An Investigation of Equivalent Scales in Demand Using the 1991 Latvian Household Budget Survey

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ABSTRACT

The 1991 Latvia household budget survey provided data for establishing basic information about food consumption levels and patterns in Latvia during the first year of major economic reforms. This study evaluates one aspect of economic decision making of households: how income is allocated for consumption of various broad categories of food items. The analysis uses the 1991 data to examine the importance of income and household composition on food expenditures. Estimated income elasticities for various food commodities suggest the magnitude of changes in real household income that have occurred in Latvia. With relatively low income elasticities (estimated from the 1991 data), declines in household income would not be met by significant reductions in food expenditures, suggesting greater reductions in expenditures on other goods. In addition to current estimates obtained from the Latvian data, the economic approach and method of empirical analysis are provided in sufficient detail to be useful for other researchers replicating the methods and procedures on similar data sets.

AN INVESTIGATION OF EQUIVALENT SCALES IN DEMAND USING THE 1991 LATVIAN HOUSEHOLD BUDGET SURVEY

Latvia, along with other countries of the former Soviet block, is making the transition from a centrally planned economy to a market-oriented one. The economic reforms associated with this transition have had profound effects on Latvian society. As subsidies have been withdrawn, prices have risen rapidly, and the Latvian living standard has come under great pressure. In this context, it is important to observe and evaluate the relative effects of the economic reforms in progress in order to develop effective social assistance programs and policies.

This study evaluates one aspect of the economic decision making of individual households: how income is allocated for consumption of various broad categories of food items. Latvian household survey data are used to examine the importance of income, family size, and family composition on demand for various categories of food. The estimates of demand parameters, based on relatively current data, can be used to evaluate the impacts of income changes on food consumption as well as to anticipate changes in household welfare under the economic transition. In addition to the estimates obtained from Latvian data, the economic approach and method of empirical analysis are provided in sufficient detail to be useful for others conducting studies that might use similar methods and procedures.

Economic Conditions in Latvia

It is important to consider specific aspects of the Latvian economy in its transition to a market economy. Drawing especially on information from the World Bank (1993), discussion here focuses on aspects relevant to changes in household welfare.

In 1991 Latvia abandoned Soviet pricing policies and began comprehensive price reforms. These changes preceded those of most other former Soviet republics and involved administrative price adjustments combined with liberalizing prices for an increasing share of consumer goods. By mid-1992 less than 8 percent of goods and services in the consumer price index remained under government control, and those were mainly related to energy and municipal services.

Price reform resulted in sharply increased prices for goods and services. During 1991 retail prices increased by 172 percent on an average annual basis. This is in contrast to average annual inflation rates of 4.7 percent for 1989 and 10.5 percent for 1990. Along with the price reforms, government subsidies declined steadily. The ratio of subsidies to GDP decreased from 13.7 percent in 1990 to 1.3 percent in 1991, mainly because subsidies on food commodities were withdrawn.

Although nominal wages were adjusted during 1991 to compensate workers for the price increases, the adjustment was not indexed fully to prices and real wages fell by 29 percent during this time. This followed increases of 4.9 percent in 1988, 5.1 percent in 1989, and 5.3 percent in 1990.

In 1991, the government introduced new rules for wage formation inside and outside the government sector, with all rules involving some form of indexing. Wages set by the state were linked to the minimum wage, which was determined by the value of a fixed market basket and revised every six months according to changes in the prices of a group of essential goods and services. Wages outside the budget sector were freed from ceilings, but were made subject to minimum compensation for price increases. In July 1992, the government placed additional limits on wages in state-owned enterprises by restricting wage increases to only 70 percent of the forecast price increases.

In January 1991, the government initiated a new social security program that included a pension system and substantially increased family assistance benefits. A Social Insurance Fund was established to administer four cash benefit programs: pension benefits, family benefits, sick pay and benefits, and unemployment benefits. The benefit levels were tied to the government's established minimum living level.

