−3.11	10.64	—	—	—	−34.578N
	Under–$1,000	−0.0286		28.5	1.263	383	
	$ 1,000–$1,999	− .2239		45.9	1.348	658	
	$ 2,000–$2,999	− .6186		59.7	1.390	883	
	$ 3,000–$3,999	−1.0191		70.5	1.440	1,080	
	$ 4,000–$4,999	−0.6742		80.2	1.458	1,244	
	$ 5,000–$5,999	− .2979		89.0	1.445	1,368	
	$ 6,000–$7,499	− .1524		98.5	1.427	1,496	
	$ 7,500–$9,999	− .0712		111.9	1.468	1,748	
	$10,000–over	− .0243		140.2	1.488	2,220	

TABLE A-2 (concluded)

Age Group	*Income Group*	*Expected Shift 1950–1970* r_{ik}	*Age Effect* a_i	*Income Effect*[a] $\hat{Y}_k{}^b$	*Family Size Effect*[b] $\sum_j w_{ijk} j^c$	*Typical Food Expenditure* $a_i \hat{Y}_k{}^b \sum_j w_{ijk} j^c$	*Expected Effect on Aggregate Expenditure* $0.01 r_{ik}(a_i \hat{Y}_k{}^b \sum_j w_{ijk} j^c)N$
		(per cent)					(1950 dollars)
35–44	All	−3.12	11.21	—	—	—	−40.543N
	Under–$1,000	−0.0406		28.5	1.153	368	
	$ 1,000–$1,999	− .2022		45.9	1.286	662	
	$ 2,000–$2,999	− .5001		59.7	1.412	945	
	$ 3,000–$3,999	− .8305		70.5	1.491	1,178	
	$ 4,000–$4,999	− .7185		80.2	1.522	1,368	
	$ 5,000–$5,999	− .3803		89.0	1.527	1,523	
	$ 6,000–$7,499	− .2387		98.5	1.533	1,693	
	$ 7,500–$9,999	− .1051		111.9	1.560	1,957	
	$10,000–over	− .1039		157.7	1.539	2,721	
45–54	All	0.88	11.56	—	—	—	11.179N
	Under–$1,000	.0323		28.5	1.164	383	
	$ 1,000–$1,999	.0845		45.9	1.223	649	
	$ 2,000–$2,999	.1547		59.7	1.319	910	
	$ 3,000–$3,999	.1849		70.5	1.407	1,147	
	$ 4,000–$4,999	.1444		80.2	1.440	1,335	
	$ 5,000–$5,999	.1108		89.0	1.477	1,520	
	$ 6,000–$7,499	.0875		98.5	1.515	1,725	
	$ 7,500–$9,999	.0495		111.9	1.541	1,993	
	$10,000–over	.0314		160.9	1.490	2,771	

55–64	All	0.91	11.63	—	—	—	9.982*N*
	Under–$1,000	.0688		28.5	1.099	364	
	$ 1,000–$1,999	.1582		45.9	1.173	626	
	$ 2,000–$2,999	.1706		59.7	1.273	884	
	$ 3,000–$3,999	.1824		70.5	1.323	1,085	
	$ 4,000–$4,999	.1169		80.2	1.368	1,276	
	$ 5,000–$5,999	.0789		89.0	1.431	1,481	
	$ 6,000–$7,499	.0654		98.5	1.441	1,651	
	$ 7,500–$9,999	.0409		111.9	1.531	1,992	
	$10,000–over	.0279		152.6	1.413	2,503	
65–74	All	0.57	11.07	—	—	—	4.645*N*[c]
	Under–$1,000	.1249		28.5	1.075	339	
	$ 1,000–$1,999	.1436		45.9	1.196	608	
	$ 2,000–$2,999	.1166		59.7	1.258	831	
	$ 3,000–$3,999	.0809		70.5	1.299	1,014	
	$ 4,000–$4,999	.0462		80.2	1.373	1,219	
	$ 5,000–$5,999	.0193		89.0	1.397	1,376	
	$ 6,000–$7,499	.0143		98.5	1.429	1,558	
	$ 7,500–$9,999	.0132		111.9	1.473	1,825	
	$10,000–over	.0110		152.6	1.435	2,424	
75–over	All	1.09	10.44	—	—	—	7.101*N*
	Under–$1,000	0.4057		28.5	1.100	327	
	$ 1,000–$1,999	.3111		45.9	1.185	568	
	$ 2,000–$2,999	.1461		59.7	1.258	784	
	$ 3,000–$3,999	.0811		70.5	1.310	964	
	$ 4,000–$4,999	.0650		80.2	1.415	1,185	
	$ 5,000–$5,999	.0270		89.0	1.463	1,359	
	$ 6,000–$7,499	.0270		98.5	1.496	1,538	
	$ 7,500–$9,999	.0135		111.9	1.416	1,654	
	$10,000–over	.0135		152.6	1.416	2,256	

[a] Using 1950 mean incomes. For each of the first eight income classes, incomes were averaged over all age groups. For the highest income class the mean incomes used are appropriate to the particular age group (or where frequencies are very small to a subset of age groups).

[b] Using 1950 family-size distributions for each age-income group. Where frequencies are very small, family-size effects have been averaged over adjacent income classes in a given age group.

