An International Comparison of Household Expenditure Patterns, Commemorating the Centenary of Engel's Law

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AN INTERNATIONAL COMPARISON OF HOUSEHOLD EXPENDITURE PATTERNS, COMMEMORATING THE CENTENARY OF ENGEL'S LAW[1]

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A comparison of elasticities for food, clothing, housing, and miscellaneous items with respect to total expenditure and family size, based on regression analyses of about 40 surveys from about 30 countries. The elasticities are found to be similar but not equal. Engel's law, formulated in 1857, is confirmed by all surveys.

Few dates in the history of econometrics are more significant than 1857. In that year Ernst Engel (1821–1896) published a study on the conditions of production and consumption in the Kingdom of Saxony [**6**], in which he formulated an empirical law concerning the relation between income and expenditure on food. Engel's law, as it has since become known, states that the proportion of income spent on food declines as income rises. Its original statement was mainly based on an examination of about two hundred budgets of Belgian laborers collected by Ducpétiaux. Since that date the law has been found to hold in many other budget surveys; similar laws have also been formulated for other items of expenditure.

With the formulation of Engel's law an important branch of econometrics took its start, though it was not until our days that consumption research was placed on a sound theoretical and statistical basis. It is proper that in this centennial year econometricians should pay tribute to one of their most illustrious precursors. His successful attempt to derive meaningful regularities from seemingly arbitrary observations will always be an inspiring example to the profession, the more so because in his day economic theory and statistical techniques were of little assistance in such an attempt. There can, I think, be no more fitting tribute to this enlightened empiricist than a further inquiry into the subject to which he devoted much of his life's work.

There is no need to go into details of Engel's analysis and of the developments that preceded it, for these matters have recently been discussed in the scholarly article by Stigler [**13**]. It should be enough to note that Engel was mainly influenced by two of his older contemporaries. One was the French engineer Frédéric Le Play, who had collected budgets from households all over Europe, mostly, it seems, from humanitarian interest. Engel had been Le Play's student at the Ecole des Mines in Paris. The other main influence was the Belgian statistician Quételet, who was a firm proponent of the idea that human characteristics, at least in the average, were governed by laws as definite as those which govern

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physical phenomena. Engel was, moreover, not entirely free of the materialism of his time, often epitomized in the phrase "Der Mensch ist was er isst"; he later wrote a monograph entitled "Der Kostenwerth des Menschen" (The Cost of Man). It should also be mentioned that Engel made the first empirical study of a demand curve.

The empirical study of consumption, it will be noted, had an international flavor from an early date. Le Play's observations covered many countries, and Engel himself had no hesitation in applying an inference drawn from Belgian data to his own country. As budget statistics in individual countries were improved, however, the interest in international comparisons diminished. The purpose of the budget surveys that were undertaken shifted gradually from the study of consumption for its own scientific interest to the construction of a cost-of-living index number. It was not until the 1930's that economists began to understand the significance of the results to be obtained from analysis of budget data. Allen and Bowley's *Family Expenditure* [1] marked the turning point in this respect, and it is noteworthy that it again deals with data from various countries.

The international comparison of expenditure patterns has recently acquired a new practical interest, which is actually quite similar to that which prompted Engel to use Belgian data. (He was concerned with the balance between production and consumption when population increases.) Many countries are now engaged in the construction of development programs and to do this adequately it is clearly necessary to have some idea about the changes in consumption that are likely to occur with rising income levels. In many underdeveloped countries, however, the data for estimating changes in consumption are unfortunately lacking. There is a real question concerning the extent to which data from one country are applicable to conditions in another country; it is one of the principal aims of the present investigation to clarify this point. In recent years the number of countries, both poor and rich, from which budget surveys are available has increased considerably and there is now enough material for, at the least, a first impression of the comparability of expenditure patterns.

It may be wise to deal at once with an objection which occurs to many people when they hear of an international comparison of expenditure patterns. They are willing to admit the possibility of comparison between countries, such as Holland and Belgium, which to them seem very similar. They become dubious, however, when conspicuously different countries, such as the United States and Ghana, or Brazil and Finland, are viewed under the same heading. Now it would be difficult to deny that these countries are in fact different in many ways, but this only makes it all the more interesting to see whether the same laws of expenditure apply to them also. The discovery of widely applicable generalizations is the principal aim of science. It will be shown, in fact, that there are meaningful propositions which appear to be valid in nearly all the countries considered, without reference to their climatic or cultural condition.

Because of limitations of data and resources it was decided to restrict the investigation to four major items of expenditure, namely food (not including al-

TABLE I

SURVEYS USED IN THE ANALYSIS

Country	Date	Sample Size	Type of Persons	Reference
Australia				
Queensland	1939/40	450	Entire country	The Government Statistician, Brisbane. *The Queensland Yearbook, 1945*. No. 6.
Austria	1954/55	6,023	City dwellers	Österreichisches Statistisches Zentralamt, *Der Verbrauch der Städtischen Bevölkerung Österreichs*. Vienna: 1956.
Belgium	1853	199	Industrial workers	Engel, Ernst, "Die Lebenskosten Belgischer Arbeiter Früher und Jetzt," *Bulletin de l'Institut International de Statistique*, IX (1895), pp. 38–39.
Brazil	1953	3,182	City dwellers	*Anuario Estatistico do Brasil*, XIV (Decembro, 1953), pp. 343–44.
Burma, Rangoon				
Hindustani	1927	768	Single workers	Bennison, J. J., "Report of an Enquiry into the Standard and Cost of Living of the Working Classes in Rangoon." Rangoon: 1928.
Tamils, Telugus, Uriyas	1927	1,599	Single workers	
Chittagonians	1927	654	Single workers	
Canada	1947/48	3,558	Non-farm population	Dominion Bureau of Statistics, "Canadian Non-farm Family Expenditures, 1947–48." Reference Paper No. 42. June, 1953.
Ceylon	1953	1,085	Rural and urban	Central Bank of Ceylon, Department of Economic Research. "Survey of Ceylon's Consumer Finances." Colombo: 1954.
China				
Peiping	1927	283	City dwellers	Gamble, S. D., *How Chinese Families Live in Peiping*. New York: Funk and Wagnalls Company, 1933.
Shanghai	1929/30	305	Laborers	The City Government of Greater Shanghai, Bureau of Social Affairs, "Standard of Living of Shanghai Laborers." Shanghai: 1934.
Cuba	1953	1,365	City dwellers	Central Bank of Cuba, Unpublished data.
Finland	1950/51	535	City dwellers	"Elinkustannustutkimus Helmikuu 1950-Tammikuu 1951," *Sosiaalisia Erikoistutkimuksia*, XXXII, No. 21 (1954).
France	1951	2,579	City dwellers	"Les Dépenses et les Consommations de Ménages à Paris, Rennes et dans 17 Grandes Villes de Province (Novembre–Decembre 1951)," *Bulletin Mensuel de Statistique*, Supplément 4 (October–December, 1953).