Establishing viable social assistance programs requires coordination, planning, and understanding of the structure of household demand for goods and services that are considered basic needs in the society. In order to maintain an effective wage and income policy during the transition, to ameliorate the social and economic impacts of the economic changes, as well as to anticipate adjustments in household behavior, basic information on household demand patterns is needed.

Latvian Household Survey Data

The data used to evaluate the structure of household consumption come from household budget surveys conducted by the Latvian government and published by the State Committee of Statistics. The surveys were conducted annually in order to get detailed information on household consumption, saving, expenditure patterns, and other factors. The 1991 data serve as a *baseline* for evaluating economic adjustments in the transition process. Also, the 1991 Household Budget Survey is the most recently available data source in Latvia.

The household survey was centrally administered and families were randomly selected to represent wage earning households in different occupational strata. There was no systematic sample rotation and some households remained in the sample for several years. Surveyors conducted bi-monthly interviews with the selected families to gather detailed information on salaries, payments-in-kind, pensions, other sources of income, and expenditures. It was reported that the quality of the data had declined significantly by 1992; there has been no new survey of Latvian households since then.

The 1991 survey provides extensive information on household composition (size, age, and gender distribution), occupational status of household members, sources of income, and patterns of expenditure, all reported on a quarterly basis. The structure of the survey data is of a balance sheet of household expenditures. However, except for agricultural activities, it is not possible to separate input costs associated with other private production of goods and services. The cash receipts from sales from household product activities are reported. However, net income from these activities can not be determined. In determining total household income and expenditure, attempts have been made to obtain appropriate quantitative measures of variables as much as possible, given the limitation of available information.

Total household expenditure was calculated from survey data as follows. Expenditures on food were derived from multiplying private consumption of various food items by a weighted price. Data on quantities purchased and expenditures on various food items through different marketing channels (private market, state farms, and cooperative and collective farms) were used to calculate a weighted average price for each food item, where the weights were the shares of each supply channel in the household's total purchase. The reported quantities of food consumed were multiplied by the (weighted) average price to calculate the total food expenditure.

Expenditures on various nonfood items like housing, transportation, and clothing were reported directly. These expenses were added to total food expenditure to obtain total household expenditure. Note, however, that reported expenditures on durables like building construction were included even though the appropriate value to include should be the annual value of *services* from the building. Actual expenses for rents and utilities were used even though these are still heavily subsidized sectors. Lack of data on private (open) market prices prevented us from using imputed market values rather than the actual expenses in calculating values included in total household expenditures. The sum of calculated food and reported nonfood expenditures gave the total household expenditures.

Income and Demographic Characteristics of the Sample

The 1991 sample included 1,189 households. Tables 1 through 14 summarize the income, expenditure, and demographic characteristics of the sample households. Table 1 summarizes household statistics from the survey. It shows the average gross and per capita household income, average gross and per capita household expenditure, family size, and family composition.

As seen in Table 1, the average total and per capita expenditure exceed average gross and per capita reported income. This is typical of household survey data where respondents are, in general, found to underreport their incomes. Also, dissaving may have occurred during this period. For these reasons, reported income may not properly represent the purchasing power of the household. Consequently, total expenditure was used as the measure of household resources available for consumption purposes.

Table 2 summarizes income sources. While households received income from wages and salaries, the percentage of households receiving payments through the social safety net (for instance, assistance for poor households) is rather high. Of the 1,189 households included in the sample, 746 (62.5 percent) received some form of assistance. Similarly, 820 (69.0 percent) households earned part of their income from private economic activity (for example, selling vegetables from backyard gardens or handicrafts). Interest income (earned from holding bonds or other financial instruments) is the least important source of income. Pensions constitute less than 10 percent of the income for surveyed households, while the subsidies' share is less than 1 percent.

Table 3 summarizes the pattern of household expenditure on various broad categories of items. Total household expenditure was classified into 11 broad categories. *Food* expenditure includes household consumption of food at home only, and it covers both purchased food as well as consumption of self-produced items and food commodities received as pay for work at state and collective farms. Food consumption values are calculated as described earlier. Expenditure for *housing* includes rent as well as construction of new buildings. *Utilities* include gas, electricity, and water. *Transportation* expenses include only those for private transportation, and do not include business related transportation expenditures. *Services* include items like telephone service, postage, repair and maintenance of household items, laundry and cleaning services and supplies, and personal care expenses. All expenditure data refer to annual household expenditure.