[c] *N* is number of families, including one-person families, in 1970.

TABLE A-3

Computation of the Effect on Food Consumption of Expected Shifts Among Race-Area Groups 1950–1970 (double log model)

Race-Area Group	*Income Group*	*Expected Shift 1950–1970* r_{ik}	*Race-Area Effect* a_i	*Income Effect*[a] $\hat{r}_k^b$	*Family Size Effect*[b] $\sum_j w_{ijk} j^c$	*Typical Food Expenditure* $a_i \hat{r}_k^b \sum_j w_{ijk} j^c$	*Expected Effect on Aggregate Expenditure* $0.01 r_{ik}(a_i \hat{r}_k^b \sum_j w_{ijk} j^c)N$
		(per cent)					(1950 dollars)
North, Metropolitan, White	All	−0.77	14.87	—	—	—	− 9.267N^c
	Under–$1,000	− .0378		22.9	1.122	382	
	$ 1,000–$1,999	− .0711		36.0	1.189	636	
	$ 2,000–$2,999	− .1319		46.0	1.329	909	
	$ 3,000–$3,999	− .1897		53.8	1.425	1,140	
	$ 4,000–$4,999	− .1435		60.7	1.472	1,329	
	$ 5,000–$5,999	− .0821		66.9	1.483	1,475	
	$ 6,000–$7,499	− .0578		73.6	1.510	1,653	
	$ 7,500–$9,999	− .0331		82.8	1.546	1,903	
	$10,000–over	− .0229		116.6	1.524	2,642	
North, Nonmetropolitan, Total	All	−1.07	13.44	—	—	—	−10.868N
	Under–$1,000	− .0834		22.9	1.109	341	
	$ 1,000–$1,999	− .1497		36.0	1.213	587	
	$ 2,000–$2,999	− .2024		46.0	1.367	845	
	$ 3,000–$3,999	− .2875		53.8	1.478	1,069	
	$ 4,000–$4,999	− .1684		60.7	1.504	1,227	
	$ 5,000–$5,999	− .0562		66.9	1.541	1,386	
	$ 6,000–$7,499	− .0595		73.6	1.501	1,485	
	$ 7,500–$9,999	− .0374		82.8	1.531	1,704	
	$10,000–over	− .0255		109.4	1.480	2,176	

South, Metropolitan, White	All	0.99	13.88	—	—	—	10.990N
	Under–$1,000	.0337		22.9	1.156	367	
	$ 1,000–$1,999	.0965		36.0	1.235	617	
	$ 2,000–$2,999	.1767		46.0	1.368	873	
	$ 3,000–$3,999	.2603		53.8	1.426	1,065	
	$ 4,000–$4,999	.1859		60.7	1.451	1,222	
	$ 5,000–$5,999	.1079		66.9	1.484	1,378	
	$ 6,000–$7,499	.0705		73.6	1.476	1,508	
	$ 7,500–$9,999	.0342		82.8	1.517	1,743	
	$10,000–over	.0244		105.6	1.505	2,206	
South, Nonmetropolitan, White	All	– .68	13.03	—	—	—	– 6.717N
	Under–$1,000	– .0438		22.9	1.188	354	
	$ 1,000–$1,999	– .1022		36.0	1.321	620	
	$ 2,000–$2,999	– .1544		46.0	1.411	846	
	$ 3,000–$3,999	– .1523		53.8	1.473	1,033	
	$ 4,000–$4,999	– .1064		60.7	1.480	1,171	
	$ 5,000–$5,999	– .0563		66.9	1.509	1,315	
	$ 6,000–$7,499	– .0375		73.6	1.587	1,522	
	$ 7,500–$9,999	– .0209		82.8	1.571	1,695	
	$10,000–over	– .0063		105.6	1.590	2,188	
West, Metropolitan, Total	All	2.36	13.67	—	—	—	24.452N
	Under–$1,000	.1744		22.9	1.092	342	
	$ 1,000–$1,999	.2719		36.0	1.182	582	
	$ 2,000–$2,999	.3953		46.0	1.301	818	
	$ 3,000–$3,999	.5570		53.8	1.404	1,033	
	$ 4,000–$4,999	.4003		60.7	1.439	1,194	
	$ 5,000–$5,999	.2636		66.9	1.476	1,350	
	$ 6,000–$7,499	.1692		73.6	1.492	1,501	
	$ 7,500–$9,999	.0767		82.8	1.508	1,707	
	$10,000–over	.0517		109.9	1.414	2,124	

TABLE A-3 (concluded)

