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An Empirical Test: The 1960 BLS Consumer Expenditures Survey

THE PRECEDING CHAPTERS have (1) set out a general framework in which one can discuss how education may be expected to affect consumption patterns of households, (2) developed certain empirical implications of this model, and (3) discussed the particular estimating equation to be used in testing these implications. We now turn to some empirical results.

The body of data discussed in this chapter is the Bureau of Labor Statistics' *Survey of Consumer Expenditures 1960–61.*[1] Published reports from this cross-sectional survey give the average expenditure of households during the year under review for various commodity groups, classified by several household characteristics. The data were grouped into cells by region (four regions), disposable income (ten groups), and years of schooling completed (four groups) for 157 observations. For each cell, the average years of schooling completed, average age of head, average family size, average yearly expenditure on each good, X_i, and the average total consumption expenditure, C, were given.

The procedure used was to fit separate Engel curves for the expenditures on various goods by the usual least-squares method. Since the observations are the cell means and the cells have an unequal number of households, the regressions are weighted by the square root of the

[1] The data were collected by personal interviews using the family or consumer unit as the unit of observation for a total of 13,728 usable observations. The sample design used in the survey is described briefly as follows in BLS Report No. 237–89: "Separate stratified area samples were selected for urban areas, rural areas in metropolitan counties, and rural areas in nonmetropolitan counties. A three-stage sample design was used within each area to obtain a sample of consumer units representative of all U.S. consumer units. . . ."

size of the cell in order to conform to the assumption of a homoscedastic residual.[2]

Before turning to the data, let us look at a simple heuristic device that is useful in determining the extent to which the data are broadly consistent with the neutrality model of Chapter 2. The neutrality model suggests that the effect of education on expenditures will be positive, zero, or negative as the income elasticity is greater than, equal to, or less than unity. There are, then, nine possible combinations of the two coefficients, three of which are consistent with the neutrality model. This may be summarized by a two-way schematic diagram relating the estimated income elasticities and education elasticities. In this diagram those cells on one diagonal (the cells containing x's) are consistent with education having a positive, technologically neutral effect on nonmarket productivity. If, for example, the income elasticity of some good were 0.75 and statistically less than unity and its educa-

Education Elasticity	*Income Elasticity* $\eta > 1$	$\eta \simeq 1$	$\eta < 1$
$\epsilon_E > 0$	x		
$\epsilon_E \simeq 0$		x	
$\epsilon_E < 0$			x

[2] Assume the error term u in the ungrouped individual data is a random variable distributed independently of the determining variables and has an expected value of zero and a variance σ^2. Then the variance of the error term in the grouped data, $\sigma_{\bar{u}}^2$ is inversely proportional to the size of the cell n_i:

$$\sigma_{\bar{u}}^2 = \sigma^2/n.$$

Weighting by the square root of the cell size, $\sqrt{n_i}$, restores the homoscedasticity:

$$\bar{u}' = (\sqrt{n_i}u_1 + \sqrt{n_i}u_2 + \dots + \sqrt{n_i}u_n)/n_i$$

$$\text{var}\,(\bar{u}') = \text{var}\,[\sqrt{n_i}(u_1 + u_2 + \dots + u_n)/n_i]$$

$$= n_i(n_i\,\text{var}\,(u))/n_i^2 = \text{var}\,(u).$$

All regressions across cell means in this study are so weighted. For a more thorough discussion of weighted regressions, see Malinvaud, *Statistical Methods,* pp. 242–46.

tion elasticity 0.30 and statistically significant, that good would fall into the upper right-hand cell and would not be consistent with a positive, neutral effect. On the basis of a purely random selection—no relationship between the two elasticities—one would expect one-third of the expenditure items to fall along this diagonal. Notice that even those items on the principal diagonal, or conforming in signs, need not imply strict neutrality; the latter would require a constant ratio between ϵ_E and $(\eta - 1)$ (see equation 2.11).

THE GOODS-SERVICES DICHOTOMY

The expenditure items were first aggregated into two categories, goods and services, where the differentiation was made principally on the intuitive grounds of the tangibility of the product. The "goods" component included expenditures on food for home consumption, tobacco, alcohol, shelter, utilities, housefurnishings and equipment, clothing, reading, and automobiles (purchases and operation expenses). The "service" component included expenditures for food away from home, household operations, personal care, medical care, recreation, education, and travel expenses other than automobile. The results of these two regressions on the 157 observations using the log of expenditure as the dependent variable are given below (t values are in parentheses).

Item	ln *Consumption*	ln *Education*	*Age*	*Family Size*	*Region*	$\bar{R}^2$
Goods	0.934	−0.073	−0.003	0.026	−0.045	.996
	(65.66)	(−4.28)	(−4.75)	(2.54)	(−6.52)	
Services	1.117	0.189	0.006	−0.048	0.101	.988
	(41.86)	(5.93)	(4.68)	(−2.54)	(7.77)	

The income elasticity of "goods" is 0.934, significantly less than unity, and, as predicted, the education coefficient is negative; the income elasticity of "services" is greater than one and, also as predicted, its education coefficient is positive. The interpretation of these results in the context of the model developed in the earlier chapters is that, as the education level rose, nonmarket productivity was increased, contributing to the household's real income. This additional real income was allocated between the two commodities on the basis of their income elasticities. Thus, the consumption of services rose relative to the consumption of goods, and, since the productivity effect was presumed to be neutral, this resulted in an increase in the expenditure on services and a decrease in the expenditure on goods.

