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Author(s): Allen C. Kelley
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Demographic Impacts on Demand Patterns in the Low-Income Setting

Allen C. Kelley*
Duke University

I. Introduction and the Problem

Studies of the impacts of demographic change on economic growth, especially those using macro simulation models, have mushroomed in the last 2 decades.[1] While most of these studies show a negative impact of population growth on development, the models have come under increasing attack given their underlying theoretical specifications, their tenuous empirical foundations, and their inability to articulate well important aspects of microeconomic-demographic behavior.[2] Until these microeconomic-demographic relationships are better understood, the macroeconomic-demographic representations will of necessity continue to rest on shaky foundations. One of these microeconomic-demographic linkages pertains to the impacts of family size on household behavior.

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[1] E.g., see R. Barlow, "The Economic Effects of Malaria Eradication," *American Economic Review* 57 (May 1967): 130–57; R. Barlow and G. Davis, "Policy Analysis with a Disaggregated Economic-Demographic Model," *Journal of Public Economics* 3 (February 1974): 43–70; F. Denton and B. Spencer, "Household and Population Effects on Aggregate Consumption," *Review of Economics and Statistics* 58 (February 1976): 86–95; S. Enke, *Description of the Economic-Demographic Model* (Santa Barbara, Calif.: Tempo Center for Advanced Studies, 1971); G. Rodgers, M. Hopkins, and R. Wéry, *Population, Employment and Inequality* (West Mead: Saxon House, 1978).

[2] W. Brian Arthur and Geoffrey McNicholl, "Large-Scale Simulation Models in Population and Development: What Use to Planners?" *Population and Development Review* 1 (December 1975): 251–65; Warren C. Sanderson, "Economic-Demographic Simulation Models: A Review of Their Usefulness for Policy Analysis," *Research Memorandum* (Laxenburg: International Institute for Applied Systems Analysis, 1979).

In speculations about household behavior in developing countries, there are many untested but firmly held convictions related to the impact of family size and composition on spending and saving. For example, children are assumed to make rather fixed consumption demands (the adult-equivalency model) and are assumed to be financed by reducing household saving. Therefore saving diminishes with household size.[3] Clearly, this is not the only analytical possibility. Children may in fact increase or decrease the market and/or home work of parents, they may contribute directly or indirectly to market and home activity, and they may make large or small consumption demands depending on scale economies in consumption and on whether consumption is "quality adjusted."[4] As I have shown in studies of Kenyan urban households and nineteenth-century American households, the impact of family size on household saving is small when these various indirect effects are taken into account.[5] The impact of household composition and size on saving is therefore an empirical issue; the direction and magnitude of the relationship is far from established, given the evidence presently available. Simple adult-equivalency formulations in macroeconomic-demographic models which show an unequivocal negative impact of family size on saving require qualification.

This paper examines another of the key relationships required for constructing economic-demographic models. In particular, I ask, What are the impacts of alternative demographic structures (number and ages of children) on the *composition* of household demand? If demographic structures exert a major impact, these structures should be explicitly modeled in macroeconomic-demographic paradigms; if not, simplifications can be made without doing violence to empirical reality, and modeling may be focused on more fruitful aspects of economic-demographic analysis.

This inquiry is directed both toward ascertaining the appropriate functional form of these relationships and toward identifying the most useful demographic specification which captures household structure. In terms of functional form, most budget studies of Engel curves employ the simple double-logarithmic model, the weakness of which is nicely summarized by H. S. Houthakker: ". . . the assumed constancy

[3] A. J. Coale and E. M. Hoover, *Population Growth and Economic Development in Low-Income Countries: A Case Study of India's Prospects* (Princeton, N.J.: Princeton University Press, 1958); Enke, pp. 25–28.

[4] P. Demeny, "Demographic Aspects of Saving, Investment, Employment and Productivity," *World Population Conference 1965* (New York: United Nations, 1967); Allen C. Kelley, "Savings, Demographic Change and Economic Development," *Economic Development and Cultural Change* 24 (July 1976): 683–93.

[5] Allen C. Kelley, "Interactions of Economic and Demographic Household Behavior," in *Population and Economic Change in Developing Countries,* ed. Richard A. Easterlin (Chicago: University of Chicago Press, 1980), pp. 403–70.

of elasticities can only be satisfied approximately and over limited ranges of total expenditure. This well-known defect . . . has to be offset against many advantages. . . . Perhaps one day a new type of Engel curve will be found which satisfies all theoretical requirements and fits the data adequately, although no doubt at the cost of increased computational difficulty."[6] I shall examine one such functional form which possesses some of the desired attributes described by Houthakker yet, as he predicted, is expensive computationally. I employ the Box and Cox method which transforms the data in ways that generate flexible functional forms which conveniently encompass, as limiting cases, most of the traditional Engel curves. While this approach is agnostic in its methodology, consumer-demand theory has yet to identify a demand system which has established econometric superiority.[7] However, this study supplies statistical modifications which may provide some additional insight into the sought-after budget-expenditure regularities.