Germany	1907	852	City dwellers	"Erhebung von Wirtschaftsrechnungen minderbemittelter Familien im Deutschen Reiche," 2. Sonderheft zum *Reichs-Arbeitsblatte*. Berlin: 1909.
	1928	1,422	Manual & clerical workers, Govt. officials	"Die Lebenshaltung von 2,000 Arbeiter-, Angestellten- und Beamtenhanshaltungen," *Einzelschrifter zur Statistik des Deutschen Reiches*, No. 22 (1932).
	1951	910	City dwellers	Statistisches Bundesamt, *Statistisches Jahrbuch für die Bundesrepublik Deutschland*. Wiesbaden: 1953.
Ghana (Gold Coast)				
Accra	1954	453	City dwellers	Government Statistician's Office, "1953 Accra Survey of Household Budgets." Statistical and Economic Papers No. 2. Accra: 1953.
Kumasi	1955	570	City dwellers	———, "Kumasi Survey of Population and Household Budgets." Statistical and Economic Papers No. 5. Accra: 1956.
Secondi-Takoradi	1955	546	City dwellers	———, "Sekondi-Takoradi Survey of Population and Household Budgets." Statistical and Economic Papers No. 4. Accra: 1956.
Akuse	1954	163	City dwellers	———, "1954 Akuse Survey of Household Budgets." Statistical and Economic Papers No. 3. Accra: 1595.
Guatemala				
Guatemala City	1947	179	City dwellers	Dirección General de Estadística, "Estudio sobre los Condiciones de Vida de 179 Familias en la Ciudad de Guatemala." Guatemala City: 1948.
India				
Bombay	1921	603 597	Single workers Workers' families	Government of Bombay. Labour Office. *Report on an Enquiry into Working Class Budgets in Bombay*, by G. Findlay Shirras. Bombay: 1923.
Bhopal City	1951	360	Workers	Ministry of Labour, Labour Bureau, "Report on an Enquiry into the Family Budgets of Workers in Bhopal City." Delhi: 1954.
Punjab	1950	465	Industrial workers	Board of Economic Enquiry, Punjab, "An Economic Survey of Industrial Labour in Punjab," by Om Prakash. 1952.
Ireland	1951/52	2,880	City dwellers	Central Statistics Office, "Household Budget Inquiry, 1951–1952." Dublin: 1954.

TABLE I—*Continued*

Country	Date	Sample Size	Type of Persons	Reference
Italy	1952/53	1,574	Entire country	Cao-Pinna, V., "Contributo alla Preparazione dello Schema di Sviluppo dell'Occupazione e del Reddito in Italia nel Decennio 1955–1964" Rome: 1954. Additional data kindly supplied by the author.
Japan	1953	21,964	Urban workers	Bureau of Statistics, *Japan Statistical Yearbook*. 1954.
	1955	885	Urban workers	———, "Annual Report on the Family Income and Expenditure Survey." Tokyo: 1956.
Latvia	1936/37	170	Urban and rural workers	Davidsons, P., "Valsts statistika pārvalde: Ģimeņu Budžeti 1936–37." Riga: 1940.
Libya	1950	35	Arab workers	Nicholson, J. L., "A Survey of the Living Conditions of Arab Families in Tripolitania in November–December, 1950," *Revue de l'Institut International de Statistique*, XXII, Nos. 1–3 (1954).
Mexico				
Mexico City	1931	970	City dwellers	Ferrocarriles Nacionales de México, Oficina de Estudios Económicos, "Un Estudio del Costo de la Vida en México." Estudio Número 2, Serie A. Mexico City: 1931.
Netherlands	1951	1,938	Manual and white collar workers	Centraal Bureau voor de Statistiek. "Nationaal budgetonderzoek 1951," Serie B 1, No. 4; B 2, No. 3. Utrecht: 1954.
Northern Rhodesia	1951	223	European mine employees	Central African Statistical Office, "Report on Northern Rhodesia Family Expenditure Survey 1951." Causeway, Southern Rhodesia: 1953.
Norway				
Oslo & Bergen	1952	197	City dwellers	Statistisk Sentralbyrå, "Forbruksundersøkelse 1952." Oslo: 1953.
Panama				
Panama City	1952	449	City dwellers	Dirección de Estadística y Censo, "Estudio de los Ingresos, Gastos y Costo de la Vida: Ciudad de Panamá 1952–1953," by P. Paro. 1954.
Philippines				
Manila	1954	923	City dwellers	Central Bank of the Philippines, Department of Economic Research. "Incomes and Expenditures of Metropolitan Manila Households." Manila: 1954.

Poland	1927	192	Working class	"Budżety Rodzin Robotniczych," *Statystyka Polski*, XL, Zeszyt I (1930).
Portugal				
Porto	1950/51	2,592	City dwellers	Instituto Nacional de Estatística, "Inquérito ao Custo de Vida na Cidade do Porto, 1950–1951." Estudos No. 27. Lisbon: 1955.
Puerto Rico				
San Juan	1950	278	Office workers	U. S. Department of Labor, Bureau of Labor Statistics, "Income and Expenditure of Office Workers' Families." Washington: 1953.
Whole Territory	1952	999	Working class	Puerto Rico Department of Labor, "Survey of Income and Expenditures of Wage Earners' Families in Puerto Rico in 1952." Preliminary Releases. San Juan: 1954–1956.
Sweden	1955	388	Entire country	Kungl. Socialstyrelsen, Sveriges Officiella Statistik, Priser och Konsumtion, "Levnadskostnaderna År 1952." Stockholm: 1956.
Switzerland	1919	277	Entire country	Bureau Fédéral de Statistique, "Comptes de Ménage de 277 Familles Suisses pour 1919." Berne: 1922.
United Kingdom				
Working Class	1937/38	2,219	Industrial workers	Prais, S. J. and H. S. Houthakker, *The Analysis of Family Budgets*. Cambridge: Cambridge University Press, 1955.
Middle Class	1938/39	1,361	Government officials and teachers	*Ibid.*
United States	1901	11,156	Industrial employees	*Eighteenth Annual Report of the United States Commissioner of Labor*. Washington, D. C.: 1903, pp. 582–83.
	1950	12,489	City dwellers	*Study of Consumer Expenditures, Incomes, and Savings*, Vol. II. Tabulated by the Bureau of Labor Statistics, U. S. Department of Labor for Wharton School of Finance and Commerce. Philadelphia: University of Pennsylvania, 1956.