There was a tradeoff of "goods" inputs for "services" inputs, and the weighted average of the two education effects was zero (or, more precisely, 0.001).

The table discussed above illustrates the consistency of these results with the predictions of the model. Both of the expenditure items fall on the principal diagonal. One should keep in mind when evaluating the results for this dichotomy that since the weighted average of the consumption elasticities (or income elasticities) must be unity and the weighted average of the education elasticities must be zero, there is in fact only one degree of freedom in the two regressions for each coefficient.[3]

Education Elasticity	*Income Elasticity*		
	$\eta > 1$	$\eta \simeq 1$	$\eta < 1$
$\epsilon_E > 0$	Services		
$\epsilon_E \simeq 0$			
$\epsilon_E < 0$			Goods

The family-size coefficients show a relative increase in expenditures for goods over services as size increases (holding constant the household's income, education, age, and region as these variables are defined). So, ceteris paribus, an increase in family size shifts expenditures toward necessities, or the larger families behave as if they had lower real income. Any of the three explanations discussed in Chapter 3 can offer an interpretation: "Goods" may be on balance more complementary with children; larger families may be less efficient and thus in fact have lower real incomes; or, since $-\epsilon_{iF}/(\eta_i - 1) > 1$ for

[3] For example, given that ϵ_{gE} for goods is -0.073 and its weight is 72.7 per cent, by deduction ϵ_{sE} for services is:

$$\epsilon_{gE}w_g + \epsilon_{sE}w_s = 0$$

$$-0.073\ (0.727) + \epsilon_{sE}\ (0.273) = 0$$

$$\epsilon_{sE} = +0.19\ .$$

both goods and services, the evidence is consistent with some diseconomies of scale.[4]

The age coefficients suggest that households with older heads, ceteris paribus, spend a larger share of their expenditures on services. Of all the ad hoc explanations, the most appealing seems to be that since the goods component includes purchases of consumer durables and housing, this age effect is simply reflecting the fact that households tend to purchase these durable items at a younger age.

The relatively strong effect of the region dummy is intriguing. If interpreted as an efficiency parameter, it suggests that living in the South, other things being the same, increases efficiency. Unfortunately, it is not clear what effect the variable is reflecting. It might be the effect of climate, or the degree of urbanization, but, alternatively, it could be differences in prices.[5] If prices are systematically lower in the South, since the multiple regression holds total consumption expenditures fixed, a household in the South would be purchasing a larger basket of goods; that is, it would have a higher real income. If this is the case, the Southern household would be expected to shift its consumption pattern towards luxuries—as in fact it appears to do.

As in the case of the more detailed expenditure classification presented in the latter part of this chapter, the Engel curves for goods and services were fitted in a number of forms. The linear fit for the two categories is shown below (with t values in parentheses).

The expenditure item "shelter" includes expenditures for rent and

	Consumption	*Education*	*Age*	*Family Size*	*Region*	$\bar{R}^2$
Goods	58.882 (56.19)	−3.570 (−0.46)	−5.159 (−1.56)	248.144 (6.30)	−207.188 (−7.52)	.993
Mean Elasticity	.828	−0.010				
Services	35.417 (44.95)	11.679 (2.01)	5.194 (2.09)	−176.330 (−5.96)	172.026 (8.31)	.982
Mean Elasticity	1.326	0.088				

[4] See Chapter 3, footnote 13. The mean family-size elasticities of the two items are:

$$\epsilon_{gF} = +0.083$$

$$\epsilon_{sF} = -0.154;$$

thus

$$-\epsilon_{iF}/(\eta_i - 1) = 1.26 \text{ and } 1.32, \text{ respectively.}$$

[5] The Department of Labor estimates an index of comparative living costs of city workers. The simple average for ten metropolitan areas and one nonmetro-

repairs by renters and expenditures for mortgage interest payments, property taxes, and insurance and repairs by homeowners, plus other lodging expenditures. Since the forgone return on the owner's equity and the repayment of the mortgage principal are not included, the shelter expenditure does not adequately reflect the household's consumption of the item, and biased estimates result if the percentage of homeowners varies systematically across cells. The shelter item was therefore adjusted to reflect more adequately changes in expenditure across the cells. The total consumption expenditure (the independent variable) was also adjusted to reflect total current consumption expenditure, C^*.[6] The results of the comparable regressions using H_R in the goods component and using C^* are (with t values in parentheses):

Item	ln *Consumption**	ln *Education*	*Age*	*Family Size*	*Region*	$\bar{R}^2$
Goods	0.957	−0.120	−0.007	0.004	−0.032	.993
	(45.82)	(−4.94)	(−7.01)	(2.89)	(−3.23)	
Partial Correlation	0.97	−0.38	−0.51	0.24	−0.26	
Services	1.165	0.144	0.001	−0.002	0.128	.989
	(39.78)	(4.25)	(0.40)	(−1.33)	(9.39)	
Partial Correlation	0.96	0.34	0.03	−0.11	0.62	

It is interesting to note that, in addition to increasing the significance of the predicted education effect on both items, the use of C^* emphasizes

politan area in the South was an index of 93 compared to 102 in the non-South for twenty-nine metropolitan areas and three regional nonmetropolitan areas for autumn 1966. Similar indices of 94 and 101 in autumn 1959 for goods, rents, and services in four cities in the South and sixteen cities in the non-South suggest that market prices are lower in the South. See Helen H. Lamale and M.S. Stotz, "The Interim City Worker's Family Budget," *Monthly Labor Review*, August 1960.