I have several specific objectives. First, I will utilize the Box and Cox transformation to identify Engel curves using microeconomic household data from Kenya. Second, I will employ several criteria to assess whether this functional form is an improvement over competitors. Third, I will explore alternative demographic specifications. This is a potentially important extension since most work on Engel curves omits demographic attributes or utilizes rather arbitrarily aggregated measures of household structure: family size, adult equivalents, or per capita units. Houthakker is understandably cautious in assessing the likely productivity of these efforts: "A more correct treatment of family size is quite complicated, whereas blind application of an adult-equivalent scale intended for nutritional purposes to all commodities is probably worse than useless, not to speak of the difficulty of choosing between the many scales that have been proposed from Engel's days to our own."[8]

To preview the results: I will conclude that the highly flexible Box and Cox model adds little to the simple log-linear formulation, and

[6] H. S. Houthakker, "An International Comparison of Household Expenditure Patterns Commemorating the Centenary of Engel's Law," *Econometrica* 25 (July 1957): 543.

[7] For an incisive analytical treatment of the ways in which household composition might be included in Engel and demand functions, see J. Muelbauer, "Household Composition, Engel Curves and Welfare Comparisons between Households: A Duality Approach," *European Economic Review* 5 (1974): 103–22. He clearly reveals the difficulties of and the possibilities for obtaining true household equivalency effects and, in particular, distinguishing between quality and quantity adjustments as a result of changing household composition. His ideas have been largely applied to British and developed-country data; empirical studies for the Third World are yet to appear.

[8] Houthakker, pp. 543–44.

furthermore, the complex demographic specifications yield relatively little insight. Over reasonable ranges of income and family size in the low-income setting, very simple expenditure-allocation models describe empirical reality quite well. These households alter their spending (and saving) less in response to family size and composition and more in terms of total resources available. This is not all that surprising since low-income households have relatively little discretion in budget allocations—they are, after all, close to the margin of subsistence. Indeed, I suspect that allocation decisions in these households relate more to the *quality* of consumption *within* broad budget categories than to the choice between broad budget categories themselves. Unfortunately, this issue could not be examined in this paper because of data constraints, nor is it modeled in most studies of economic-demographic change. With the recent attention of policymakers to "basic human needs," there may well be increased interest in "third-generation" economic-demographic models in examining these quality-quantity substitutions within the household's budget. At any rate, my results may be useful to those planners and modelers who develop economic-demographic paradigms since there may well be an empirical case for notably simplifying these frameworks when the focus is on *broad* categories of production and consumption. Elaborate adult equivalency or family-size and age-structure specifications to capture demographic influences on compositional changes in demand are likely to yield relatively little impact and represent misplaced modeling emphasis. Attention to delineating economic-demographic linkages could be directed elsewhere more productively.

II. The Model

The Box and Cox procedure assumes that there exists a transformation of the household budget share (B_i) which is normally distributed and linearly associated with its various determinants: the household's total expenditure (E_i) and the household's demographic structure (D_i).[9] Several alternative variants of D_i will be considered, including per capita units, adult-equivalent units, and the number of children and adults. In its general form, the statistical model can be represented as

$$\frac{B_i^{\gamma_0} - 1}{\gamma_0} = \alpha + \beta_1 \frac{(F_i^{\gamma_1} - 1)}{\gamma_1} + \beta_2 \frac{(D_i^{\gamma_2} - 1)}{\gamma_2} + \varepsilon_i . \quad (1)$$

[9] See G. Box and D. Cox, "An Analysis of Transformation," *Journal of the Royal Statistical Society* (1964), pp. 211–54; G. Box and P. Tidwell, "Transformation of the Independent Variables," *Technometrics* 4 (November 1962): 531–50.

Estimates of the parameters can be obtained by maximum-likelihood techniques.[10]

While this model has been employed in several contexts,[11] it seems particularly suitable to the study of household budget shares since the limiting values of the γ_i's encompass many of those functional forms which have been extensively examined in the Engel-curve literature. For example, in Prais and Houthakker's classic study of household budget shares, five functional forms were postulated, each representing assumptions on household expenditure elasticities which, for various commodities, possessed some a priori support.[12] These forms were

$$\log B_i = \alpha + \beta \log E_i \,, \tag{2}$$

$$\log B_i = \alpha - \beta / E_i \,, \tag{3}$$

$$B_i = \alpha + \beta \log E_i \,, \tag{4}$$

$$B_i = \alpha + \beta E_i \,, \tag{5}$$

$$B_i = \alpha + \beta / E_i \,. \tag{6}$$

In the case where demographic elements are omitted from (1), it has been shown by Benus, Kmenta, and Shapiro[13] that equations (2)–(6)