coholic beverages), housing (including fuel and light), clothing (including footwear), and all other items. Food expenditure includes an imputed value for home-produced items wherever data were available, but since nearly all surveys covered urban consumers only, this component is normally small. No attempt was made to analyze the composition of these four items in different countries, and consequently it was not necessary to go into the difficulties associated with products that are peculiar to certain regions. The dependent variables, it should be emphasized, are expenditures (money amounts) rather than quantities bought. The elasticities calculated therefore reflect both the increase in physical quantities and the increase in "quality" (average price per physical unit) associated with a rise in the level of living. The expenditure elasticity, in fact, is the sum of the quantity elasticity and the quality elasticity [**12,** p. 112]. Since the latter has been shown to be considerable in many cases [**12,** Ch. 8], [**3**], [**5**], our results cannot be immediately applied to the estimation of changes in physical quantities. The results for food, in particular, are not directly comparable with those obtained by Bennett [**2**] and Juréen [**10**] in their international comparisons.

The analysis also had to be simplified in other ways. Due to the lack of relevant data it was necessary to disregard prices as a factor determining differences in consumption patterns. The principal explanatory variable used in all cases was total expenditure (excluding direct taxes). Even on the theoretical level there are strong arguments for using this variable rather than current income, (cf., [**12,** p. 80–81]). On a more practical level the unambiguousness of total expenditure is particularly important when we have to deal with data of various origins whose exact nature is not always precisely described. One other variable, family size (defined as the number of persons), was introduced whenever possible.

A list of the surveys utilized is given in Table I. It will be noted that nearly all of them refer to urban households. As to the selection of data, an attempt was made to include all surveys conducted after World War II for which the results were available in sufficient detail. The search was facilitated by the bibliography in [**16**]. The minimal degree of detail that made a survey eligible for analysis was a one-way classification of the four major expenditure groups by income or total expenditure. Only the data for Brazil were of a different nature, as explained below. A few available surveys, particularly for European countries and the United States, were excluded because they would not have added sufficient variety. A number of older surveys were also analyzed both to provide some comparison over time and to improve coverage of the poorer countries for which information is least adequate.

The selection of families within each survey had been done by various methods, such as random sampling from lists, voluntary cooperation, taking every tenth house in the street, etc. Although in theory random sampling is the best method, in practice it does not always work out satisfactorily because of the low response rates commonly obtained in surveys which require considerable effort on the part of the respondent. The selection of households and the results obtained are therefore subject to various biases, which are more fully discussed in [**12,** Ch. 4]. No attempt has been made here to correct for those biases.

The principal criterion by which the similarity of expenditure patterns in different countries was judged was the elasticity of particular items of expenditure with respect to total expenditure. In what follows, this elasticity will often be referred to, briefly though inaccurately, as the "income elasticity." The fact that an elasticity is independent of the units of measurement of the variables it relates was especially important for the present purpose since the original data were always expressed in national currencies and since no attempt could be made to determine appropriate rates of exchange. The official exchange rates are of very limited usefulness in view of the many restrictions on international trade.

The choice of a mathematical form for the relation between particular expenditures and total expenditure was a matter of great concern. As Prais [**11**] has shown, calculated income elasticities depend on the type of function that has been fitted. Practical considerations limited the choice of function to three types: the linear, semi-logarithmic, and double-logarithmic. Linear functions were used by Allen and Bowley, but it is now generally recognized that they do not provide an adequate fit. Indeed the considerable variation between income elasticities which Allen and Bowley observed in their data may be partly due to their choice of an inappropriate function. The semi-logarithmic function is a stronger contender; it was recommended by Prais and Houthakker [**12**] for necessities. In the present inquiry, however, the double-logarithmic function was preferred. Its deciding advantages, in addition to those given in [**8**], are that it allows more freedom in dealing with multiple currencies and that it permits an easier introduction of the effects of family size. Interestingly enough, Engel himself also used a double-logarithmic approximation in his paper of 1857 (pp. 30–31).

The function fitted was accordingly as follows:

$$\log Y_i = \alpha_i + \beta_i \log X_1 + \gamma_i \log X_2 + \epsilon_i$$

where Y_i is expenditure on the ith group of items, X_1 is total expenditure, X_2 is family size, ϵ_i is a disturbance term, and α_i, β_i, and γ_i are constants to be estimated. The parameters were estimated by means of classical least squares regression, with observations weighted according to the number of households represented in each group average. The multiple regression coefficients, β_i and γ_i are the partial elasticities of the ith group of items with respect to total expenditure and family size respectively.

In household surveys income (or total expenditure) and family size tend to be rather strongly correlated, particularly if the households all belong to the same social class. The reason is that larger families usually contain more earners, so that family income is higher. Even if this factor is absent the head of a large household is more likely to be in the prime of his life and earning-power compared to the young head of a newly-formed and small household or the aged head of a household from which the children have departed. The implication is that if households are grouped by income or total expenditure it is impossible to obtain

reliable estimates for β_i and γ_i in the above equation, because the two effects are inextricably intermingled. Multiple regressions can only be estimated if each of the predetermined variables has enough independent variation.

Reliable estimates can be obtained if the households are cross-classified by income (or total expenditure) and family size.[2] Unfortunately many surveys are published without cross-classifications; for those surveys a special procedure for estimating β_i (applied only to food) was necessary.