[6] Since Shelter $= H_O + H_r + H_D$, i.e., the sum of housing expenditure by owners (o) and renters (r) and other dwelling expenditures, the new housing variable H_R was defined as

$$H_R = \frac{(\text{Shelter} - H_O - H_D)}{\text{per cent } R} + H_D,$$

where per cent R is the fraction of households in the cell that rent their homes. Thus, H_R is considered an estimate of what the rental figure would be if all households in the cell were renters. The H_D is predominantly "lodging out of home city." Since H_R is undefined for cells with no renters, of which there were nine in the 157 total, regressions using H_R in any form had 148 observations.

Total current consumption is defined as

$$C^* = C - \text{Shelter} - \text{housefurnishings} - \text{automobile} + H_R.$$

Again, all regressions using this variable contain 148 observations, since H_R is undefined where the cell contains no renters.

the fact that age is an important determinant of expenditures for durables (included in the goods component) but not of expenditures for nondurable services.

THE CONSUMPTION PATTERN

To go beyond this broad dichotomization of expenditures, similar weighted regressions were run for each of the following detailed items: food at home, food away from home, tobacco, alcohol, housing,[7] utilities, household operations, housefurnishings and equipment, clothing, medical care, personal care, leisure (reading and recreation), education, and travel. The regression equations for these fourteen market goods are given in Table 1.

TABLE 1

Regression Equations for Consumption Items, 1960 BLS Data, Constant Elasticities

Item	ln *Consumption*	ln *Education*	*Age*	*Family Size*	*Region*	$\bar{R}^2$
Food (home)	0.639	−0.173	0.001	0.141	−0.133	.939
	(14.07)	(−3.18)	(0.50)	(4.40)	(−5.78)	
Food (away)	1.225	0.205	0.002	−0.099	0.078	.927
	(16.09)	(2.25)	(0.63)	(−1.85)	(2.09)	
Tobacco	0.723	−0.852	−0.034	0.0349	−0.0436	.702
	(5.32)	(−5.24)	(−5.08)	(0.36)	(−0.66)	
Alcohol	1.611	−0.584	−0.024	−0.214	−0.576	.899
	(13.06)	(−3.95)	(−3.84)	(−2.46)	(−9.55)	
Housing	1.008	0.3767	0.0201	−0.1028	−0.1268	.937
	(17.77)[a]	(5.56)	(7.12)	(−2.58)	(−4.64)	
Utilities	0.435	0.126	0.013	0.179	−0.126	.851
	(7.54)	(1.82)	(4.52)	(4.40)	(−4.47)	
Household operations	1.113	0.314	0.008	−0.086	0.183	.978
	(30.54)	(7.19)	(4.14)	(−3.35)	(10.28)	
Housefurnishings and equipment	0.981	−0.059	−0.008	0.167	0.118	.938
	(13.30)[a]	(−0.67)	(−2.09)	(3.20)	(3.27)	
Clothing	1.216	−0.024	−0.005	0.078	0.108	.982
	(28.63)	(−0.48)	(−2.38)	(2.62)	(5.20)	
Personal care	0.939	−0.125	−0.010	0.000	0.159	.974
	(24.90)	(−2.75)	(−5.36)	(0.02)	(8.62)	
Medical care	0.831	0.030	0.00	0.01	0.033	.888
	(13.04)	(0.39)	(2.50)	(0.24)	(1.06)	
Leisure	1.299	0.147	−0.007	−0.030	−0.062	.977
	(25.58)	(2.41)	(−2.81)	(−0.83)	(−2.48)	
Education	1.594	1.485	0.021	0.505	0.431	.877
	(7.26)	(5.64)	(1.94)	(3.26)	(4.02)	
Travel	1.386	−0.416	−0.029	−0.028	0.075	.957
	(18.62)	(−4.67)	(−7.76)	(−0.53)	(2.06)	

Note: t values in parentheses.

[a] Implies coefficient not statistically different from one (the t values for testing the difference from unity are 0.14 for housing and −0.26 for housefurnishings).

[7] "Housing" is defined here as the ratio of total shelter expenditures minus expenditures for owned dwellings to the percentage of households that rent.

To consider the relationship between the income elasticities and the sign of the education coefficients, we again make use of our two-way schematic diagram.

Education Elasticity	*Income Elasticity* $\eta > 1$	$\eta \simeq 1$	$\eta < 1$
$\epsilon_E > 0$	Food away Household operations Leisure Education	Housing	Utilities
$\epsilon_E \simeq 0$	Clothing	Housefurnishings and equipment	Medical care
$\epsilon_E < 0$	Alcohol Travel		Food at home Tobacco Personal care

Eight of these items are qualitatively consistent with the neutrality model for education. Food away from home, household operations, leisure, and education expenditures are luxuries and have positive education effects; food at home, tobacco, and personal care are necessities and have negative education coefficients, as predicted. The income elasticity for housefurnishings and equipment is approximately 1.0 and, as expected, the effect of education on this item is negligible. The housing item is consistent in terms of sign, but the income elasticity is not statistically different from unity.