[10] The density function of B_i can be shown to be

$$f(B_i) = B_i^{\gamma_0} - 1(2\pi\sigma^2)^{-1/2} \exp\left\{ -\frac{1}{2\sigma^2}\left[\left(\frac{B_i^{\gamma_0} - 1}{\gamma_0}\right) - \beta_0 - \beta_1\left(\frac{E_i^{\gamma_1} - 1}{\gamma_1}\right) - \beta_2\left(\frac{D_i^{\gamma_2} - 1}{\gamma_2}\right)\right]^2\right\}.$$

Estimates of γ_i, α, and β_i are obtained by maximizing this function or its logarithm. Similarly, under assumptions of normality, the probability density function for ε_i may be written as $f(\varepsilon_i) = (2\pi\sigma^2)^{-1/2} \exp\left[-\tfrac{1}{2}(\varepsilon_i^2/\sigma^2)\right]$.

[11] P. J. Dhrymes and M. Kurz, "Technology and Scale in Electricity Generation," *Econometrica* 32 (January 1964): 287–315; V. Mukerji, "Generalized SMAC Function with Constant Ratios of Elasticities of Substitution," *Review of Economic Studies* 30 (October 1963): 233–36; James Heckman and Solomon Polachek, "Empirical Evidence on the Functional Form of the Earnings-Schooling Relationship," *Journal of the American Statistical Association* 69 (June 1974): 350–54; K. J. White, "Estimation of the Liquidity Trap with a Generalized Functional Form," *Econometrica* 40 (January 1972): 192–98; P. Zarembka, "Functional Form in the Demand for Money," *Journal of the American Statistical Association* 63 (June 1968): 502–11.

[12] S. J. Prais and H. S. Houthakker, *The Analysis of Family Budgets* (Cambridge: Cambridge University Press, 1955).

[13] J. Benus, J. Kmenta, and H. Shapiro, "The Dynamics of Household Budget Allocation," *Review of Economics and Statistics* 58 (May 1976): 129–38.

can be taken as special cases of (1):

$$\text{if } \gamma_0 \longrightarrow 0 \quad \text{and} \quad \gamma_1 \longrightarrow 0\,, \quad \text{then} \quad (1) \longrightarrow (2)\,;$$

$$\text{if } \gamma_0 \longrightarrow 0 \quad \text{and} \quad \gamma_1 = -1\,, \quad \text{then} \quad (1) \longrightarrow (3)\,;$$

$$\text{if } \gamma_0 \longrightarrow 1 \quad \text{and} \quad \gamma_1 \longrightarrow 0\,, \quad \text{then} \quad (1) \longrightarrow (4)\,;$$

$$\text{if } \gamma_0 = 0 \quad \text{and} \quad \gamma_1 = 1\,, \quad \text{then} \quad (1) = (5)\,;$$

$$\text{if } \gamma_0 = 1 \quad \text{and} \quad \gamma_1 = -1\,, \quad \text{then} \quad (1) = (6)\,.$$

Thus, while the choice of functional form between (2) through (6) often requires employing some ad hoc criteria, the more general specification represented by (1) enables the researcher to approach the functional-form decision in a more rigorous manner. If one draws on large-sample theory, various hypotheses about the parameters may be examined. In particular, twice the difference in the logarithmic likelihood between a null and alternative hypothesis is distributed χ^2 with the number of degrees of freedom depending on the number of parameters in the null hypothesis.

This study, then, represents an extension of the promising work of Benus et al. in that I apply the generalized Box and Cox model to several budget categories, utilize microeconomic data from a developing country, and investigate several alternative specifications of the household's demographic structures. I then take up in somewhat more detail the empirical significance of the apparent merits of the more generalized functional form.[14]

III. The Data

The data represent a subsample from the Kenyan Urban Household Budget Survey for the years 1968–69. This subsample includes 401 households which have one or two parents and their own children. Based on an examination of the raw data, consistency checks, and an appraisal of the data collection and sampling techniques, I have argued elsewhere that this particular data file provides information of unusually high quality for a developing country.[15]

Six budget categories have been selected for analysis: food, clothing, housing, and miscellaneous (all else), as well as meats and cereals.[16] The first four budget categories correspond to those employed tradi-

[14] The Benus et al. study was particularly useful in its joint utilization of cross-section and time-series information to reveal the dynamics of household budget allocation. It was also interesting in its methodology. Given their rather large data file, Benus et al. formulated their hypotheses with unutilized data from the same data set.

[15] Kelley, "Interactions of Economic and Demographic Household Behavior," pp. 543–44.

[16] Food excludes alcohol and tobacco.

tionally in the Engel-curve literature; the last two categories were selected to provide somewhat narrower classifications to ascertain whether the results are sensitive to the level of classification. As in many studies of Engel curves, I have employed total expenditure as the major independent variable. This measure more closely approximates permanent income and, moreover, is likely to be measured with greater reliability than is total income.