Food and clothing are the two most important expenditure categories: food accounts for about 45 percent and clothing accounts for about 16 percent of total expenditure. Housing and utilities are a small fraction of total expenditure due to being valued as the actual expenses incurred by households.

Table 1. Selected household summary statistics, Latvia 1991

Variable	Mean	Maximum	Minimum
		(rubles per year)	
Gross Income	13248.99	45406.72	1232.19
Per Capita Income	5410.18	23248.85	1232.19
Total Expenditure	13642.01	52501.47	2376.86
Per Capita Expenditure	5624.98	21769.40	1711.74
		(number per household)	
Family Members	2.80	9.0	1.0
Children (age ≤ 2 yr.)	0.095	3.0	0.0
Children (3–6 yr.)	0.23	3.0	0.0
Children (7–11 yr.)	0.35	5.0	0.0
Children (12–17 yr.)	0.356	4.0	0.0
Adults (Working Age)	1.51	4.0	0.0
Retired	0.26	2.0	0.0

Table 2. Sources of income, Latvia 1991

Sources of Income	Households Receiving Income	Households Receiving Income	Average Share in Gross Incomes
	(number)	(percent)	
Wages and Salaries	1189	100.0	70.55
Social Safety Net	746	62.5	3.07
Subsidies	347	29.2	0.98
Pensions	319	26.8	8.36
Interest Income	13	1.1	0.05
Private Economic Activities	820	69.0	10.42
Other Sources	1189	100.0	6.57

Table 3. Household expenditure patterns, Latvia 1991

Expenditure Group	Annual Expenditure	Share of Total Expenditure
	(rubles)	(percent)
Food at Home	5872.10	44.83
Housing	264.73	1.43
Utilities	165.94	1.29
Furniture and Accessories	887.67	5.64
Clothing	2183.49	15.70
Transportation	535.33	3.23
Entertainment and Education	487.22	3.80
Alcohol	564.05	4.09
Food Away from Home	501.17	4.20
Services	874.72	6.61
Miscellaneous	1319.08	9.18

Table 4. Income and expenditure in families of different sizes, Latvia 1991

	Family Size		
Income and Expenditure	1–2	3–4	5 or More
		(number)	
Number of Households	559	496	134
		(rubles per year)	
Gross Household Income	9972.19	15575.08	18308.63
Per Capita Income	6709.15	4490.92	3393.99
Total Expenditure	10414.37	15882.66	18812.82
Per Capita Expenditure	7074.01	4569.36	3487.48

(The actual reported expenditures are subject to subsidies and price controls and do not reflect the relative scarcities of these items). Because food and clothing are so expensive, few resources remain for other goods and services.

Table 4 highlights income and expenditure by family size. Average expenditure exceeds average income for all family sizes, but the spread between income and expenditure is similar across different family sizes.

Table 5 shows the relationship between family size and composition and gross income distribution while Table 6 shows the relationship between family size and composition and per capita income distribution. It is evident from these two tables that while family size increases with gross income (except for the greatest income group), the reverse is true for the relationship between per capita income and family size. The greatest concentration of families is within the gross income range of 7,500 rubles per year to 22,500 rubles per year, and within the per capita income range between 2,000 and 6,000 rubles per year. Households with higher per capita income have fewer children than families with lower per capita income.

Household Expenditure, Family Size and Composition, and Budget Shares

Tables 7 and 8 show that total expenditure is positively related to family size. Households with higher per capita expenditure generally have fewer children than those with lower per capita expenditure. The retired population appears to be concentrated in the lower expenditure groups. Households with total expenditure of up to 7,500 rubles per year have the greatest number of retired persons per family, followed by households with total expenditure between 7,500 and 15,000 rubles per year. In contrast, households with annual total expenditure above 15,000 rubles have fewer retired persons.