The remaining five items—utilities, travel, clothing, medical expenditures, and alcohol—are not consistent with the neutrality model. The first point that should be made regarding these items is that, while the simple neutrality model developed in Chapter 2 is not suitable for interpreting these results, the basic model of Chapter 1 is. For example, if we believe that education's effect on the production function that uses clothing as an input is less than its effect on other production functions—and is positive in general—then the relative price of commodity Z_c would rise, $(\widetilde{\Pi}_c - \widetilde{\Pi}) > 0$. Thus, even though the income elasticity is greater than unity, the increase in the relative price could induce enough substitution away from Z_c to offset the income effect.[8] So the insignificant education effect may be viewed as the net

[8] The equation in Chapter 2, footnote 7 is useful here. We have seen that for clothing $\eta_i > 1$; thus, the first term, the income effect, would be positive. If we

effect of the expansion from the income effect and the contraction caused by a change in the relative price of Z_c. In a similar manner, any other item not consistent with the simple neutrality model may also be reflecting a nonneutral productivity effect of education.

This explanation has a shortcoming: it is conjectural. Since we do not know the direction of the technological bias or the size of the price elasticity of the commodity, the explanation of the nonneutral case can only be offered ex post. The model can interpret the nonneutral cases but we cannot form expectations about them. Thus, its predictive power is impaired by the existence of nonneutrality. However, the model is still useful in helping us understand these expenditure patterns, and, from a broader perspective, the essence of the model itself leads us to expect relative price effects even though we are as yet unable to specify where they may be strongest. As more relevant data become available and as additional evidence is accumulated, the basic model of Chapter 1 will allow us to interpret these nonneutral cases, incorporating substitution effects as well as changes in income.[9] For the present, the formulation is restricted to the joint hypothesis that education has a positive effect on nonmarket production and that this effect is neutral across items.

Nevertheless, a few of these nonneutral cases deserve some special attention. Consider the alcohol expenditure. Grossman argues that in addition to being an input in the production of some desirable commodity associated with alcoholic beverages, alcohol is also a *negative* input in the production of "good health."[10] So, if additional education

suppose $(\tilde{\Pi}_i - \tilde{\Pi}) > 0$ and $|\epsilon_i| > 1$, the substitution effect will be negative and could offset the positive income effect. So if education is biased away from Z_i, and Z_c is price-elastic, $\tilde{X}_i$ may be zero as observed. Alternatively, if education is biased toward Z_c and it is price-inelastic, the substitution effect could again offset the income effect.

A third alternative, consistent with this item and with the observed coefficients for housefurnishings and medical care, is that $Y_c = 0$, that is, education has no consumption income effect.

[9] From the equation mentioned in the previous footnote it is clear that, ceteris paribus, we would expect larger price effects for items whose price elasticities are farther from minus unity. In the recent literature showing various estimates of price elasticities for broad categories of expenditure, such a relationship between ϵ_i and nonneutrality is at best only faintly observable. Most of these price elasticity estimates indicate inelasticity. If we believe that all of these items are price-inelastic, we would infer that education is biased toward those items below the principal diagonal in the two-way diagram above.

[10] See M. Grossman, "The Demand for Health."

increases the demand for good health through an income effect, one way this commodity might be increased is by substitution away from alcohol. This could explain the negative effect of education on alcohol expenditures.[11]

Since the expenditure on travel includes the purchase of an automobile, this item is particularly vulnerable to the bias discussed in Appendix B relating to durable goods.[12] The direction of this bias was shown to be upward for the income elasticity and downward for the education coefficient or any independent variable positively related to consumption. Such a bias could help explain the finding for travel, that its income elasticity is 1.39 and its education elasticity is —0.42. To the extent that clothing is a durable good the argument also applies to that item.[13]

Finally, it is possible to offer another explanation for some observed nonneutrality. This explanation relies on the search model mentioned in the previous chapter. Mincer has shown that the existence of price dispersion in markets for consumer goods will, under certain conditions, result in wealthier consumers paying relatively lower prices for luxuries and relatively higher prices for necessities.[14] If it were assumed that education had no nonmarket productivity effect, and that nonwage income (V) were zero, then changes in education would have the same proportionate effect on income and on the price of

[11] The argument might be applied to tobacco consumption as well. In this case, however, the negative education effect observed is also consistent with the commodity being a necessity.

[12] The fact that this bias is stronger for durable goods leads Prais and Houthakker to qualify their conclusions that consumption is the preferable determining variable in Engel curves by saying it "seems preferable a priori, at any rate for those items that are not household durables." See Prais and Houthakker, *The Analysis of Family Budgets,* p. 81.

[13] Regarding expenditures on housing, Margaret Reid, in her study on housing and income, concludes, "Estimates . . . indicate an elasticity of housing with respect to normal (permanent) income close to 2.0." See Margaret Reid, *Housing and Income,* Chicago, University of Chicago Press, 1962, p. 377. This suggests that the results I obtained here considerably understate the income effect; if such a bias exists, it will likewise overstate the effect of education on housing expenditures, which can explain the findings shown here vis-à-vis the neutrality model.

[14] See J. Mincer, "Market Prices, Opportunity Costs, and Income Effects," p. 80. I am grateful to Jacob Mincer for several conversations from which this discussion emerged.

time. If, then, all commodities had the same time intensity, in the context of Mincer's search model the more educated would pay lower prices for luxuries and the less educated would pay lower prices for necessities.

Thus, in a multiple regression that holds total consumption expenditure (but not income) constant, if all items are price-elastic, education would be expected to have a positive effect on expenditures for luxuries and a negative effect on necessities. This is the same predicted effect as the positive neutral nonmarket-productivity hypothesis implies. On the other hand, if all items are price-inelastic, education would be negatively correlated with expenditures on luxuries and positively correlated with expenditures for necessities.[15]

This discussion of the search model emphasizes two important points. First, if differences in the price of time and market search are partly captured by the education variable, price effects may result which will induce some substitution. The influence of education on the efficiency of search in general is a part of its nonmarket productivity effect. But differences in the price of time which induce shifts in the relative amounts of search are not. Second, without relying on the concept of nonmarket productivity one can develop other models that will generate the same implications about the observed effects of education. But these models—one that relies on search costs, for example, or one that assumes education affects the utility function directly (see Appendix A)—require sets of assumptions which are quite strong and surely not innocuous. They also appear to be no more capable of predicting the nonneutral cases than the nonmarket productivity model.