Race-Area Group	Income Group	Expected Shift 1950–1970 r_{ik}	Race-Area Effect a_i	Income Effect[a] $\hat{Y}_k{}^b$	Family Size Effect[b] $\sum_j w_{ijk} j^c$	Typical Food Expenditure $a_i \hat{Y}_k \sum_j w_{ijk} j^c$	Expected Effect on Aggregate Expenditure $0.01 r_{ik}(a_i \hat{Y}_k{}^b \sum_j w_{ijk} j^c)N$
		(per cent)					(1950 dollars)
West, Nonmetropolitan, Total	All	−0.98	13.76	—	—	—	−10.417N^c
	Under–$1,000	− .0726		22.9	1.107	349	
	$ 1,000–$1,999	− .1140		36.0	1.248	618	
	$ 2,000–$2,999	− .1820		46.0	1.349	854	
	$ 3,000–$3,999	− .2326		53.8	1.436	1,063	
	$ 4,000–$4,999	− .1591		60.7	1.470	1,228	
	$ 5,000–$5,999	− .1020		66.9	1.503	1,384	
	$ 6,000–$7,499	− .0542		73.6	1.472	1,491	
	$ 7,500–$9,999	− .0349		82.8	1.529	1,742	
	$10,000–over	− .0285		109.4	1.517	2,284	
North, Metropolitan, Nonwhite	All	.81	6.78	—	—	—	7.465N
	Under–$1,000	.0458		45.6	1.038	321	
	$ 1,000–$1,999	.1747		75.5	1.145	586	
	$ 2,000–$2,999	.2259		101.7	1.223	843	
	$ 3,000–$3,999	.1888		122.9	1.260	1,050	
	$ 4,000–$4,999	.1094		142.1	1.313	1,265	
	$ 5,000–$5,999	.0406		160.4	1.278	1,390	
	$ 6,000–$7,499	.0141		178.5	1.304	1,578	
	$ 7,500–$9,999	.0053		204.8	1.411	1,959	
	$10,000–over	.0053		256.6	1.438	2,502	

South, Metropolitan, Nonwhite	All	.08	6.25	—	—	—	$0.592N$
	Under–$1,000	.0095		45.6	1.077	307	
	$ 1,000–$1,999	.0247		75.5	1.203	568	
	$ 2,000–$2,999	.0272		101.7	1.269	807	
	$ 3,000–$3,999	.0119		122.9	1.282	985	
	$ 4,000–$4,999	.0049		142.1	1.331	1,182	
	$ 5,000–$5,999	.0012		160.4	1.398	1,401	
	$ 6,000–$7,499	.0003		178.5	1.314	1,466	
	$ 7,500–$9,999	.0004		204.8	1.341	1,716	
	$10,000–over	—		—	—	—	
South, Nonmetropolitan, Nonwhite	All	−0.74	6.23	—	—	—	$-4.836N$[c]
	Under–$1,000	− .1644		45.6	1.094	311	
	$ 1,000–$1,999	− .3289		75.5	1.302	612	
	$ 2,000–$2,999	− .1771		101.7	1.322	838	
	$ 3,000–$3,999	− .0316		122.9	1.297	993	
	$ 4,000–$4,999	− .0253		142.1	1.418	1,255	
	$ 5,000–$5,999	− .0063		160.4	1.480	1,479	
	$ 6,000–$7,499	− .0063		178.5	1.480	1,646	
	$ 7,500–$9,999	—		—	—	—	
	$10,000–over	—		—	—	—	

[a] Using 1950 mean incomes. For each of the first eight income classes, an average income effect was used for all area groups. For the highest income class, income effects apply to a particular race-area group or to a subset of groups.

[b] Using 1950 family size distributions for each race-area group.

[c] N is number of families, including one-person families, in 1970.

COMMENT

KARL A. FOX, Iowa State University

A major research conference is a speculative undertaking. No one member of its planning committee is sure of the relative importance of all the topics that seem logically related to its central theme. The committee as a whole may succeed quite well in listing topics that are germane. But it cannot always find competent scholars who are willing to divert their energies to preparing papers ideally suited to the conference framework. Frequently it gets instead some papers of good intrinsic quality centered at considerable distances from their ideal locations in the conference structure and oriented at odd angles with its major axes.

My preamble is not directed exclusively toward the present conference. However, by concentrating on the interrelations between two fields, this conference did invite greater risks of heterogeneity and doubtful relevance than do conferences confined to a single discipline or subdiscipline. In some cases demographers with research in process properly oriented with respect to demographic axes may have been led to bring economic factors in by the side entrance; conversely, economists may have been induced to add demographic afterthoughts to research studies originally designed to measure relationships only among economic variables.

I believe some such considerations as these are needed to rationalize the inclusion of Mrs. Crockett's paper in its present (November 7 draft) form in the conference. Considered as a family budget analysis in the tradition of Engel, Bowley, and Houthakker, the research project mentioned in her paper seems well designed and may contribute significantly to our knowledge of the net effects of area, race, and home ownership status upon family expenditure patterns. Her preliminary estimates of elasticities of food expenditures with respect to income and family size look reasonable and interesting when viewed as contributions to the main stream of family budget analysis. However, her conference paper turns the basic study to a use for which it is very poorly adapted; in the nature of the case, she has presented us with a by-product rather than a main product, and I am afraid that the by-product is of little value to either demographers or economists.

Instead of discussing Mrs. Crockett's paper point by point, I will make a largely independent attempt to answer the question implied in her title—namely, what effects do demographic factors have upon the demand for food?