Table 9 shows that, on average, food expenditure accounts for slightly less than one-half of total expenditure. Expenditure on clothing constitutes the second most important category of expenditure and, accounting for about 16 percent of total expenditure, is quite a bit smaller than that of food. Housing shares increase with family size, due to a large extent to housing costs being levied on a per person basis. Table 10 shows the relationship between total household expenditure and shares of different expenditure categories. Food at home is the most important category of expenditure for households in all expenditure groups. However, the share of food at home steadily declines with total expenditure levels. Housing and utilities account for a small fraction of total expenditure for all groups. The shares for furniture and accessories and for transportation seem to

Table 5. Gross income distribution and family composition, Latvia 1991

Income Groups	Avg. Gross Income	Avg. Family Size	Children (age ≤ 2)	(3-6)	(7-11)	(12-17)	Adults	Retired	Households
	(rubles per year)			(average number)					(number)
Less than 7,500	5597.82	1.42	0.04	0.046	0.06	0.096	0.68	0.49	218
7,500-15,000	11073.11	2.69	0.11	0.23	0.33	0.30	1.47	0.24	548
15,000-22,500	18022.69	3.55	0.09	0.30	0.56	0.51	1.92	0.17	322
22,500-30,000	24999.74	4.11	0.13	0.38	0.47	0.78	2.20	0.16	87
Greater than 30,000	34741.31	3.36	0.07	0.29	0.29	0.36	2.29	0.07	14
Total	13248.99	2.80	0.095	0.23	0.35	0.356	1.51	0.26	1189

Table 6. Per capita income distribution and family composition, Latvia 1991

Income Groups	Avg.Gross Income	Avg. Family Size	Children (age ≤ 2)	(3-6)	(7-11)	(12-17)	Adults	Retired	Households
	(rubles per year)			(average number)					(number)
Less than 2,000	1819.24	3.89	0.37	0.74	0.67	0.33	1.78	0.00	27
2,000-4,000	3138.56	3.59	0.20	0.37	0.58	0.56	1.65	0.22	381
4,000-6,000	4901.04	2.88	0.06	0.22	0.35	0.36	1.60	0.27	409
6,000-8,000	6917.65	2.04	0.01	0.07	0.12	0.17	1.37	0.30	207
8,000-10,000	8803.10	1.69	0.00	0.04	0.10	0.14	1.11	0.29	96
Greater than 10,000	13133.64	1.41	0.00	0.00	0.00	0.03	1.06	0.32	69
Total	5410.18	2.80	0.095	0.23	0.35	0.356	1.51	0.26	1189

Table 7. Family composition and total expenditure distribution, Latvia 1991

Total Expenditure	Family Size	Children (age ≤ 2)	Children (3-6)	Children (7-11)	Children (12-17)	Adults	Retired	Households
			(average number per household)					(number)
Less than 7,500	1.25	0.046	0.020	0.046	0.053	0.596	0.483	151
7,500-15,000	2.52	0.090	0.201	0.269	0.277	1.395	0.287	613
15,000-22,500	3.70	0.109	0.358	0.579	0.550	1.966	0.140	349
22,500-30,000	4.05	0.186	0.237	0.576	0.695	2.169	0.186	59
Greater than 30,000	4.00	0.118	0.412	0.588	0.706	0.218	0.000	17
Total	2.80	0.095	0.229	0.352	0.356	1.511	0.260	1189

Table 8. Family composition and per capita expenditure distribution, Latvia 1991

Per Capita Expenditure	Family Size	Children (age ≤ 2)	Children (3-6)	Children (7-11)	Children (12-17)	Adults	Retired	Households
			(average number per household)					(number)
Less than 2,000	6.00	2.00	2.000	0.000	0.000	2.000	0.000	1
2,000-4,000	3.86	0.219	0.459	0.638	0.604	1.766	0.177	351
4,000-6,000	2.88	0.070	0.206	0.345	0.379	1.630	0.244	427
6,000-8,000	2.04	0.013	0.078	0.147	0.138	1.281	0.642	231
8,000-10,000	1.65	0.010	0.020	0.089	0.158	1.099	0.277	101
Greater than 10,000	1.29	0.00	0.013	0.026	0.013	0.910	0.333	78
Total	2.80	0.095	0.229	0.352	0.356	1.511	0.260	1189