Table 1 presents the means and standard deviations of the variables used in the analysis as well as the distribution of family size in terms of number of children. Because one of the Engel-curve functions requires taking a logarithmic transformation of the expenditure category, it was necessary to insert an arbitrarily small number for the zero entries in expenditure categories for meats and clothing. These are relatively small budget items for which there may have been no expenditures during the weeks of the survey. I took the average of the five lowest existing observations in these categories and inserted this number for the zero entries. A total of 35 households had zero entries. It is unlikely that the results are materially influenced by this transformation.

IV. The Results

The objective here is to present evidence on the best functional form and to assess the impact of selecting one functional form over the other in terms of making inferences about family size and structure on household demand patterns in a low-income country. I begin by examining the functional forms in terms of the value of the likelihood function. Observations are also presented on the relative constancy of the expenditure elasticities across commodity groupings and across demographic specifications. I then explore in some detail the nature and implications of the various demographic specifications. I conclude with

TABLE 1

MEANS AND STANDARD DEVIATIONS OF VARIABLES IN ANALYSIS (Kenyan Shillings)

Variable	Mean	SD
Foods	214.4	112.0
Meats	51.2	34.9
Cereals	37.4	26.8
Clothing	28.5	68.0
Housing	100.7	144.7
Miscellaneous	188.5	259.4
Total expenditure (excluding meats and cereals)	532.0	464.7
Adult equivalents*	3.7	1.3
Children	2.9	2.2

NOTE.—Proportion of families having: zero children = .130, 1 child = .167, 2 = .182, 3 = .190, 4 = .087, 5 = .082, 6 = .080, 7 = .080.

* A child under 17 is taken to equal .5 adult.

a summary of findings and provide an assessment of their implications in terms of aggregate modeling of economic-demographic demand specifications.

Selection of Functional Form

Table 2 presents the values of the likelihood function and the expenditure elasticities for six budget categories, three functional forms, and four demographic specifications. In considering the several functional forms in terms of the value of their likelihood functions, it is seen that the Box and Cox framework has a slight edge. The linear Engel curve is generally inferior in terms of fit.

If one next focuses on the Box and Cox model and examines the results across table 2, observations can be provided on the best functional form in terms of alternative demographic specifications. Here it is seen that there is almost no basis for discriminating among the various demographic specifications. Indeed, with the exception of cereals and food, the several models which have "demographic enrichments" provide values of the likelihood function which are almost identical to the model where no demographic elements are present—the "household-unit" model. At least in terms of the value of the likelihood-function criterion, demographic augmentations do not contribute much additional insight into household demand patterns.

As a final element in appraising functional form, consider the changes in expenditure elasticities with respect to total expenditure. Recall that Houthakker and others have been particularly concerned about the constant-elasticity assumption underlying the log-linear formulation. While over very wide ranges of total expenditure this hypothesis has little appeal, the relevant empirical issue is whether the constancy-of-elasticity assumption holds approximately over reasonable ranges of expenditure and income. For making this assessment, I have computed the expenditure elasticities for the linear and the Box and Cox models at the mean expenditure level and at one standard deviation above the mean. This is a reasonably wide range of experience. (See table 1.)

Focusing first on the Box and Cox models, one can see that, with the exception of clothing, expenditure elasticities are almost constant over wide ranges of total expenditure. While for the linear formulation the elasticities change somewhat more, I have noted above that the linear model appears to be less successful in explaining demand patterns than is the Box and Cox formulation. I therefore conclude that, in terms of the basic shape of the Engel curves, the highly flexible Box and Cox model and the log-linear formulation provide strikingly similar results.

TABLE 2

COMPARISON OF EXPENDITURE ELASTICITIES AT THE EXPENDITURE MEAN AND 1 STANDARD DEVIATION ABOVE THE EXPENDITURE MEAN FOR THREE ENGEL-CURVE FUNCTIONAL FORMS, SIX BUDGET CATEGORIES, AND FOUR DEMOGRAPHIC SPECIFICATIONS