[15] A difficulty with this interpretation arises when we consider the additional explanatory variable, C, total consumption expenditure. If income rises as education rises (with C held fixed), then C is an inadequate measure of permanent income. Indeed, given the assumptions of the previous paragraph, C can be interpreted as reflecting only transitory changes in income.

An alternative set of assumptions would be to allow $V > 0$ and to suggest that the wage and V are negatively related—as E raises the wage (and the price of time), V declines. Then, holding C fixed, the increase in E involves a compensated rise in the wage and little or no change in income. In the simple but extreme case where income is completely unaffected, the rise in E would reduce search and thereby raise all prices absolutely, affect no relative prices, and lead to a reduction in the real value of the market basket and thus to a relative shift toward necessities.

Before leaving Table 1, let us briefly consider the coefficients of the other independent variables.[16] Looking at the results with respect to the age variable, one gets the impression that the age effect has again duplicated the education results. In only two of the fourteen cases (food at home and leisure) do the signs of the education and age coefficients differ. But the following diagram suggests how infrequently the age variable shifted expenditures toward luxuries.

Age Effect		*Income Elasticities*	
	$\eta > 1$	$\eta \simeq 1$	$\eta < 1$
(+)	Household operations Education	Housing	Utilities Medical care
(0)	Food away		Food at home
(−)	Alcohol Clothing Leisure Travel	Housefurnishings and equipment	Tobacco Personal care

In fact, the diagram suggests that, despite its apparent similarity to the education effect, the age effect is quite erratic. (Note that the effect of age on the consumer durable items is negative.)

Regarding the family-size coefficients, an intuitively satisfying interpretation of many of these results is that items complementary to children—probably food, housefurnishings and equipment, utilities, clothing, and education—have significant positive effects, while the more substitutable items—perhaps alcohol and food away from home—have negative effects, with some other items exhibiting no significant effects whatever.[17] The hypothesis that, other things held constant, an increase in family size reflects a decrease in nonmarket efficiency and so leads to a shift toward necessities is consistent with twelve of these items (clothing and education are the exceptions), although only five exhibit statistical significance.

[16] Some caution is necessary in interpreting these age and family-size effects since the data were not cross-classified by these two variables and only the cell means are used. On balance this introduces no biases but does cause an understatement of the statistical significance of the coefficients. For a discussion of this point, see Yoel Haitovsky, "Unbiased Multiple Regression Coefficients," *Journal of the American Statistical Association,* September 1966.

[17] From the vantage point of my personal intuition, the exceptions here are that household operations and housing appear to be substitutes while medical care and travel are not significantly affected by family size.

Viewing family size as a scale phenomenon, it was suggested in Chapter 3 that a γ_i (defined in Chapter 3, footnote 13) greater than unity for all items implies diseconomies of scale, while a γ_i less than unity implies economies of scale. Alternatively, one might look at δ_i, the sum of the income- and family-size elasticities, as the degree of homogeneity of the function with respect to income and family size. Table 2 gives the value of γ_i and δ_i for each item (γ_i is undefined for $\eta_i = 1$ and therefore is not reported for two items, housing and housefurnishings). The figures in the table do not constitute evidence of either economies or diseconomies of scale.[18]

TABLE 2
Implied Scale Effects of Family Size, by Item

Item	γ_i	δ_i	*Item*	γ_i	δ_i
Food (home)	1.25	1.09	Housefurnishings and equipment		1.52
Food (away)	1.41	0.91	Clothing	−1.16	1.47
Tobacco	0.40	0.84	Personal care	0.05	0.94
Alcohol	1.12	0.93	Medical care	0.21	0.87
Housing		0.68	Leisure	0.42	1.20
Utilities	1.04	1.01	Education	−2.72	3.21
Household operations	2.44	0.84	Travel	0.23	1.30

The effect of region on real income is also more difficult to determine for these detailed expenditure items. For eight of the fourteen, the coefficient is consistent with the hypothesis that real income is higher in the South (i.e., expenditures shift toward luxuries), but for the remaining six items, Southerners shifted expenditures toward necessities. The conclusion at this point must be that the mechanism through which region affects expenditures and the direction of its effect on real income remain open questions.

These same regressions were run in linear form, and the results are summarized in Table 3. One can compare these elasticities with those shown in Table 1. All of these linear regressions include the

[18] One cannot conclude from this evidence that there are no important scale effects. One circumstance that could produce the results observed would be unequal scale effects for the various commodities. For example, in Chapter 10 of their *Analysis of Family Budgets,* Prais and Houthakker suggest that the specific economies of scale in foodstuffs are about +.2 while their overall estimate of economies of scale is about +.13. So as size increases, foodstuffs become relatively cheaper. Thus, the observed relative shift toward food at home as income and family size increase proportionately may be reflecting substitution toward that relatively cheaper commodity; it need not imply diseconomies of scale. Only if there were a consistent shift toward necessities might one infer something about overall economies of scale.