Table 9. Family size and expenditure shares, Latvia 1991

Expenditure Categories	Family Size 1–2	Family Size 2–4	Family Size 5 or More
		(percent)	
Food at Home	45.08	44.19	46.67
Housing	1.02	1.74	2.03
Utilities	1.24	1.31	1.43
Furniture	4.93	6.41	5.75
Clothing	15.52	16.05	14.62
Transportation	2.88	3.43	3.95
Entertainment and Education	4.18	3.57	3.05
Alcohol	3.78	4.40	4.29
Food Away from Home	5.16	3.46	2.84
Services	6.97	6.33	6.14
Miscellaneous	9.24	9.11	9.23

Table 10. Total expenditure distribution and expenditure shares, Latvia 1991

Expenditure Categories	Expenditure Group: Less than 7,500	7,500–15,000	15,000–22,500	22,500–30,000	Greater than 30,000	Total
			(percent)			
Food at Home	51.85	46.23	42.10	35.88	26.74	44.93
Housing	0.75	0.75	2.00	4.98	7.86	1.43
Utilities	1.50	1.37	1.17	0.86	0.64	1.29
Furniture	2.92	4.39	8.45	7.24	11.12	5.64
Clothing	12.22	16.04	16.44	17.28	13.75	15.70
Transportation	2.42	2.59	3.36	8.09	13.76	3.23
Entertainment and Education	4.43	3.98	3.54	2.44	1.76	3.80
Alcohol	3.23	4.31	4.16	3.84	3.59	4.09
Food Away from Home	6.27	4.56	3.08	2.25	1.44	4.20
Services	7.03	6.86	6.22	5.50	4.81	6.61
Miscellaneous	7.34	9.02	9.58	11.64	14.53	9.18

increase with household expenditure levels. Shares of other expenditure categories do not show any systematic variation with total expenditure.

Table 11 shows the relationship between per capita expenditure and shares of different expenditure categories. Here, too, food at home is the most important category although the share declines as with per capita expenditure increases. Clothing, furniture and accessories, and transportation shares seem to increase with increased per capita expenditure.

Food Expenditure

The pattern of household food demand is the focus of this study, so it is important to examine more closely how Latvian families spend their money for various food items. Expenditure on food items consumed at home were calculated and then aggregated into eight broad categories: grains and cereals, fruits and vegetables, meat and meat products, milk and other dairy products, fish and fish products, eggs, vegetable oils, and confectionery items. Total food expenditure was calculated by simply adding total spending for these broad categories.

Table 12 shows how food expenditure shares food vary with family size. It is evident that the share spent on grains increases slightly with family size. For fruits and vegetables and for meat, the shares remain stable for family sizes of up to four. Shares for these two categories fall for households with more than four. Shares of other food categories do not change significantly with family size.

Table 13 shows the shares of different food categories in total food expenditure as total household expenditure varies. The share of grains falls while that of meat increases with higher household expenditure. Share of dairy products remains stable for various (total household) expenditure groups except for households with expenditure greater than 30,000 rubles. For these households, the share falls. Other food categories do not show much variation in expenditure. Comparison of shares for different per capita expenditure groups (Table 14) shows that share of grains falls with increases in per capita expenditure while the reverse is true for meat and meat products. However, the changes are rather small. For other food categories, no systematic pattern is observed.