BUDGET CATEGORY	HOUSEHOLD UNIT			ADULT EQUIVALENTS			NUMBER OF CHILDREN			CHILDREN (Dummy Variable)		
AND MODEL	$\mu_{\bar{E}}$	$\mu_{\bar{E}+\sigma}$	MLR	$\mu_{\bar{E}}$	$\mu_{\bar{E}+\sigma}$	MLR	$\mu_{\bar{E}}$	$\mu_{\bar{E}+\sigma}$	MLR	$\mu_{\bar{E}}$	$\mu_{\bar{E}+\sigma}$	MLR*
Food:												
Box and Cox ...	.567	.534	−1,642	.545	.509	−1,631	.539	.501	−1,632	.542	.498	−1,647
Linear	.405	.559	−1,764	.386	.540	−1,749	.383	.537	−1,749	.344	.539	−1,749
Log linear	.591	.591	−1,649	.572	.572	−1,641	.580	.580	−1.645	...	...	...
Meat:												
Box and Cox ...	.605	.524	−1,265	.568	.510	−1,263	.558	.473	−1,258	.566	.485	−1,263
Linear	.444	.598	−1,343	.423	.578	−1,335	.412	.567	−1,328	.406	.561	−1,328
Log linear	.689	.689	−1,348	.680	.680	−1,348	.679	.679	−1,348	...	...	...
Cereals:												
Box and Cox ...	.333	.333	−1,236	.287	.277	−1,219	.289	.279	−1,224	.306	.300	−1,228
Linear	.259	.395	−1,295	.218	.342	−1,271	.221	.346	−1,280	.246	.359	−1,275
Log linear	.301	.301	−1,295	.301	.301	−1.289	.279	.279	−1,294	...	...	...
Clothing:												
Box and Cox ...	1.236	1.745	−1,004	1.344	1.757	−1,001	1.361	1.776	−1,000	1.366	1.782	−1,077
Linear	1.654	1.269	−1,604	1.699	1.282	−1,602	1.716	1.287	−1,600	1.866	1.295	−1,601
Log linear	1.189	1.189	−1,004	1.263	1.263	−1,002	1.249	1.249	−1,002	...	...	...
Housing:												
Box and Cox ...	1.090	1.159	−1,537	1.168	1.197	−1,538	1.169	1.250	−1,537	1.165	1.247	−1,557
Linear	1.246	1.118	−1,823	1.263	1.112	−1,822	1.162	1.125	−1,823	1.260	1.125	−1,823
Log linear	1.217	1.217	−1,581	1.202	1.202	−1,582	1.207	1.207	−1,582	...	...	...
Miscellaneous:												
Box and Cox ...	1.448	1.507	−1,634	1.465	1.518	−1,634	1.452	1.508	−1,634	1.450	1.570	−1,634
Linear	1.462	1.204	−1,847	1.463	1.204	−1,848	1.464	1.204	−1,848	1.463	1.204	−1,848
Log linear	1.619	1.619	−1,692	1.619	1.619	−1,693	1.617	1.617	−1,693	...	...	...

* MLR = maximum-likelihood ratio.

Alternative Demographic Specifications

Table 3 presents the results of possibly the most flexible functional forms in terms of demographic specifications. For both the Box and Cox and the linear models, the number of children is entered in terms of dummy variables, permitting the impact of additional children to exert an influence dictated by the data. The findings are quite interesting. Overall, the number of children exerts a small impact on household demand. Indeed, for clothing, housing, and miscellaneous, the joint demographic effects are insignificantly different from zero, though for food (including meat and cereals) the joint influence is statistically significant.[17] Moreover, the individual impacts which appear to be present show up only in relatively large families. For families under three or four children, the level and composition of demand is largely invariant with family size. For families of five and above, more food is consumed, and this is largely paid for by a lower average consumption of clothing and, to a lesser extent, housing.[18]

This general finding of the relative unimportance of alternative demographic specifications on household demand is also revealed by examining the demographic elasticities in terms of adult equivalents, and number of children, for the three Engel-curve formulations. These elasticities, computed at the mean level of adult equivalents and number of children, as well as 1 standard deviation above the mean, are presented in table 4. Focusing only on the broad expenditure categories (food, clothing, housing, and miscellaneous), we see that the elasticities are absolutely small. For the number-of-children variable, and with the exception of clothing (the smallest of the four items in terms of total expenditure), the absolute values of the elasticities lie in the range of 0–.2.[19] For the double-log model, they are virtually zero; for the Box and Cox transformation, the elasticities are almost as small. To obtain a feeling for the quantitative significance of this finding, I have made separate calculations on the level of commodity expenditure by different family sizes. Considering the estimates for food for the Box and Cox model, for example, a family with five children consumes only two more shillings (.4% of average total expenditures) of food, other things being equal, than a family with one child. It appears,

[17] The results for the linear model are illustrative. For food, meat, cereals, clothing, housing, and miscellaneous, the computed F-statistics for the hypothesis that $\gamma_1 = \ldots = \gamma_7 = 0$ are 4.85, 4.89, 6.49, 1.92, 1.32, and 1.08, respectively. For these models the relevant F-statistics for 95% and 99% significance levels are 2.01 and 2.64, respectively.

[18] It has been shown in a separate study that household saving is largely invariant to family size (Kelley, "Interactions of Economic and Demographic Household Behavior").

[19] While the number-of-children variable is discrete, for purposes of making the elasticity computations I have treated it as if it were continuous.