Before discussing this complication we give the results for cross-classified surveys in Table II. This table also contains results for Poland which are based on data for individual households rather than on group averages, and for France and Italy which are not based on cross-classifications by total expenditure and family size. In the latter two cases a regional and occupational breakdown, together with a one-way classification by total expenditure, was used which provided a sufficient variation in total expenditure and family size, provided the observed differences in expenditure items can indeed be attributed to those determinants. Since such an assumption is somewhat questionable the Italian and French elasticities deserve less confidence than the other ones. In the case of Mexico only estimates for food are given, the reason being that it was not possible to discover the number of households in each group average, so that an unweighted regression was computed although the numbers in the different groups apparently varied considerably. The correlation of food expenditure on total expenditure and family size was very high and the effect of weighting (had it been possible) would have been slight, but for the other items the correlation was somewhat lower and an unweighted regression might have been misleading. The regressions for Ireland were also unweighted, but this probably did not affect the results because the numbers in the groups appeared to be rather similar. Standard errors are given in brackets.

The data for Germany 1928, the Netherlands, and the United Kingdom were broken down according to the occupation of the head of the household. In order to derive combined figures it was assumed that the occupations had the same values of β_i and γ_i, but different values of α_i. This amounts to postulating that the occupations differ in their expenditure patterns by multiplicative "social-class factors," which represent effects other than those of total expenditure and family size. This technique is more fully discussed in [**8,** p. 17]; see also [**12,** Ch. 11].

Let us now look at the elasticities with respect to total expenditure in Table II. Those for food are all significantly less than one and therefore confirm Engel's law abundantly.[3] The range, however, is substantial, the highest figure being .731 for Poland and the lowest .344 for the British middle-class survey. Since

[2] Almost equally good results can be obtained if two one-way classifications *and* a joint frequency distribution of all households by income and family size are available. The appropriate procedure [**9**] was discovered too recently for use in the present analysis.

[3] Engel's law strictly speaking refers to income elasticities, but the latter are normally smaller than elasticities with respect to total expenditure (since the elasticity of total expenditure with respect to income is normally less than one), and the strict form of the law is therefore also confirmed. See [**12,** pp. 101–102].

TABLE II

PARTIAL ELASTICITIES FOR FOUR EXPENDITURE GROUPS WITH RESPECT TO TOTAL EXPENDITURE (b) AND FAMILY SIZE (c)

Country	Food		Clothing		Housing		Miscellaneous	
	b	c	b	c	b	c	b	c
Austria	.554	.351	1.767	−.350	.741	−.210	1.620	−.392
	(.019)	(.022)	(.055)	(.064)	(.038)	(.044)	(.022)	(.025)
Canada[a]	.647	.292	1.337	−.114	1.114	−.447	1.131	−.061
	(.008)	(.007)	(.092)	(.081)	(.043)	(.038)	(.036)	(.032)
Finland	.621	.272	1.622	−.310	.802	.008	1.445	−.367
	(.026)	(.019)	(.063)	(.047)	(.077)	(.056)	(.048)	(.036)
France[b]	.483	.466	1.158	.232	1.098	−.652	1.656	−.536
	(.020)	(.029)	(.024)	(.034)	(.048)	(.068)	(.029)	(.041)
Germany 1907	.537	.261	1.498	.061	.913	−.154	1.604	−.358
	(.018)	(.015)	(.045)	(.038)	(.026)	(.022)	(.046)	(.039)
Germany 1927–28 manual workers	.598	.291	1.297	−.014	1.056	.476	1.474	−.481
	(.035)	(.019)	(.054)	(.029)	(.483)	(.262)	(.334)	(.181)
Germany 1927–28, clerical workers	.501	.274	1.035	.226	.881	−.052	1.469	−.298
	(.030)	(.025)	(.059)	(.049)	(.070)	(.058)	(.089)	(.074)
Germany 1927–28, government officials	.385	.319	.918	.149	.887	−.023	1.606	−.335
	(.027)	(.027)	(.079)	(.081)	(.054)	(.055)	(.069)	(.071)
Germany 1927–28, all three groups[c]	.473	.295	1.049	.102	.906	.196	1.447	.034
	(.020)	(.015)	(.047)	(.036)	(.045)	(.035)	(.082)	(.063)
Ireland[g]	.597	.323	1.177	.009	.705	−.221	1.478	−.219
	(.019)	(.024)	(.307)	(.382)	(.021)	(.026)	(.025)	(.032)
Italy[d]	.602	.346	1.042	−.733	[e]		[e]	
	(.096)	(.312)	(.196)	(.733)				
Japan 1955	.556	.309	1.593	−.051	.861	−.383	1.416	−.178
	(.025)	(.027)	(.119)	(.128)	(.023)	(.024)	(.040)	(.043)
Latvia[f]	.430	.482	1.094	−.065	1.024	.002	1.567	−.516
	(.030)	(.033)	(.077)	(.084)	(.059)	(.062)	(.037)	(.040)
Mexico[g]	.657	.248	[e]		[e]		[e]	
	(.017)	(.014)						
Netherlands manual workers	.714	.237	1.634	−.110	.514	.021	1.273	−.241
	(.050)	(.014)	(.097)	(.027)	(.129)	(.036)	(.106)	(.029)
Netherlands white collar workers	.490	.304	1.059	.034	.619	−.016	1.403	−.157
	(.025)	(.019)	(.043)	(.034)	(.044)	(.035)	(.045)	(.036)
Netherlands both groups[c]	.502	.291	1.088	.001	.613	−.001	1.406	−.200
	(.022)	(.014)	(.045)	(.029)	(.036)	(.023)	(.041)	(.026)
Norway[h]	.515	.131	1.266	−.044	.800	.031	1.524	−.296
	(.048)	(.030)	(.237)	(.149)	(.144)	(.091)	(.050)	(.032)
Poland[i]	.731	.213	1.784	−.497	.662	−.068	1.774	−.534
	(.030)	(.027)	(.041)	(.036)	(.026)	(.022)	(.030)	(.026)
Sweden	.631	.311	1.119	.003	.803	−.008	1.446	−.269
	(.048)	(.048)	(.138)	(.138)	(.085)	(.084)	(.047)	(.046)
Switzerland	.460	.397	1.445	.044	.824	−.137	1.879	−.629
	(.036)	(.026)	(.075)	(.055)	(.242)	(.178)	(.118)	(.086)
United Kingdom, working class	.594	.294	1.042	.143	.553	−.072	1.793	−.390
	(.021)	(.019)	(.029)	(.026)	(.026)	(.023)	(.026)	(.023)
United Kingdom, middle class	.344	.386	1.342	−.111	.346	.145	1.488	−.221
	(.019)	(.021)	(.154)	(.169)	(.031)	(.034)	(.016)	(.018)
United Kingdom both groups[c]	.519	.330	1.096	.139	.477	−.045	1.640	−.358
	(.027)	(.032)	(.057)	(.067)	(.023)	(.027)	(.027)	(.032)
United States 1901[h]	.712	.158	1.435	.016	.839	−.111	1.561	−.241
	(.004)	(.002)	(.019)	(.012)	(.016)	(.010)	(.045)	(.028)
United States 1950, large cities, North	.693	.224	1.399	.016	.764	−.155	1.367	−.111
	(.017)	(.016)	(.059)	(.054)	(.011)	(.010)	(.011)	(.010)