Economic Model

The relationship between household consumption expenditure on food and household income, family size, and composition is generally known as an *Engel function*, a function derived from

Table 11. Per capita expenditure distribution and expenditure shares, Latvia 1991

Expenditure Categories	Per Capita Expenditure in Rubles per Year: Less than 2,000	2,000–4,000	4,000–6,000	6,000–8,000	8,000–10,000	Greater than 10,000	Total
				(percent)			
Food at Home	58.65	50.13	45.64	2.58	37.74	33.85	44.93
Housing	0.27	0.81	1.40	1.97	2.29	1.73	1.43
Utilities	4.09	1.63	1.23	1.10	1.08	0.91	1.29
Furniture	3.40	4.03	5.79	6.06	7.11	8.96	5.64
Clothing	10.83	14.20	16.02	15.23	18.34	18.73	15.70
Transportation	2.11	2.72	2.99	3.47	3.55	5.73	3.23
Entertainment and Education	5.87	3.66	3.86	3.88	4.10	3.45	3.80
Alcohol	8.21	4.37	4.04	4.10	3.87	3.42	4.09
Food Away from Home	0.55	3.77	4.12	4.70	5.11	3.90	4.20
Services	3.35	6.52	6.38	6.92	6.84	7.08	6.61
Miscellaneous	2.67	8.26	8.63	10.19	10.07	12.34	9.18

Table 12. Family size and food expenditure share, Latvia 1991

Food Groups	Family Size: 1-2	3-4	5 or More	Total
		(percent)		
Grains	14.33	15.65	16.47	15.62
Fruits and Vegetables	19.23	19.34	18.77	19.03
Meat and Meat Products	29.23	29.21	28.39	29.12
Dairy Products	16.14	15.65	16.32	15.94
Fish and Fish Products	2.76	2.56	2.54	2.57
Eggs	4.11	3.98	4.08	4.04
Vegetable Oils	0.91	0.77	0.72	0.83
Confectionery Items	13.29	12.84	12.71	12.85

Table 13. Total expenditure distribution and food expenditure share, Latvia 1991

Food Groups	Less than 7,500	7,500-15,000	15,000-22,500	22,500-30,000	Greater than 30,000	Total
	Per Capita Income Groups in Rubles per Year					
	(percent)					
Grains	15.41	15.06	14.95	14.76	12.88	15.62
Fruits and Vegetables	19.70	18.95	19.43	20.53	18.75	19.03
Meat Products	27.12	29.20	29.96	29.54	34.71	29.12
Dairy Products	17.10	16.00	15.38	15.14	13.88	15.94
Fish Products	2.85	2.69	2.54	2.26	2.93	2.57
Eggs	4.05	4.03	3.97	4.51	3.94	4.04
Vegetable Oils	0.84	0.83	0.81	0.82	0.85	0.83
Confectionary Items	12.93	13.24	12.96	12.44	12.06	12.85

Table 14. Per capita expenditure distribution and food expenditure share, Latvia 1991

Food Categories	Less than 2,000	2,000-4,000	4,000-6,000	6,000-8,000	8,000-10,000	Greater than 10,000
	Per Capita Income Groups in Rubles per Year					
	(percent)					
Grains	17.49	16.51	15.10	13.54	12.39	13.71
Fruits and Vegetables	19.86	18.82	19.41	19.53	19.64	20.50
Meat Products	26.52	27.87	29.46	30.18	30.87	29.38
Dairy Products	15.85	16.67	15.81	15.76	14.80	14.94
Fish Products	2.80	2.70	2.55	2.84	2.46	2.69
Eggs	3.61	4.13	3.89	3.88	4.79	4.24
Vegetable Oils	0.64	0.76	0.83	0.83	1.03	0.90
Confectionery Items	13.29	12.54	12.95	13.44	14.02	13.64

demand functions holding prices constant. Economic theory of consumer behavior forms the basis for the derivation and empirical specification of demand and Engel functions. Appendix A provides a brief review of consumer demand theory. The following sections draw especially from Goungetas and Johnson and Deaton and Muellbauer.

Household Characteristics

The demand function as expressed by

$$x_i^* = x_i(p_1, p_2, \ldots, p_n, Y) \qquad \forall_i, \; i = 1, 2, \ldots, n. \tag{1}$$

where

Y is the given income,

p_i are prices, and

x_i is the quantity purchased of good i (i = 1, 2, ..., n).

represents an individual consumer's demand function. However, real world data on consumption patterns are usually household data. So, in order for (1) (also equation A.5) to be a valid demand function that may be estimated using household data, it must be true that individual preferences also represent the overall household preference pattern (that the household preference ordering has the same properties as individual preferences).