TABLE 3
Elasticity Estimates, Linear Form

Item	$\bar{\eta}_i$	$\bar{\epsilon}_{iE}$	$\bar{\epsilon}_{iF}$	$\bar{R}^2$	*Mean Expenditure*
Food (home)	0.526	−0.112	0.554	.9496	989
Food (away)	1.455	−0.021	−0.606	.8988	246
Tobacco	0.519	−0.563	0.224	.8176	91
Alcohol	1.455	−0.349	−0.397	.8375	78
Housing	1.832	−0.094	−1.458	.6718	658
Utilities	0.463	0.052	0.450	.8850	249
Household operations	1.493	0.198	−0.808	.9204	288
Housefurnishings and equipment	1.028	0.043	0.246	.9233	266
Clothing	1.338	−0.054	−0.026	.9761	518
Personal care	0.855	−0.136	0.034	.9634	145
Medical care	0.893	−0.027	−0.106	.8669	340
Leisure	1.221	0.298	0.041	.9602	245
Education	2.787	1.262	−1.176	.6937	53
Automobiles	0.938	−0.146	0.319	.8869	693
Travel (not auto)	2.167	−0.169	−1.308	.4897	77
Weighted average[a]	1.1036	−0.0467	−0.1221		

[a] See text for a discussion of these averages.

same set of five independent variables: total consumption, education, age, family size, and region. The weighted averages of η_i and ϵ_{iE} do not equal unity or zero in this case, since the housing Engel curve has fewer observations than the other regressions and therefore is not strictly consistent with the other fourteen items. When including the consistent "shelter" item and also fitting the equation to the remaining "miscellaneous expenditures" item, the weighted average of the η_i is 1.0000 and of the ϵ_{iE}, —0.0002.

In order to determine whether there were interaction effects between some of the independent variables, many of the Engel curves were also run in double-log form, while the cross-products of total consumption with education and of total consumption with age were included as separate independent variables. Thus, the equation fitted was

$$\ln X = a + b_1 \ln C + b_2 \ln E + b_3 A + b_4 F + b_5 R + b_6 (\ln C \cdot \ln E) + b_7 [\ln C \cdot (A)] + \epsilon, \qquad (4.1)$$

and the income elasticity varies in this case with the level of education and age (provided b_6 and/or b_7 is not zero). The income elasticity at the mean is defined as

$$\bar{\eta}_i = \frac{\partial \ln X_i}{\partial \ln C} = b_1 + b_6 \overline{\ln E} + b_7 \bar{A}. \qquad (4.2)$$

So, for instance, if b_7 is positive, the income elasticity rises with age.

Table 4 shows the implied elasticities of income, education, and family size from the "best" regression (in terms of highest $\bar{R}^2$) in the various forms fitted. The "constant" form gives a constant income and

TABLE 4
Elasticity Estimates, Form With Highest $\bar{R}^2$

Item	η_i	ϵ_{iE}	ϵ_{iF}	$\bar{R}^2$ [a]	*Form*[b]	*Mean Expenditure*[c]
Food (home)	0.526	−0.112	0.554	.950	1	989
Food (away)	1.225	0.205	−0.319	.927	2	246
Tobacco	0.519	−0.563	0.224	.818	1	91
Alcohol	1.611	−0.584	−0.687	.899	2	78
Housing	0.990	0.372	−0.397	.942	3	658
Utilities	0.463	0.052	0.450	.885	1	249
Household operations	1.113	0.314	−0.277	.978	2	288
Housefurnishings and equipment	0.981	−0.059	0.536	.938	2	266
Clothing	1.113	0.083	0.377	.984	3	518
Personal care	0.939	−0.125	0.002	.974	2	145
Medical care	0.831	0.030	0.034	.888	2	340
Leisure	1.299	0.147	−0.096	.977	2	245
Education	1.594	1.485	1.622	.877	2	53
Automobiles	1.228	−0.347	0.290	.938	3	693
Travel (not auto)	1.378	0.097	−0.831	.802	3	77
Weighted average	0.9517	0.0186	0.1532			
Simple average	1.054	0.0663	0.0988			

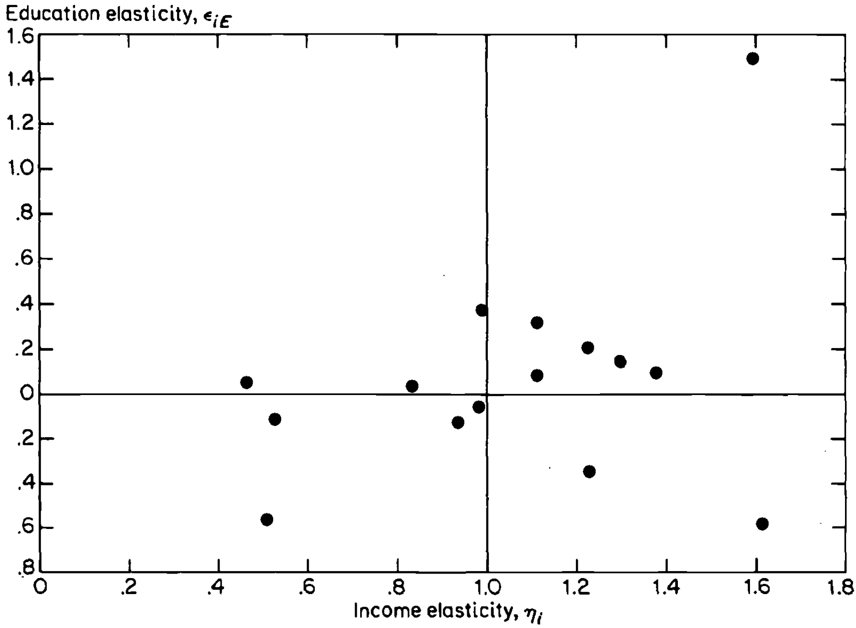
[a] See footnote 3, Chapter 3.
[b] Form: 1 = linear; 2 = constant elasticity; 3 = interaction.
[c] Mean total expenditure = 4936.

education elasticity; all others are computed at the mean value of the relevant variables. The "interaction" form is that shown in equation (4.1). The relationship between ϵ_{iE} and η_i is summarized in the following two-way diagram and is also illustrated in Chart 1.