TABLE II—*Continued*

Country	Food		Clothing		Housing		Miscellaneous	
	b	*c*	*b*	*c*	*b*	*c*	*b*	*c*
United States 1950, suburbs, North	.664 (.029)	.280 (.030)	1.303 (.090)	.135 (.092)	.978 (.115)	−.236 (.117)	1.255 (.108)	−.125 (.112)
United States 1950, small cities, North	.653 (.029)	.258 (.028)	1.367 (.079)	.074 (.076)	.810 (.054)	−.237 (.052)	1.370 (.049)	−.068 (.047)
United States 1950, large cities, South	.685 (.015)	.213 (.015)	1.231 (.055)	.134 (.055)	.789 (.040)	−.271 (.040)	1.245 (.021)	−.097 (.021)
United States 1950, suburbs, South	.698 (.037)	.190 (.034)	1.147 (.062)	.175 (.057)	.974 (.085)	−.292 (.078)	1.178 (.036)	−.090 (.033)
United States 1950, small cities, South	.687 (.031)	.235 (.032)	1.068 (.055)	.287 (.057)	1.122 (.081)	−.543 (.083)	1.217 (.033)	−.151 (.034)
United States 1950, large cities, West	.682 (.023)	.193 (.021)	1.410 (.048)	−.111 (.045)	.654 (.032)	−.182 (.029)	1.243 (.011)	−.044 (.010)
United States 1950, suburbs, West	.709 (.031)	.225 (.028)	1.285 (.067)	.124 (.061)	.933 (.031)	−.401 (.028)	1.081 (.010)	−.111 (.010)
United States 1950, small cities, West	.645 (.029)	.292 (.029)	1.195 (.064)	.145 (.063)	.766 (.059)	−.292 (.059)	1.286 (.038)	−.187 (.038)
United States 1950, all classes of cities	.692 (.002)	.221 (.002)	1.280 (.006)	.080 (.006)	.895 (.013)	−.287 (.012)	1.248 (.006)	−.082 (.006)

[a] Direct taxes (which are excluded from total and miscellaneous expenditure) estimated from other data in source.
[b] Based on breakdown by city (Paris, Rennes, and 17 others combined) and total expenditure.
[c] Allowing for possible social-class differences in levels of Engel curves (see text).
[d] Based on breakdown by region (North vs. South), farm vs. non-farm, and total expenditure.
[e] Not computed because of insufficient data.
[f] Family size estimated from number of equivalent adults.
[g] Unweighted (see text).
[h] "Normal" families only, consisting of two adults and young children.
[i] Based on figures for individual households.

the standard errors are quite small the differences between the various estimates are mostly significant. The figures for Germany 1927–28, for the United Kingdom, and for the Netherlands, all of which refer to different social groups suggest that the elasticities for food may decrease with an increase in the general level of income, (see also [**17**, p. 271], though there is not much support for this thesis in the remainder of the table. It will be noted, for instance, that the elasticities for the United States and Canada are high compared to those of most European countries.

An explanation of the differences between the elasticities consequently seems difficult. It is conceivable, and indeed probable, that relative prices may influence the elasticities; thus it has sometimes been suggested that the income elasticity of a commodity is an increasing function of its price relative to other commodities. It is also possible that the income elasticity is determined not by the relative price of the item as a whole, but by relations among the prices of its components. No attempt can be made here to verify these ideas, but they may be fruitful for further research.

The elasticities for clothing with respect to total expenditure are all, with one statistically insignificant exception, greater than unity, and, with five exceptions, less than 1.5. In the technical sense clothing is therefore a luxury, though a moderate one. No particular pattern is apparent in the elasticities for different countries, and here again prices may have been an important determinant.

For housing (which includes fuel and light, but not furniture) the elasticities are mostly below one. Very small values are observed for the U.K., particularly in the middle-class survey. Even within the U.S. there are considerable differences in the elasticities; it appears that they are largest for suburbs (except in the South) and smallest in large cities. The reason might be that only persons who are prepared to spend a relatively large part of additional income on housing will move to the suburbs. Apart from this factor (whose importance for other countries has not been investigated) the pattern is again fairly random. Housing elasticities are presumably affected not only by international differences in rent, but also by the various types of rent control that exist in most countries. It appears, however, that on the whole housing is a necessity in the technical sense, a phenomenon known as Schwabe's law.[4]

The elasticities for miscellaneous expenditures are all well above one; indeed those for the Dutch manual workers, Canada, and the United States are the only ones below 1.4. In the latter two countries the larger share of transportation expenses, which are more of a necessity there, partly explains the low elasticity, though it should also be pointed out that the elasticities for the four commodity groups are not independent of each other. The sum of the four elasticities, each being weighted by the expenditure on the commodity concerned, must always equal unity (in formula, $\sum Y_i\beta_i = X_1$). As total expenditure rises, the share of the luxuries increases by definition, and to preserve the identity just mentioned it is necessary that some or all of the elasticities decline. In Canada and the United States, which have high average total expenditures, the elasticity for food is relatively high; those for clothing and housing are about average; hence the elasticity for miscellaneous items must be relatively low. A rather similar argument applies to the Dutch manual workers.

It also follows from this argument that the assumed constancy of elasticities can only be satisfied approximately and over limited ranges of total expenditure. This is a well-known defect of double-logarithmic Engel curves [**12,** p. 82 ff.], which has to be offset against their many advantages such as good fit, ease of computation, and automatic correction for heteroscedasticity. Perhaps one day a new type of Engel curve will be found which satisfies all theoretical requirements and fits the data adequately, though no doubt at the cost of increased computational difficulty. In the meantime various checks indicate that the above defect is numerically of minor importance.