As a demand analyst, I have frequently been irritated—and puzzled—at the failure of well-regarded econometricians to specify which of many possible things they mean by the word "demand" in their empirical studies. A few of the leading time series analysts, including Henry Schultz, Stone, and the former Bureau of Agricultural Economics group (Ezekiel, Waugh, Foote, and others), have been careful to define their terms. Thus, a price-elasticity of consumer demand must be measured by using *quantities* purchased by consumers and *retail prices*; an income elasticity of consumer demand involves *quantities* purchased by consumers and a measure of consumer income. From the basic demand surface expressing quantity purchased as a function of retail price and consumer income one can derive a relationship between *consumer expenditures* and consumer income—but to avoid confusion I believe this should be called an *expenditure* relationship rather than a "demand" relationship.

Measuring "the" demand for food also involves aggregation problems —in practice, the construction of appropriately weighted index numbers of the prices and quantities purchased of individual foods. This point will be elaborated below in connection with Table 3. For the moment I will simply point out that Mrs. Crockett has been quite careless about identifying expenditures with quantities purchased, even to the point of remarking that certain categories of families with above-average food expenditures "eat more food." This last phrase raises still further questions of definition—does more food mean more calories, more pounds, or "more" as measured by some sort of price-weighted index? It is just as important for applied economists to discriminate among these concepts as it is for actuaries to distinguish between crude death rates and age-specific death rates or for electricians to distinguish between volts, watts, and amperes. In general, if an economic variable is worth measuring, it is worth defining.

If these comments appear quibbling, consider some of the figures in Table 1. This table presents analyses made by this discussant several years ago, based on family budget data for Spring 1948.[1] In column (2) we note that the elasticity of food expenditures with respect to disposable personal income was 0.51 with both variables on a per family basis and 0.42 with both variables on a per capita basis. On a per capita basis, the income-elasticity of food expenditures away from home was 1.14, while that of food expenditures for use at home was 0.29. The elasticity of *expenditures* per meal eaten at home (with respect to income per family member) was 0.28, while a weighted average of the income elasticities of *quantities* of food consumed per meal at home was 0.14. The income

[1] Originally published in Karl A. Fox, "Factors Affecting Farm Prices, Farm Income, and Food Consumption," *Agricultural Economics Research*, Vol. III, no. 3, pp. 65–82, July, 1951.

TABLE 1

Food Expenditures and Quantities Purchased: Logarithmic Regressions upon Family Income, Urban Families, United States, Spring, 1948

Item	*Relative Importance*[a] (1)	*Effect of One Per Cent Change in Income upon:* Expenditure (2)	Quantity Purchased (3)	Col. (2) minus Col. (3) (4)
		Per cent[b]	Per cent[b]	Per cent[b]
A. Per family:				
All food expenditures		0.51		
At home		0.40		
Away from home		1.12		
B. Per family member:[c]				
All food expenditures		0.42		
At home		0.29		
Away from home		1.14		
C. Per 21 meals at home:[c]				
All food (excluding accessories)	100.0	0.28	0.14[d]	0.14
All livestock products	50.8	.33	.23[d]	.10
Meat, poultry, and fish	29.2	.36	.23	.13
Dairy products (excluding butter)	16.9	.32	.23	.09
Eggs	4.7	.22	.20	.02
Fruits and vegetables	19.0	.42	.33[d]	.09
Leafy, green, and yellow vegetables	4.9	.37	.21	.16
Citrus fruit and tomatoes	5.2	.41	.42	− .01
Other vegetables and fruits	8.9	.45	.35	.10
Other foods	30.2	.08	− .12[d]	.20
Grain products	11.4	.02	− .21	.23
Fats and oils	9.8	.13	− .04	.17
Sugars and sweets	5.2	.20	− .07	.27
Dry beans, peas, and nuts	1.5	− .07	− .33	.26
Potatoes and sweet potatoes	2.3	.05	− .05	.10

[a] Per cent of total expenditures for food used at home, excluding condiments, coffee, and alcoholic beverages.

[b] Regression coefficients based upon logarithms of food expenditures or quantities purchased per 21 meals at home and logarithms of estimated Spring 1948, disposable incomes per family member, weighted by proportion of total families falling in each family income group. The object was to obtain coefficients reasonably comparable with those derived from time series.

[c] Per capita regression coefficients are lower than per family coefficients in this study whenever the latter are less than 1.0. This happens because average family size was positively correlated with family income among the survey group.

[d] Weighted averages of quantity-income coefficients for subgroups.

Basic data from United States Bureau of Human Nutrition and Home Economics, 1948 Food Consumption Surveys, Preliminary Report no. 5, May 30, 1949; Tables 1 and 3.

elasticity of *calories purchased* per meal at home would have been substantially less than 0.14, and the income elasticity of *calories ingested* might have been negligibly different from zero. Thus, the income elasticity of "demand for food" could range from zero to 0.42 or 0.51, depending on what we meant by "more food." A vague question gets an ambiguous answer.

For the moment, let us state our analytical problem as that of anticipating changes in expenditures for food as reflected in the coefficient of 0.28 for "expenditures per 21 meals at home." Specifically, let us ask, as Mrs. Crockett does, what will be the effects of each of a number of demographic and economic factors upon changes in food expenditures (measured at Spring 1948 prices) from 1950 to 1970?