TABLE 3

Regression Results of Box and Cox and Linear Models Where Number of Children Are Specified as Dummy Variables

Expenditure Category	Parameter											
	α	β	λ	μ	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	VLF*
					Box and Cox Model							
Food	−2.83	2.32	.28	.01	.25	.21	.12	.51	.64	.84	1.28	−1,632
		(24.50)			(.97)	(.88)	(.49)	(1.72)	(2.12)	(2.72)	(4.19)	
Meat	−12.52	3.69	.51	.02	−.52	.06	.05	.33	−.10	2.53	2.20	−1,256
		(15.10)			(−.77)	(.09)	(.07)	(.41)	(−.13)	(2.99)	(2.64)	
Cereals	.12	1.06	.61	.15	.94	1.00	.77	1.78	5.13	3.23	4.99	−1,223
		(6.34)			(.91)	(.96)	(.75)	(1.46)	(4.09)	(2.51)	(3.94)	
Clothing	−.74	.06	.06	.51	−.06	−.48	−.54	−.34	−1.13	−1.00	−.84	−1,002
		(8.91)			(−.15)	(−1.20)	(−1.35)	(−.70)	(−2.26)	(−1.95)	(−1.67)	
Housing	−.09	.25	.26	.42	.20	.15	.24	.20	.80	.37	−.28	−1,539
		(19.90)			(.45)	(.34)	(.55)	(.38)	(1.47)	(.66)	(−.52)	
Miscellaneous	−.22	.16	.40	.66	.08	−.03	.61	.83	−.54	−.45	−.43	−1,635
		(38.27)			(.11)	(−.04)	(.83)	(.94)	(−.61)	(−.48)	(−.57)	
					Linear Model							
Food	108.59	.16	...	...	13.92	5.33	12.48	32.17	47.68	59.11	76.98	−1,749
		(17.50)			(.95)	(.37)	(.87)	(1.85)	(2.69)	(3.27)	(4.28)	
Meat	25.83	.04	...	...	−2.87	−.71	2.42	6.09	5.92	23.51	20.93	−1,328
		(12.80)			(−.56)	(−.14)	(.48)	(1.01)	(.96)	(3.75)	(3.36)	
Cereals	20.09	.02	...	...	4.87	4.48	4.60	9.77	25.58	14.92	25.43	−1,275
		(6.02)			(1.09)	(1.02)	(1.05)	(1.84)	(4.74)	(2.72)	(4.65)	
Clothing	−10.03	.09	...	...	1.94	−1.50	−19.35	−11.43	−24.01	−17.26	−24.42	−1,601
		(15.07)			(.19)	(−.15)	(−1.98)	(−.96)	(−1.99)	(−1.40)	(−2.00)	
Housing	−15.16	.24	...	...	−9.53	−5.29	−5.11	−24.50	14.44	−25.25	−45.95	−1,823
		(22.38)			(−.54)	(−.31)	(−.30)	(−1.18)	(.68)	(−1.17)	(−2.14)	
Miscellaneous	−83.40	.52	...	...	−6.34	1.46	11.98	3.75	−38.11	−16.60	−6.61	−1,848
		(47.44)			(−.35)	(.08)	(.68)	(.18)	(−1.75)	(−.75)	(−.30)	

Note.—Box and Cox model: $(X_i^\gamma - 1)/\gamma = \alpha + \beta(E^\mu - 1)/\mu + \gamma_1 D_1 + \ldots + \gamma_7 D_7$; linear model: $X_i = \alpha + \beta E + \gamma_1 D_1 + \ldots + \gamma_7 D_7$, where X_i = expenditure on good i, E = total expenditure, $D_i (i = 1, \ldots, 6) = 1$ for family of 1, . . . , 6 children and zero otherwise, and $D_7 = 1$ for a family of seven or more children, and zero otherwise. Numbers in parentheses are t-values.

* VLF = Value of the likelihood function.

therefore, that larger family sizes do not exert a particularly strong incremental demand for total or individual budget components and that the consumption of additional children is in large part "paid for" by the lowering of average consumption for the remaining members of the household.

This conclusion rests on the implicit assumption that household total expenditure (and income) is in large part not caused by changing household size. That assumption requires examination.