Turning now to the elasticities with respect to family size in Table II we recall first that family size is measured by the number of persons, without any weighting according to age and sex. This measure is readily available in most surveys. A more correct treatment of family size is quite complicated, whereas blind application of an equivalent-adult 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

[4] Those elasticities with respect to total expenditure that are greater than one would probably be below one if they were converted to income elasticities.

to our own. The procedure followed in the present paper is crude but flexible, and therefore suitable for the uniform analysis of several sets of data.

The coefficients γ_i in the equation on p. 539 actually represent a combination of two effects. The first or "specific" effect results from the increase in the "need" for various commodities when family size increases. The increase in need is usually less than proportional to the increase in size (no matter how the latter is measured) because of "economies of scale" in large households. Since an increase in family size does not increase the need for every commodity in the same proportion (and may indeed reduce the need for some), and since γ_i refers to the influence of family size when total expenditure is held constant, there is also what is metaphorically called an income effect: an increase in family size makes people relatively poorer. Although, for example, an increase in family size may increase a household's "need" for clothing, the simultaneously arising "need" for more food may force it to spend less for clothing on balance. In an adequate analysis these two opposing effects could be separated, but the coefficients γ_i fail to do so. If the specific effect is stronger than the income effect γ_i will be positive, otherwise it will be negative.

The elasticities with respect to family size are related to each other by an identity, just as the elasticities with respect to total expenditure were seen to be. Since the γ_i are partial elasticities the total effect of a change in family size on all expenditures must be zero, and hence $\sum Y_i\gamma_i = 0$. Consequently it is not possible for the γ_i to be all positive or all negative.

From Table II it appears that the partial elasticities for food with respect to family size are all significantly positive, and mostly between .2 and .35. The samples for which the lowest values were found, viz., Norway and the United States 1901, both consisted of "normal" families only, i.e., of families composed of two parents with varying numbers of young children. Since in such families an increase in family size necessarily means an increase in children rather than in adults, it is not surprising that γ is lower in those two cases than in surveys where an increase in family size will normally involve a certain proportion of adults. The use of a common unit-consumer scale for food in all surveys would have prevented this discrepancy, though it would have raised other problems and was in any case impracticable.[5]

The estimates of γ for clothing and housing illustrate previous remarks about the interaction of specific and "income" effects of family size. For both items the specific effects are no doubt positive (probably more strongly for clothing than for housing), but nevertheless many of the partial elasticities are negative. In the case of clothing it appears that the γ's are most likely to be negative in the surveys with the lowest average total expenditures. In those surveys the specific effect of family size on food was evidently strong enough to submerge the specific effect on clothing. Even in one of the U.S. city classes, however, γ is negative,

[5] On the basis of an analysis of a number of U. S. surveys (including some not analyzed here) Brady and Barber [4] arrived at a value of γ of $\frac{1}{3}$. This estimate has become known as the "cube-root law." Our calculations suggest that a value of $\frac{1}{3}$ is somewhat too high, particularly for the United States. The estimation procedure followed by these authors was apparently rather different from our own.

and so it is in Canada. In the latter two cases the rather high value of the elasticity of clothing with respect to total expenditure may be part of the explanation, for the income effect will be the stronger, the larger the "income elasticity" of the item concerned. The γ's for housing are mostly negative.

It is hard to say whether the specific effect of family size on miscellaneous expenditures as a whole is positive or negative. For items like entertainment and domestic help it is quite conceivably negative, but for other components (domestic appliances, furniture, transportation) it is probably positive. For the group as a whole the specific effect may therefore be small, and the γ's, which are all negative, would then be determined mostly by the income effect. Here again γ appears to be most negative where β is largest.

So far we have looked only at surveys for which separate estimates of the β's and γ's could be made. For the other surveys listed in Table I the information presented was not sufficient for that purpose. This is particularly unfortunate because the cross-classified surveys only refer to European and North American countries and to Japan, whereas countries elsewhere, with their lower income levels, are more interesting from the point of view of economic development. While the estimates from the latter countries are consequently less reliable than those from the countries with cross-classified data, they are by no means useless, because the information in Table II provides a basis for interpreting and adjusting them.

The unadjusted estimates in Table III are the gross elasticities for each of the four expenditure groups with respect to total expenditure, no allowance being made for variations in family size. Since family size and total expenditure are positively correlated, this means that the unadjusted b_i's in Table III overstate the effect of total expenditure when the effect of family size (as measured by γ_i) would have been positive. When γ_i would have been negative the unadjusted b_i's understate the effect of total expenditure.

The γ_i's appropriate to the surveys in Table III are of course unknown, but for food, at least, there is enough similarity in the γ_i's of Table II to warrant a crude adjustment. If we put γ_{food} equal to .28, for instance (which is approximately the mean for Table II), then the b's in Table III can be adjusted by reducing each by $.28 \sum w\tilde{x}_1\tilde{x}_2 / \sum w\tilde{x}_1^2$, where $\tilde{x}_1$ is the logarithm of total expenditure measured from its mean, $\tilde{x}_2$ is the logarithm of family size measured from its mean, w is the number of households in each group, and the summation extends over all groups in the survey.[6] The adjusted b's for food are also given in Table III.

It will be seen, then, that the adjusted estimates of β_{food} in Table III are not too dissimilar from those in Table II. In order to give an impression of the effect of the adjustment a few surveys already present in Table II have also been included in Table III (Austria, Canada, France, Germany 1928, Ireland, Sweden, and U.S. 1950); Italy, too, has been included, although no adjustment was pos-

[6] This formula can be easily verified by putting as the dependent variable not y (the logarithm of food expenditure) but $y - .28\, x_2$.