We can rough out part of the answer immediately on the basis of logic and experience. Other things being equal, a 40 per cent increase in population will mean a 40 per cent increase in expenditures for food. Also, from the coefficient 0.28 in Table 1, it appears that a 50 per cent increase in per capita income from 1950 to 1970 should mean something like a 14 per cent increase in per capita expenditures for food. Now, after the two obvious factors—population growth and the income elasticity of food expenditures—have been taken into account, there remain a number of demographic or "distributional" factors, the effects of which are not immediately clear and which have received only limited attention in the economic literature. Mrs. Crockett has used a number of these factors in her research design: race-area groups, home ownership categories, and groupings of families according to the age of the head of the family, family income, and the number of persons in the family. All of Mrs. Crockett's factors other than family income may be classed as demographic variables.

In dealing with these factors, it will be convenient to start with *quantities* of individual food products purchased rather than with food expenditures, and to think in terms of projecting quantities purchased per capita of the entire United States population. In what way do changes in demographic (and income) distributions affect average per capita purchases of a given product (q_1)? We may write, following Mrs. Crockett,

$$q_1 = f[y, s, A, k_{(ra)t}] \tag{1}$$

where y stands for family income, s the number of persons in the family, A the age of the head of the family, and $k_{(ra)t}$ is an adjustment factor that applies to a particular combination of race, area, and home tenure status. Mrs. Crockett has analyses in process based on seven age groups, nine race-area groups, nine income groups, six family size groups, and two home ownership categories; altogether, these cross-classifications would provide 6,804 "cells." If we arrayed these 6,804 cells as of 1950, starting with the one which showed the highest per capita purchases of the given product and ending with the cell which showed the lowest per capita purchases (q_1, 6,804) we would have a suitable basing point from which to measure the effects of demographic and income changes. We would also be in a position to make preliminary judgments as to the probable relative orders of magnitude of changes in per capita purchases that might arise from "likely" changes in the distributions of various demographic (and income) variables.

For example, the variance of q_1 could be broken down into a set of components representing the direct effects of each principle of classification, plus interaction terms and unexplained variation. If the coefficient of variation of q_1 arrayed in this fashion were very large, we would be encouraged to look for sizable effects on its average level in consequence of changes in the distributions of one or more explanatory factors. If the coefficient of variation of q_1 were small, the effects of changes in the distributions of explanatory factors would (in most practical situations) also be small.[2]

[2] This point deserves further clarification. Note that the coefficient of variation (V) of a set of values is defined as the ratio (times 100) of its standard deviation (σ) to its mean (M):

$V = 100(\sigma/M)$. Consider the following sets of values:

	Quantities Purchased	
Individual	A	B
1	1	1
2	0	1
3	0	1
.	.	.
.	.	.
.	.	.
9	0	1
10	0	0
$N = 10$	$M = 0.1$	$M = 0.9$
	$\sigma = 0.3$	$\sigma = 0.3$
	$V = 300$	$V = 33$

If in Set A the second individual changes his purchases from 0 to 1, M rises from 0.1 to 0.2 and σ from 0.3 to 0.4, while V falls to 200. If in Set B the second individual changes his purchases from 1 to 0, M falls from 0.9 to 0.8, σ rises from 0.3 to 0.4, and V rises from 33 to 50. The assumed change in Set A is extremely important, as it *doubles* per capita purchases; in contrast the assumed change in Set B is relatively unimportant as it reduces per capita purchases by only 11 per cent.

It follows that per capita purchases of goods desired by (for example) a limited age group may be strongly influenced by changes in age distribution, whereas per capita purchases of goods used in similar quantities by all age groups will be relatively impervious to changes in age distribution.

It is common knowledge that the demand for space in high schools and the demand for wedding rings are highly sensitive to changes in age distribution of the sort we are now experiencing; these demands *per capita of the general population* will show sharp percentage increases in the near future. But it seems intuitively obvious that the demand for food is relatively impervious to changes in age distribution—that, in fact, food may be the least promising of all major commodity groups for the sort of analysis Mrs. Crockett undertakes. Everyone eats; except for pre-school children, average calorie requirements for persons in different age groups are within about 25 per cent of the over-all average for the entire population. The range of variation in protein requirements per person by age groups is rather similar.

In 1955, I made a rough analysis of the effects upon calorie and protein requirements of the change in age distribution of the United States population from July 1, 1940 to July 1, 1953. This analysis is summarized in Table 2. It suggested that calorie requirements per capita of the total population may have decreased by 3 to $3\frac{1}{2}$ per cent during that period

TABLE 2

Age Distribution of the Total Population and Its Effects on Recommended Daily Food Allowances, United States, 1940 and 1953

	(1)	(2)	(3)	(4)	(5)	(6)
	Population Distribution				*Recommended Daily Dietary Allowances*	
	Actual		*Per Cent of Total*			
Age Group	July 1, 1940	July 1, 1953	July 1, 1940	July 1, 1953	Calories[a]	Protein[a]
	millions	*millions*	*per cent*	*per cent*	*number*	*grams*
All ages	132.8[b]	160.4[b]	100.0	100.0	—	—
0–4	11.4[b]	18.2[b]	8.6	11.3	1,000	40
5–9	10.6	15.6	8.0	9.7	1,800	55
10–14	11.7	12.4	8.8	7.7	2,600	75
15–19	12.3	10.8	9.3	6.7	3,000	85
20–34	33.0	35.4	24.8	22.1	2,800	60
35–54	34.0	40.6	25.6	25.4	2,500	60
55 and over	19.8	27.4	14.9	17.1	2,200	60
Weighted averages:						
(*a*) Based on 1940 age distribution					2,400	61.52
(*b*) Based on 1953 age distribution					2,319	60.08

[a] Based on recommended dietary allowances, National Academy of Sciences, Nat. Res. Coun. Pub. 302, 1953, p. 22. Allowances have been roughly adjusted to Census age groupings and rounded to the nearest 100 calories or 5 grams of protein.