To this end, I have estimated, for the sample under consideration, the following relationship: $E = a + \Sigma b_i D_i + \varepsilon_i$, where E is total expenditure and D_i (i = 1, . . . , 7) is whether or not (0, 1) the family has 1, 2, . . . or 7+ children. (The omitted category, zero children, is included in the intercept.) This somewhat flexible functional form permits us to identify any nonlinearities in the impact of family size on total household expenditure. The following results were obtained:

TABLE 4

Elasticities of Expenditure Category with Respect to Alternative Demographic Specifications

Budget Category Model	Alternative Demographic Specifications			
	Adult Equivalents		Number of Children	
	At Mean	At Mean +1 SD	At Mean	At Mean +1 SD
Food:				
Box and Cox ...	.198	.266	.097	.165
Linear	.293	.360	.145	.229
Log linear	.188	.188	.034	.034
Meat:				
Box and Cox ...	.173	.228	.139	.229
Linear	.318	.388	.209	.315
Log linear	.090	.090	.030	.030
Cereals:				
Box and Cox ...	.521	.654	.204	.332
Linear	.651	.717	.257	.376
Log linear	.456	.456	.064	.064
Clothing:				
Box and Cox ...	−.760	−1.048	−.391	−.692
Linear	−.686	−1.230	−.410	−1.020
Log linear	−.597	−.597	−.597	−.597
Housing:				
Box and Cox ...	−.031	−.043	.003	.005
Linear	−.218	−.425	−.112	−.214
Log linear	.138	.138	.026	.026
Miscellaneous:				
Box and Cox ...	−.032	−.044	−.018	−.031
Linear	−.012	−.017	−.013	−.024
Log linear	−.015	−.015	.001	.001

$$E = 481.56 - \underset{(-.91)}{76.22D_1} - \underset{(-.68)}{56.07D_2} + \underset{(1.99)}{162.33D_3} + \underset{(.16)}{16.17D_4}$$

$$+ \underset{(.68)}{68.49D_5} + \underset{(2.60)}{264.39D_6} + \underset{(1.79)}{181.72D_7} ,$$

where t-values are in parentheses and $r^2 = .06$. Only the values for D_3 and D_6 are statistically significant, and D_1 and D_2 even possess incorrect signs. It does not appear, therefore, that there is a consistent and strong relationship between total expenditure and family size. Thus the demographic impact of the separate demand equations captures the main influences of alternative family sizes and structures; that is, a strong additional and indirect demographic effect does not appear to enter through the impact of family size and composition on total expenditure itself.

A final qualification to the analysis relates to the possibility that the family-size variable may be masking yet another demographic effect, in particular, the age of the children. Large families may increase demand for a given commodity not because of household size but because these households possess relatively older members on average. To test this hypothesis, I have considered an alternative formulation which incorporates age and family-size effects simultaneously:

$$B_i = \alpha_i + \beta_i E + \gamma_i D_i + \ldots + \gamma_7 D_7 + \delta_1 C_{5\text{–}9} + \delta_2 C_{10\text{–}14} + \delta_3 C_{15+} ,$$

where C_i represents the number of children in the indicated cohort and $D_1, \ldots, D_7$ represents a binary-variable vector for whether or not the number of children is $1, \ldots, 7+$. The results are presented in table 5. While there is multicollinearity between age and family size, it is seen that the influence of age is not sufficiently strong to exert an independent effect on demand patterns. Moreover, the joint effect of age for the food, clothing, housing, and miscellaneous categories is not significantly different from zero; only for the cereal and meat subcategories is this joint impact significant.[20] The basic conclusions derived from this table are the same as those obtained in table 3, where it was learned that family-size effects were not all that important in modifying demand patterns given the broad expenditure categories considered.

[20] For food, meat, cereals, clothing, housing, and miscellaneous, the computed F-statistics for the hypothesis that $\delta_1 = \delta_2 = \delta_3 = 0$ are 1.61, 2.54, 3.44, 1.06, 1.66, and 1.48, respectively. The relevant 95% and 99% significance levels are 2.60 and 3.78, respectively.

TABLE 5

REGRESSION RESULTS OF LINEAR MODEL WHERE CHILDREN ARE SPECIFIED BY NUMBERS AND BY AGES

Budget Category	α	β	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	δ_1	δ_2	δ_3	r^2
Food	108.70	.16	13.58	4.29	9.50	27.32	43.18	55.22	73.29	3.33	−2.95	2.98	.50
	(9.19)	(17.36)	(.92)	(.29)	(.59)	(1.32)	(1.82)	(2.16)	(2.57)	(.57)	(−.43)	(.26)	
Meats	25.97	.04	−3.42	−2.36	−1.63	−.36	−.94	16.76	13.53	4.08	−1.92	2.40	.39
	(6.37)	(12.70)	(−.67)	(−.46)	(−.29)	(−.05)	(−.12)	(1.90)	(1.37)	(2.04)	(−.82)	(.61)	
Cereals	20.02	.02	4.29	3.46	2.70	7.12	20.56	8.79	17.80	.84	2.45	1.76	.20
	(5.58)	(6.04)	(.95)	(.76)	(.55)	(1.14)	(2.85)	(1.13)	(2.05)	(.48)	(1.19)	(.51)	
Clothing	−10.23	.09	2.58	.65	−14.56	−3.88	−15.61	−8.47	−14.06	−4.63	.67	−.10	.37
	(−1.27)	(15.06)	(.26)	(.06)	(−1.33)	(−.28)	(−.97)	(−.49)	(−.72)	(−1.17)	(.15)	(−.01)	
Housing	−14.90	.24	−11.17	−10.25	−13.38	−36.61	−4.45	−48.86	−77.47	5.36	10.83	−8.75	.58
	(−1.06)	(22.23)	(−.63)	(−.58)	(−.70)	(−1.49)	(−.16)	(−1.61)	(−2.28)	(.78)	(1.34)	(−.64)	
Miscellaneous	−83.57	.52	−4.99	5.31	18.44	13.17	−23.12	2.11	18.24	−4.06	−8.56	5.88	.86
	(−5.76)	(47.20)	(−.27)	(.29)	(.93)	(.52)	(−.79)	(.07)	(.52)	(−.57)	(−1.03)	(.42)	