TABLE III

GROSS ELASTICITIES FOR FOUR EXPENDITURE GROUPS WITH RESPECT TO TOTAL EXPENDITURE, AND ADJUSTED ELASTICITIES FOR FOOD

Country	Food		Clothing	Housing	Miscellaneous
	Unadjusted b	Adjusted b	Unadjusted b	Unadjusted b	Unadjusted b
Australia, Queensland	.390 (.037)	[a]	1.025 (.043)	1.180 (.076)	1.323 (.087)
Austria	.732 (.041)	.590	1.589 (.063)	.634 (.042)	1.422 (.046)
Belgium	.849 (.010)	.849	1.338 (.087)	.794 (.014)	1.992 (.066)
Brazil	.802 (.028)	.795	1.332 (.105)	1.227 (.136)	1.174 (.120)
Burma, Rangoon, Hindustani	.826 (.024)	.826	.775 (.069)	.947 (.037)	1.465 (.073)
Burma, Rangoon, Tamils, Telugus, Uriyas	.847 (.036)	.847	.658 (.049)	1.316 (.113)	1.430 (.042)
Burma, Rangoon, Chittagonians	.703 (.024)	.703	1.448 (.101)	1.031 (.103)	1.630 (.096)
Canada	.867 (.051)	.712	1.250 (.069)	.777 (.079)	1.085 (.028)
Ceylon	.856 (.037)	.810	1.108 (.063)	1.118 (.168)	1.290 (.053)
China, Peiping	.651 (.011)	.591	1.328 (.054)	.940 (.032)	1.489 (.041)
China, Shanghai	.769 (.065)	.617	1.609 (.045)	.714 (.046)	1.440 (.100)
Cuba	.704 (.020)	[a]	1.104 (.034)	1.160 (.061)	1.292 (.033)
France	.581 (.035)	[a]	1.404 (.062)	.781 (.059)	1.621 (.033)
Germany 1928 (combined)	.532 (.058)	.383	1.070 (.050)	.946 (.133)	1.454 (.082)
Germany 1951	.579 (.034)	.526	1.436 (.086)	.681 (.024)	1.552 (.042)
Ghana, Accra	.952 (.024)	.840	.967 (.098)	.635 (.062)	1.365 (.029)
Ghana, Kumasi	.954 (.032)	.818	1.042 (.091)	.618 (.044)	1.495 (.084)
Ghana, Sekondi-Takoradi	.823 (.037)	.654	1.289 (.065)	.725 (.065)	1.600 (.064)
Ghana, Akuse	.873 (.037)	.791	.865 (.086)	1.142 (.099)	1.503 (.059)
Guatemala, Guatemala City	.750 (.036)	.508	1.308 (.091)	1.029 (.087)	1.548 (.012)
India, Bombay Single workers	.709 (.049)	.709	.486 (.050)	1.475 (.099)	1.538 (.103)
India, Bombay Workers' families	.837 (.015)	.837	.775 (.141)	.733 (.068)	1.801 (.407)
India, Bhopal City	1.004 (.013)	.821	.900 (.045)	.730 (.042)	1.223 (.060)

TABLE III—*Continued*

Country	Food		Clothing	Housing	Miscellaneous
	Unadjusted *b*	Adjusted *b*	Unadjusted *b*	Unadjusted *b*	Unadjusted *b*
India, Punjab	.943	.811	1.161	.764	1.394
	(.027)		(.252)	(.037)	(.024)
Ireland	.775	.621	1.224	.583	1.358
	(.052)		(.194)	(.038)	(.039)
Italy	.615	[a]	1.219		
	(.026)		(.034)		
Japan 1953	.648	.563	1.398	.906	1.387
	(.017)		(.149)	(.034)	(.011)
Libya	.895	.805	1.830	.900	1.403
	(.073)		(.165)	(.165)	(.329)
Northern Rhodesia	.514	.393	1.081	.229	1.308
	(.109)		(.093)	(.131)	(.040)
Panama, Panama City	.790	.717	1.226	.932	1.232
	(.055)		(.064)	(.072)	(.030)
Philippines, Manila	.810	.757	1.141	.874	1.312
	(.028)		(.037)	(.047)	(.026)
Portugal, Porto	.779	.623	1.296	.564	1.246
	(.047)		(.445)	(.301)	(.122)
Puerto Rico, San Juan	.699	.692	.957	1.049	1.177
	(.040)		(.026)	.083	(.076)
Puerto Rico, Whole Territory	.812	[a]	1.147	.963	1.315
	(.031)		(.055)	(.108)	(.019)
Sweden	.843	.652	1.139	.749	1.261
	(.092)		(.077)	(.061)	(.087)
United States 1950	.816	.642	1.336	.731	1.222
	(.025)		(.048)	(.273)	(.037)

[a] Adjustment not possible.

sible for lack of data. The adjustment evidently goes in the right direction, but it sometimes overshoots the mark.

The figures in Table III for surveys not included in Table II again lend some support to the suggestion made earlier that the elasticity for food with respect to total expenditure might be higher for the countries and time periods with lower average total expenditures, though the evidence is equivocal.[7] A very high elasticity is found, for instance, for data used by Engel in his original article (Belgium 1853, data originally collected by Ducpétiaux). In that survey no adjustment was necessary because all households were of the same size (two adults

[7] It is also possible, however, that there is a statistical bias at work. Total expenditure is not strictly a predetermined variable, and it is conceivable that households have a high total expenditure because they happen to have a high food expenditure. This bias is more likely to be serious when food is a large fraction of the total, as it is in the poorer countries. The effect of the bias is to raise the estimate of the elasticity of food with respect to total expenditure. It will be reduced if the households are classified by income (as is the case in most surveys) rather than by total expenditure. The author is indebted to Robert Summers and Jens Lübbert for bringing this point to his attention.

TABLE IV

SUPPLEMENTARY DATA

Country	Geometric mean of total expenditure in 1950 U.S.$	Geometric mean of family size	Proportion spent on			
			Food	Cloth-ing	Housing	Misc.
Australia, Queensland	3,572	4.2	30	9	21	40
Austria	713	2.28	53	10	11	26
Belgium	200	6	64	14	14	8
Brazil	318	4.4	49	8	15	28
Burma, Rangoon, Hindustani	86	1	54	6	12	28
Burma, Rangoon, Tamils, etc.	114	1	61	9	16	14
Burma, Rangoon, Chittagonians	101	1	60	10	12	18
Canada	2,418	3.0	31	13	11	45
Ceylon	293	4.2	65	8	5	22
China, Peiping	268	4.5	47	7	21	26
China, Shanghai	156	4.6	54	7	15	24
Cuba	2,029		46	9	16	29
Finland	1,320	3.9	50	17	10	23
France	1,633	3.0	49	10	9	32
Germany 1907	1,700	4.3	45	10	20	25
Germany 1928, Manual	980	3.7	42	12	14	32
Germany 1928, Clerical	1,355	3.2	33	13	16	38
Germany 1928, Officials	1,454	3.5	33	14	17	36
Germany 1928, All	1,190	3.5	37	13	15	35
Germany 1951	1,887	3.6	42	15	15	28
Ghana, Accra	417	4.2	59	12	11	18
Ghana, Kumasi	381	4.1	58	14	14	14
Ghana, Sekondi-Takoradi	347	3.9	59	14	12	15
Ghana, Akuse	263	4.5	60	18	7	15
Guatemala, Guatemala City	1,129	5.0	52	10	21	17
India, Bombay, Single Workers	150	1	56	6	8	30
India, Bombay, Workers' Families	225	4	58	9	16	17
India, Bhopal City	186	4.9	61	8	13	18
India, Punjab	206	4.6	73	4	12	11
Ireland	1,327	4.1	40	13	15	32
Italy	1,237	4.5	46	15		
Japan 1953	567	4.8	50	8	12	30
Japan 1955	582	3.88	45	10	11	34
Latvia	670	2.9	34	15	15	36
Libya	196	5.4	70	6	11	13
Mexico, Mexico City	2,201	3.8	40			
Netherlands, Manual	900	3.91	39	13	14	34
Netherlands, White Collar	1,311	3.62	29	14	13	44
Netherlands, Both Groups	1,123	3.74	33	14	13	40
Northern Rhodesia	2,821	3.8	24	10	9	57
Norway	1,467	2.9	37	16	11	36
Panama, Panama City	1,758	4.9	38	12	17	33
Philippines. Manila	883	5.9	50	8	14	28
Poland	422	4.7	64	11	9	16
Portugal	580	4.4	58	7	15	20
Puerto Rico. Whole Territory	868		53	12	9	26
Sweden	1,267	2.2	37	12	16	35
Switzerland	1,602	4.1	46	10	17	27