Education Elasticity	*Income Elasticity* $\eta > 1$	$\eta < 1$
$\epsilon_E > 0$	Food away Household operations Clothing Leisure Education Travel (not auto)	Housing Utilities Medical care
$\epsilon_E < 0$	Alcohol Automobiles	Food at home Tobacco Housefurnishings Personal care

CHART 1

Scatter Diagram of the Income and Education Elasticities, Fifteen Observations



SOURCE: Table 4.

THE IMPLIED CONSUMPTION INCOME ELASTICITY

From the evidence summarized in Table 4, the neutrality model is consistent with two-thirds of the consumption items, or 60 per cent of total expenditure. (Chart 1 suggests that another 25 per cent of total expenditures—housing, utilities, and medical care—is not far outside the "neutral" quadrants I and III.) Since the model implies a positive relationship between the education and income elasticities, the correlation between ϵ_{iE} and η_i (or $\eta_i - 1$) should be positive. The simple correlation for the data in Table 4 is 0.366, with a weighted correlation of 0.176; the former is a simple average over the separate items, while the latter is equivalent to a simple average over each dollar of expenditure. The relationship in both cases has the expected sign.

Equation (2.11) suggests that the ratio of ϵ_{iE} to $(\eta_i - 1)$ is an estimate of the elasticity of consumption income, ϵ_{Y_cE}. Since each separate regression gives an estimate of ϵ_{Y_cE}, the average estimate could be considered a measure of ϵ_{Y_cE} over all expenditure items. The simple and weighted averages of ϵ_{Y_cE} across the items are +0.644 and +0.274, respectively, where the weights are expenditure shares and the averages exclude housing and personal care, since ϵ_{Y_cE} is not defined when $\eta = 1$.[19] Here, too, the relationship appears to be positive and the elasticity of consumption income is estimated to be between one-quarter and two-thirds.

An alternative procedure for estimating ϵ_{Y_cE} is to regress ϵ_{iE} on $(\eta_i - 1)$. Using each of the fifteen pairs of estimates of the income and education elasticities from Table 4, a regression of the form

$$\epsilon_{iE} = b(\eta_i - 1) + e_i \tag{4.3}$$

was run, weighting by expenditure shares and forcing the intercept to be zero. The observed regression slope, b, is an estimate of ϵ_{Y_cE}, the elasticity of consumption income with respect to education. The regression coefficient is +0.084 (its t value is 0.43); in unweighted form the estimated coefficient is +0.490 (1.47). These regression estimates are not statistically significant; the point estimates suggest that a percentage increase in the level of education raises real full income by about one-tenth of a per cent (or one-half a per cent if the unweighted regression estimate is used). That is, as education rises, with the household's permanent money income held fixed, on the average the composition of expenditures shifts toward luxuries, and the magnitude of that shift implies that a percentage increase in education is equivalent to a tenth of a percentage increase in income. This estimate of the magnitude of consumption income elasticity is quite small and its standard error relatively large. Other estimates, using different combinations of the Engel curves presented here, are discussed in Appendix C.[20] Overall, the value of the consumption income elasticity appears to be positive, though small, but this should not be considered more than a very tentative conclusion.

A final procedure used to estimate the elasticity of consumption income is to impose the neutrality assumption on the system of equa-

[19] For the goods-services dichotomy in the first section of this chapter, ϵ_{Y_cE}: services, 1.615; goods, 1.106; unweighted average, 1.36; weighted average, 1.24.

[20] Appendix C, section 6, discusses this regression procedure in greater detail and presents other slope coefficients. Because of the problem of biases related to durable goods, the elasticity of consumption income was estimated from the nondurables alone; in the weighted form its value was +0.496 (t value = 3.75).

tions and to estimate the magnitude of the neutral effect of education on nonmarket productivity by an iterative technique. Using the function for expenditure item X_i

$$\ln X_i = a_i + \eta_i \ln C + \epsilon_{iE} \ln E + b_{3i}A + b_{4i}F + b_{5i}R + e_i\,, \quad (4.4)$$

we can substitute the neutrality constraint (from equation 3.3)

$$\epsilon_{iE} = K(\eta_i - 1)$$

into the expenditure function, and obtain

$$(\ln X_i + K \ln E) = a_i + \eta_i (\ln C + K \ln E) + b_{3i}A + b_{4i}F + b_{5i}R + e_i\,. \quad (4.5)$$

This equation was estimated for various assigned values of K. For each K the residual sum of squares was summed over the expenditure items; Table 5 indicates the overall sums of squares weighted by ex-

TABLE 5
Overall Residual Sums of Squares, by Values of the Elasticity of Consumption Income K

Value of K	*Overall Residual Sum of Squares*	*Value of K*	*Overall Residual Sum of Squares*
−1.00	4.144	0.65	3.379
−0.25	3.555	0.75	3.379
0.00	3.449	0.85	3.381
0.10	3.424	1.00	3.421
0.25	3.399	3.00	3.458
0.50	3.381	10.00	3.551
0.55	3.380		

penditure shares. The value of K that yields the smallest weighted sum of squares is in the vicinity of 0.65 to 0.75, which is considerably larger than the other estimates of the elasticity of consumption income just presented.[21]