NOTE.—Numbers in parentheses are t-values.

Implications of the Results

Attempts to model the microeconomic impacts of demographic change on economic growth have largely rested on the impacts of alternative family sizes on saving and on the composition and level of demand. Formal models typically assume that larger families save less, given the increasing demands of larger numbers on the household's limited budget. In addition, it is assumed that the composition of spending is in more "unproductive" forms: away from human capital formation (schooling, health expenditures) and toward necessities in the form of food and clothing. In a previous study using data pertaining to Kenyan urban household behavior, it was learned that the level of household saving is largely invariant with family size.[21] In this study I have attempted to extend the analysis of household spending by examining how the composition of demand for *broad* expenditure categories is influenced by family size. For the most part, larger families do not manifest demand compositions different from those of small families. Instead, in the low-income setting, I speculate that the *quality* of consumption diminishes with family size. Larger families share more cramped living quarters, utilize hand-me-down clothing, consume lower-quality items, and spend less per capita on food. I have not examined in any detail the specific way in which this quality change is effected.

Comparing these results with other studies, I arrive at a mixed reading. For example, family-size effects were pervasive and generally statistically significant in Houthakker's 1957 paper. However, his data base was largely developed countries. I am arguing in this paper that in the low-income setting, family-size effects may be less important. This hypothesis is supported by Rodgers and others. In a preliminary but detailed and careful report using data from Thailand and Sri Lanka, Rodgers concludes that ". . . we still cannot confidently reject the hypothesis that household demographic composition has no effect on consumption patterns."[22] Similarly, in the ambitious Bachue-Philippines study, Rodgers et al. discovered that the composition of Philippine expenditures on 21 commodity items is largely uninfluenced by either the number of children or the number of adults in the household.[23] While both studies show some demand-compositional effects from household size and composition, these effects are relatively small in

[21] Kelley, "Interactions of Economic and Demographic Household Behavior."

[22] G. B. Rodgers, "Population, Consumption and Employment," World Employment Program: Population and Employment Project, mimeographed (Geneva: International Labour Organisation, 1974), p. 47.

[23] Rodgers et al. Of the 42 estimated demographic parameters on numbers of children or numbers of adults, only four were individually significant at the 99% level and only 10 were individually significant at the 95% level. Joint tests for the combined impact of children and adults were not reported (Rogers et al., pp. 96–98).

comparison with alternative explanatory variables, and they are not particularly pervasive across data sets and expenditure categories.

Another implication of these results pertains to the choice of functional form for Engel functions in low-income countries. It appears that at very low income levels subsistence considerations may be relatively important in determining demand patterns. Indeed, expenditure elasticities do not vary much over wide ranges of total expenditure, and the pattern of demand is largely invariant with family size. In choosing the simplest of traditional Engel-curve functions, the double-logarithmic function fitted with household data appears to give a reasonably reliable approximation to demand behavior in the low-income setting. The more complex nonlinear Box and Cox specification does not yield much additional insight. These findings may also imply that those models which highlight "subsistence" consumption, such as the Stone-Geary formulation, may capture one of the more important aspects of the early development process. While the assumptions of the Stone-Geary framework in terms of expenditure elasticities are not all that appealing for higher-income settings, they may be quite reasonable in the very low income setting.

It would be somewhat unwise to generalize from the present findings because they represent a rendering of demand changes associated with economic and demographic change in but one country, at one period of time, and in an urban setting. The contributions of the study are to utilize relevant and new data (microeconomic data for a low-income country), a general functional form permitting a statistical discrimination among alternative specifications, and an examination and comparison of several demographic formulations often treated separately in the literature. To obtain greater confidence in the results, it would be necessary to replicate the analysis on comparable data sets for differing countries at various levels of development. In addition, enrichment of the analysis to include nonnuclear households would be useful. However, if with the gathering of additional evidence the findings are found to be general, the widely held interpretation of the impact of demographic change on early stages of development will have to be modified. Furthermore, those macro simulation modeling efforts which have focused on detailed and elaborate demand structures with demographic augmentations may productively direct their attention to other key relationships of economic-demographic interactions in the low-income setting.