[b] Adjusted for underenumeration of young children. Based on U.S. Census Bureau, Current Population Reports, Series P-25, nos. 93 and 98.

and that protein requirements may have decreased by 2 or 3 per cent. These requirements are based upon calories and grams protein *ingested*; if wastes in food preparation increase with increasing real income, the decline in calories *purchased* per capita would be somewhat smaller. Interestingly enough, according to U.S. Department of Agriculture estimates, calories purchased or available per capita of the total population appear to have declined about 2½ per cent from the 1935–1939 average to 1954—time periods which very nearly correspond to those in Table 2.[3]

A connection may readily be made between the 1940–1953 changes in age distribution of the total population and the 1950–1970 changes in age distribution of males 20 years of age and older as shown in Mrs. Crockett's Table 1. If each pair of population distributions is converted into a Lorenz curve or cumulative percentage frequency distribution, the maximum departures of these curves from the diagonal line of identical distribution are 6.6 per cent for the 1940–1953 comparison and 6.2 per cent for Mrs. Crockett's 1950–1970 comparison. Thus, it seems reasonable to expect that the age distribution effects projected by Mrs. Crockett would not change per capita calorie or protein requirements between 1950 and 1970 by more than 2 or 3 per cent; the net effect on "quantity of food purchased" should be no larger than this. In fact, the constant terms in her equations (1) through (7) show an extreme range of less than 14 per cent in expected food expenditures among families whose heads are in different age brackets. This is much less than the range of 83 per cent (from −58 to +25 per cent of the 1940 average) for the calorie requirements in Table 2, and 1970 projections based on equations (1) through (7) might well show age effects of less than 2 per cent.

If age and income distributions are held constant or turned into a standardized joint distribution, it seems unlikely that changes in race-area-home ownership patterns will have any appreciable effect upon average per capita calorie or protein requirements. If changes in age distribution have a potential of 2 or 3 per cent, changes in these other factors must have a potential (in terms of calories or other nutritive requirements) of a small fraction of 1 per cent. Mrs. Crockett's projections of the effects of expected shifts among race-area groups from 1950 to 1970 are indeed of this order of magnitude.

[3] Calorie figures are shown in Table 2, p. 414, of Karl A. Fox, "Effects of Farm Product Prices on Production and Commercial Sales," in *Policy for Commercial Agriculture*, Joint Committee Print, 85th Congress, 1st Session, November 22, 1957.

Thus, we may summarize the probable effects of demographic factors (including population growth) upon changes in quantities of food purchased from 1950 to 1970 as consisting of the following orders of magnitude: (1) effect of total population growth, an increase around 40 per cent; (2) effect of changes in age distribution, a reduction of not more than 2 or 3 per cent; and (3) effect of changes in other demographic factors, not more than ½ of 1 per cent in either direction. These magnitudes are all estimated independently of changes in income level or distribution.

We could conclude our discussion at this point on the grounds that income is not a demographic variable. However, the consideration of income effects will serve to demonstrate the importance of defining terms and specifying the objectives of measurement when discussing "the demand for food." Mrs. Crockett (based on her November 7 draft) is only one of many economists whose empirical practices in this field are far below their recognized competence in theory and econometric technique.

Table 3 may be helpful in conceptualizing the various measures which relate to "the" demand for food. This work table would be a very large one, as it would include 6,804 columns defined by combinations of family income and demographic categories and perhaps 5,000 to 10,000 rows. For example, if we defined about 2,500 different commodities in terms of the forms in which they are sold in retail food stores, we could also conceive of 2,500 "equivalent prices" of these commodities as they show up in restaurant meals and another 2,500 "equivalent prices" for these commodities as they may enter into farm household use by self-suppliers. I do not know the pricing methods used in the 1950 BLS study or even whether farm households are included in the "non-metropolitan" categories cited by Mrs. Crockett; however, the three sectors of Table 3 would be almost co-extensive and consistent with the food expenditure concept of the Office of Business Economics, except that the latter includes food provided to inmates of institutions and to members of the armed forces.