From an analysis of the residual variance in Table 5, an F value is computed which suggests that an estimate of K in the range of 0.65 or 0.75 is a statistically significant improvement over a value for K of zero. Although the residual sums of squares in the table do not vary greatly in magnitude, the reduction of about two per cent, given

[21] For consistency, these estimates, derived from imposing various values of K, all contain only 148 observations, since the housing variable was not defined for cells in which there were no renters. Also, the same double-log form with no interaction effects was used for all fourteen items, so these results are not precisely comparable with those using the form with the highest adjusted-R^2. (There were fourteen items used here since "travel" and "automobile" were combined into one item.)

the large number of degrees of freedom, is significant. The variation appears to be sufficient to suggest with some confidence that this iterative procedure places the value of K above zero and above the previous estimate of one-tenth.[22]

Table 5 also permits a test of the neutrality assumption itself. Since this iterative procedure imposes the neutrality constraint on the system of demand equations while the equation-by-equation estimation does not, the overall residual sums of squares in the two cases can be compared. The analysis of variance suggests that neutrality is imposed at a high cost in terms of the residual variation: the effect of education appears to be nonneutral.[23] As was stressed repeatedly in Chapter 2,

[22] I wish to thank Finis Welch for suggesting this test to me. See Marvin Kosters and Finis Welch, "The Effect of Minimum Wages on the Distribution of Changes in Aggregate Employment," forthcoming in *American Economic Review*. From Table 5, the residual sum of squares from imposing the neutrality constraint with $K = 0.0$ is 3.449 and the total degrees of freedom are $2002 = 14(148 - 4 - 1)$. By iteration over various values of K the residual variation is reduced to 3.379 at a value of $K = 0.65$. So by selecting that value of K, one degree of freedom is lost and the residual variation is lowered by $0.070 = (3.449 - 3.379)$. Thus,

$$F_{1,2001} = \frac{0.070/1}{3.379/2001} = 41.46\,.$$

Following Kosters-Welch a step further, since this F test has degrees of freedom (1,2001), the square root of F has a t distribution. If we suppose

$$\sqrt{F_{1,2001}} = t \approx \frac{\hat{K} - 0}{\sigma_{\hat{K}}},$$

we can obtain an estimate of the standard error of K (for $K = 0.65$) as

$$\hat{\sigma}_{\hat{K}} = \frac{\hat{K}}{\sqrt{F_{1,2001}}} = \frac{0.65}{6.44} = 0.101,$$

or, for $K = 0.75$,

$$\hat{\sigma}_{\hat{K}} = \frac{0.75}{6.44} = 0.116,$$

which suggests that the estimated value of K at 0.65 or 0.75 has an estimated standard error of about 0.11.

[23] Estimating equation (4.4) for all fourteen items separately for the 148 observations gives $14(148-5-1) = 1988$ degrees of freedom, and the observed overall weighted residual sum of squares is 2.660. By imposing the neutrality model, one fewer parameter is estimated per equation, while one degree of freedom is lost by choosing the value of K which minimizes the overall weighted residual sum of squares. So the degrees of freedom in the constrained case is $14(148 - 4 - 1) - 1 = 2001$, with a residual sum of squares $= 3.379$ at the value $K = 0.65$. The analysis of variance can be set up to test the explanatory power of the

the analytical framework in which education's role is viewed is capable of handling nonneutral effects and indeed emphasizes their importance. The restrictive assumption of neutrality is imposed to simplify the framework sufficiently to permit empirical testing. These results seem to be broadly consistent with a positive effect of education on real full income—with an estimate of the elasticity of consumption income of around 0.65—but they also suggest that the simplification of nonneutrality is achieved at an appreciable cost.

It is interesting to compare these estimates of the elasticity of consumption income to the elasticity of money income with respect to education. To get an estimate of the market effect of education, using the same body of data, total consumption expenditure was regressed on education and the three other variables. The estimated constant elasticity of total consumption (and with the permanent income hypothesis, of money income as well) with respect to education, ϵ_{Y_mE}, was 0.793 (t value = 10.87). So the implied consumption-income elasticity of education is smaller than its market or money-income elasticity when the former is estimated by regression across items, and is of roughly equal magnitude when estimated by the iterative procedure just discussed.

In examining the direction and magnitude of education's effect on real full income through nonmarket efficiency, this study, instead of relying on any one test alone, has considered several measures. These—the qualitative item-by-item comparison, the two-way diagram or graph, the quantitative measures of the correlation between income and education elasticities, the slope coefficient, the value by iteration—all suggest that this effect is a positive one, although small in magnitude. The next two chapters present additional results which appear to be broadly consistent with this finding.

additional thirteen degrees of freedom that represent the thirteen nonneutral effects:

	Degree of Freedom	*Sum of Squares*	*Mean Square*	*F*
Nonneutrality	13	0.719	0.0553	41.34
Residual	1988	2.660	0.0013	
Constrained (total)	2001	3.379	0.0017	

Clearly the thirteen (net) additional parameters—the education elasticities—significantly reduce the residual variation. So this test suggests that education's effect is significantly nonneutral. It should be noted, however, that the manner in which K was estimated is not the most efficient test, since no effort was made to obtain and to use information on the covariation between residuals in the demand equations.