TABLE IV—*Continued*

Country	Geometric mean of total expenditure in 1950 U.S.$	Geometric mean of family size	Proportion spent on			
			Food	Cloth-ing	Housing	Misc.
United Kingdom, Working Class	1,751	3.5	37	8	29	26
United Kingdom, Middle Class	3,887	3.0	25	12	19	44
United Kingdom, Both Groups	2,280	2.46	35	10	21	34
United States 1901	1,502	3.7	44	13	24	19
U.S. 1950, Large Cities, North	3,372	2.6	32	11	22	35
U.S. 1950, Suburbs, North	3,910	2.9	30	11	21	38
U.S. 1950, Small Cities, North	3,038	2.7	31	10	23	36
U.S. 1950, Large Cities, South	2,960	2.7	31	11	13	45
U.S. 1950, Suburbs, South	3,563	2.9	30	10	11	49
U.S. 1950, Small Cities, West	2,495	2.7	32	12	10	46
U.S. 1950, Large Cities, West	3,275	2.4	30	10	13	47
U.S. 1950, Suburbs, West	3,592	2.8	29	10	11	50
U.S. 1950, Small Cities, West	3,197	2.6	31	10	11	48
U.S. 1950, All Classes of Cities	3,290	2.6	31	11	16	42

and four children).[8] The elasticities for the three Indian surveys, which probably refer to the poorest households of all, are also very high, but those for China are about average. There is ample scope for further study here.

In the case of clothing, housing, and miscellaneous expenditures no adjustment has been made because the relevant estimates of γ in Table II are too variable and (for clothing and housing) often not significantly different from zero. It is likely that the relatively low values of b_i in Table III need to be adjusted upward and the relatively high ones adjusted downward, but Table II provides no guidance for doing so. The gross elasticities for "miscellaneous" no doubt require an upward adjustment, which is probably of the same absolute order of magnitude as the downward adjustment applied to the gross elasticities for food.

Table IV contains some data that may assist the reader in interpreting and elaborating the results of this paper. It gives first the geometric mean of total expenditure per household in U.S. dollars of 1950, obtained by converting the figure in local currency by the official dollar exchange rate during the year in which the survey was made,[9] and adjusting this to 1950 U.S. prices by means of the U.S. cost-of-living index. It should be stressed that *official* exchange rates were used, so that the figures in Table IV cannot be immediately used for international comparisons of real income;[10] moreover most of the surveys do not

[8] In the three surveys from Burma no adjustment was necessary either, because they covered single workers. These people sent a considerable part of their earnings to their families, but the remittances were not regarded as part of their expenditure. The same applies to the single workers in Bombay (India). Those families from Bombay that were included in the present analysis all consisted of two adults and two children, so the unadjusted and adjusted b again coincide.

[9] For countries with a multiple exchange system the lowest rate quoted was used.

[10] Such comparisons have been made by Gilbert and Kravis [7] for European countries *vs.* the United States and by Watanabe and Komiya [15] for Japan *vs.* the United States.

pretend to cover the whole country. Table IV also gives the geometric mean[11] of family size and the ratios which the geometric means of food, clothing, and miscellaneous expenditures bear to their total. The total of those four means does not necessarily equal the geometric mean of total expenditure, but the discrepancy is apparently nowhere more than two or three per cent.[12]

A question naturally raised by the data of Table IV is whether the differences in average expenditure on the four commodity groups among different countries can be explained in the same way as differences within one country can be explained. The answer is that variations in total expenditure and family size certainly account for a large part of the differences in composition, but since prices are also likely to be important such an explanation would be too one-sided to deserve much confidence. An analysis involving prices is outside the scope of this paper.

Some final comments are in order. What has been shown is mainly that the elasticities of the four main items of expenditure with respect to total expenditure are similar[13] but not equal, and that the elasticities with respect to family size are rather similar (but also unequal) for food and miscellaneous items, and irregular for clothing and housing. To return to the problem of development planning mentioned in the beginning of the paper: if no data on the expenditure patterns of a country are available at all, one would not be very far astray by putting the partial elasticity with respect to total expenditure at .6 for food, 1.2 for clothing, .8 for housing, and 1.6 for all other items combined, and the partial elasticity with respect to family size at .3 for food, zero for housing and clothing, and $-.4$ for miscellaneous expenditures. But it would be prudent not to use those guesses for wide extrapolations, and more prudent still to organize a survey and cross-classify the results.

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[11] Geometric means were used because of the constant elasticity assumption made in this paper. Strictly speaking they are weighted geometric means of arithmetic group means, for in most cases no individual data were available.

[12] These ratios are given merely to facilitate examination of the elasticity estimates of this paper. Those interested in the composition of private expenditures in different countries should consult [**14**, Table 164].

[13] By "similar" is meant that the estimates fall in a fairly narrow range without, however, differing merely by sampling deviations from a common "true" value. The partial elasticities for food, to take an example, range from .34 to .73 rather than (say) from -1 to $+3$.

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