The continuing downtrend in farm population tends to increase the proportion of our total food purchases that is priced at retail-store or restaurant-meal levels. Also, family budget studies indicate that increases in disposable income per capita tend to increase the proportion of food consumed in restaurants; this also tends to increase total money expenditures for food. In addition, changes in food processing technology in the marketing system, in households, and in restaurants may affect the allocation of total food consumption among the three major categories

TABLE 3

Work Table for Studying Effects upon "Demand for Food" of Changes in Family Income and in Demographic Factors (based on categories used by Jean A. Crockett)

		Average Quantity Purchased in Each "Cell" (defined by race-area group, age of head, family income group, family size, and home-tenure status)[b]				
Commodity[a] and Price		Cell 1	Cell 2	Cell 3	. . .	Cell m
A. At retail store						
1	P_1	q_{11}	q_{12}	q_{13}	. . .	q_{1m}
2	P_2	q_{21}	q_{22}	q_{23}	. . .	q_{2m}
.	.	.	.	.		.
.	.	.	.	.		.
n	P_n	q_{n1}	q_{n2}	q_{n3}	. . .	q_{nm}
B. Equivalent price in restaurant meals						
1	$_rP_1$	$_rq_{11}$	$_rq_{12}$	$_rq_{13}$	. . .	$_rq_{1m}$
2	$_rP_2$	$_rq_{21}$	$_rq_{22}$	$_rq_{23}$	. . .	$_rq_{2m}$
.	.	.	.	.		.
.	.	.	.	.		.
n	$_rP_n$	$_rq_{n1}$	$_rq_{n2}$	$_rq_{n3}$	. . .	$_rq_{nm}$
C. Equivalent price for farm household use						
1	$_fP_1$	$_fq_{11}$	$_fq_{12}$	$_fq_{13}$	. . .	$_fq_{1m}$
2	$_fP_2$	$_fq_{21}$	$_fq_{22}$	$_fq_{23}$	. . .	$_fq_{2m}$
.	.	.	.	.		.
.	.	.	.	.		.
n	$_fP_n$	$_fq_{n1}$	$_fq_{n2}$	$_fq_{n3}$	. . .	$_fq_{nm}$

[a] Considering grade-and-cut combinations for meats and similar differentiations for other foods, the number of commodities (n) might total in the thousands.

[b] Mrs. Crockett refers to 9 race-area groups, 7 age groups, 9 family income groups, 6 family size groups, and 2 home tenure statuses, or a total number of 6,804 possible cells. The total United States population would provide an *average* of about 10,000 families per "cell"—i.e., per column of the above work table.

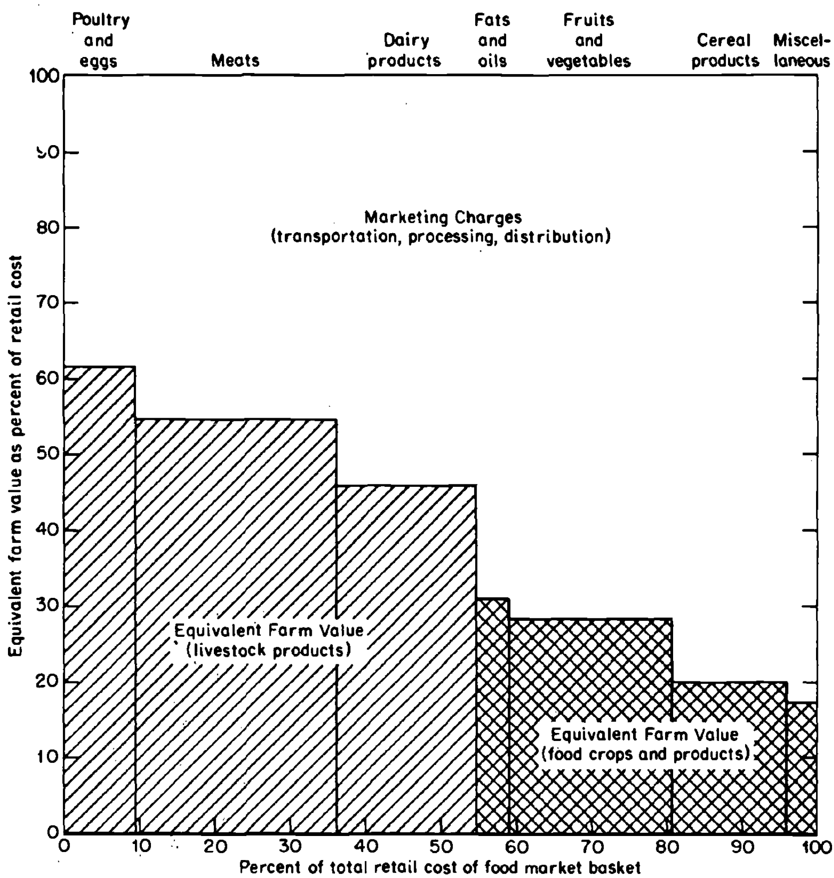
shown in Table 3; the allocation of consumption of particular foods among these three categories may be affected to a much greater extent. Changes in the value which urban housewives, and both the housewife and other members of farm families, place upon leisure or upon the use of their labor in other productive activities will also affect patterns of food consumption and expenditure.

Starting with the raw data required for Table 3, one could obtain any of the measures or concepts associated with demand, including total food expenditures, food expenditures per meal consumed at home, food consumption (as a quantity index weighted by fixed retail prices), or derived demand for resources used in production of farm food products (as measured by a quantity index using fixed farm prices as weights).

Chart 1 illustrates the differences that might arise between changes in "demand for food" as measured by a retail price weighted index of food consumption and in "demand for agricultural resources" as measured by a farm price weighted index containing the same or equivalent quantities of various foods. Marketing charges (transportation, processing, and

CHART 1

Percentage Distribution of Total Retail Cost of "Food Market Basket" among Major Food Categories and between Marketing Charges and Equivalent Farm Values, July–September, 1957



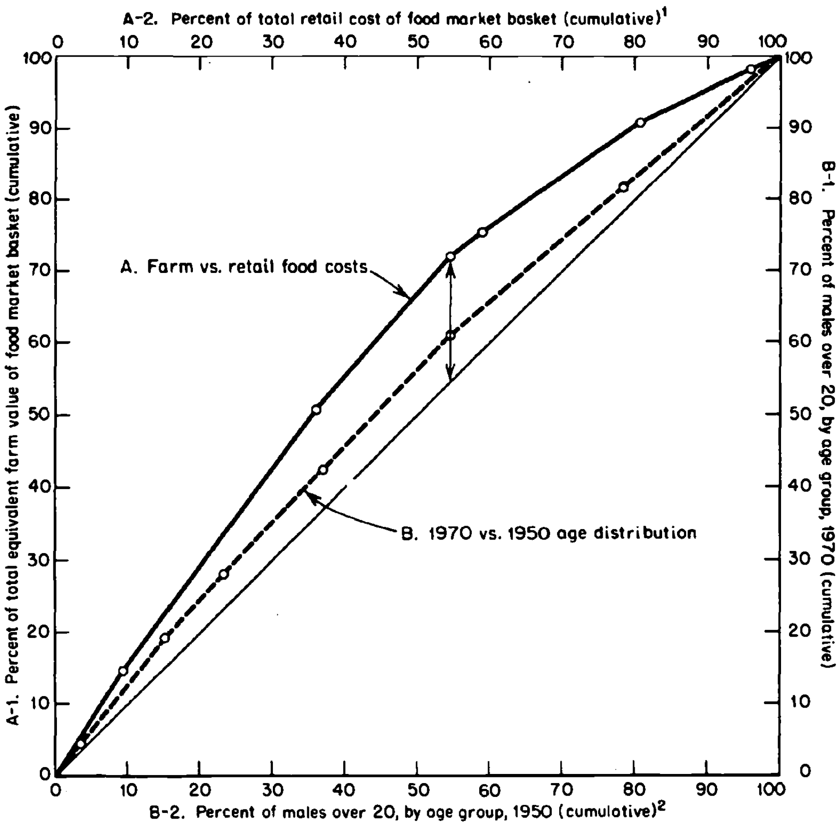
distribution) absorb a very large fraction of the retail cost of foods of crop origin; marketing charges for livestock products take up a smaller percentage of retail cost. Thus, during July–September 1957, livestock products accounted for 54.6 per cent of the retail cost of the food market basket compared with 71.8 per cent of its equivalent farm value; conversely, foods of crop origin accounted for 45.4 per cent of the retail cost and only 28.2 per cent of the equivalent farm value.

Chart 2 compares two Lorenz curves, the solid line relating cumulative frequency distributions of farm values and retail values of seven major

CHART 2

Changes in Age Distribution of U.S. Population from 1950 to 1970 Compared with Differences in the Relative Importance of Food Expenditure Categories at Retail and at Farm Price Levels, July–September 1957

(males over 20)



food categories, and the dotted line relating the cumulative frequency distributions of the 1970 and 1950 age distributions for males over 20 years of age as cited by Mrs. Crockett in her Table 1. The maximum departure of the farm-retail food cost curve from the diagonal is 17.2 per cent, almost three times as large as the maximum deviation (6.2 per cent) for the difference between 1950 and 1970 age distributions. It would appear that an error in concept, or pure sloppiness in deciding what one wishes to measure, *could* lead to a distortion in the measurement or interpretation of demand changes almost three times as large as the actual effects of a correctly measured change in age distribution of the total population.[4]

"Total food expenditures" are less well defined than any of the other measures relative to food consumption that have been discussed in the text or represented in the charts and tables. It should be noted that each quantity in Table 3 is subject to influence by its own price, by the prices of closely or distantly competing food products, and by changes in food prices generally relative to prices of nonfood consumer goods and services. Price elasticities of consumer demand for most foods, if measured at such levels of aggregation as "beef," "pork," or "all meat," are less (in absolute value) than -1.0; consequently, we cannot expect food expenditures to remain constant for a specified level of income despite changes in the level and pattern of food prices. The effects of variations in relative prices of different grades and cuts of beef may be negligible in this regard; however, when the retail price of pork drops 20 per cent between two periods or the retail price index for all foods falls 5 per cent in a short time, these price elasticities suggest that food expenditures could fluctuate 3 or 4 per cent above or below the "normal" relationship to disposable income per capita. Price variations of this magnitude are not uncommon, and their potential effects on relationships between food expenditures and income are of the same order of magnitude as potential changes in population age distribution over a 20-year period.

[4] Although this is somewhat to one side of our discussion, it might be noted that the difference between the cumulative frequency distributions of (1) requirements for marketing services and (2) resources used in farm production is even larger than that between the retail and farm value distributions—a maximum departure from the diagonal of 27.8 per cent, or well over four times as large as the maximum discrepancy noted between the 1950 and 1970 age distributions. It appears that the demand for food marketing services could change quite differently from the demand for resources used in farm production—the two types of demand might normally change in the same direction but by quite different percentages.