The assumption of the existence of well-behaved household preferences (a household utility function) allows us to interpret (1) as a household demand function. However, households differ in size, age-gender composition, regional and occupational distribution, and religious and ethnic origin. These household characteristics are expected to have important effects on household consumption expenditure. Economists have for a long time attempted to incorporate household characteristics into demand analysis because such incorporation, if relevant, should yield qualitatively better parameter estimates. Furthermore, incorporation of these factors is important in evaluating the standard of living of the household being studied. In general, one can model the effects of household characteristics on demand by incorporating these factors in the demand function. That is, the demand function may be specified as:

$$x_i^* = x_i \; (P, Y, \theta) \tag{2}$$

where x_i^* is the quantity demanded of the i^{th} good (i = 1, ..., n), Y is the household income, P a vector of prices, and θ is a vector of household characteristics where θ_k (k = 1, 2, ...r,) is the number of people with the k^{th} household characteristics.

The assumption behind the demand function as specified by (2) is that household preferences are to be interpreted as conditional preferences (Pollak and Wales 1979). This implies that θ_k is not within the household choice set. The demand function can be derived from the utility maximization problem:

$$\text{choose X to maximize } U = U(X \mid \theta)$$
$$\text{subject to } \sum_{i=1}^{n} p_i x_i \leq Y$$

where the utility function is defined over the vector **X**, given θ. In addition to the restrictions enumerated earlier, the demand function satisfies the following restriction:

$$\sum_{i=1}^{n} p_i \frac{\partial x_i^*}{\partial \theta_k} = \sum_{i=1}^{n} \frac{\partial (p_i x_i^*)}{\partial \theta_k} = 0, \qquad k = 1, 2, ..., r.$$

Estimation

In estimating a demand function that incorporates household characteristics, one can choose between two alternative approaches. First, all households can be partitioned into groups so that each group contains almost homogeneous households. Then the demand functions given by equation (1) may be estimated separately for each group and the estimated parameters may be compared. This approach allows the effects of household characteristics to be reflected on the demand equation parameters without explicitly specifying the relationship between parameters and characteristics. But the problem with this approach is that it has limited practical application because it is extremely demanding in data requirements.

The second approach is to estimate demand function (2) rather than (1). In this approach, the household characteristics and demand parameters that may be related are chosen first. Then a functional form relating the demand parameters and household characteristics is specified. In this approach, it is generally assumed that only a subset of the demand parameters is affected by household characteristics. So, in implementing this approach, one has to consider:

1. Which of the demand system parameters is/are related to household characteristics?
2. What is the functional form of such a relationship?

Estimation with Cross-Section Data. This paper reports estimation of demand equations from cross-section data, and hence centers around the estimation of the Engel function. In such data sets, there are generally no price effects (since all households are assumed to face the same prices) and all restrictions involving the price effect are absent. Of particular interest then is the relationship between income and expenditure patterns. The only restriction that remains is the Engel aggregation restriction (see Appendix A). Since prices are assumed constant in cross-section data, the demand function becomes:

$$x_i^* = x_i(Y, \theta \mid P) \qquad i = 1, 2, ..., n. \tag{3}$$

This relationship, expressing the demand for a good as a function of income and household characteristics, is commonly referred to as the *Engel function*.

Engel (1895) examined the effects of income and household composition on household demand. His proposition is that the expenditure on a good (deflated by a general equivalence scale) depends on the level of total expenditure (deflated by the equivalence scale):

$$\frac{p_i x_i}{m} = p_i f_i \left(\frac{Y}{m} \right) \qquad i = 1, 2, ..., n. \tag{4}$$

where m is the equivalence scale that reflects household composition. Note that the choice of scale is an important assumption about *equivalence* in needs, and *equivalence* in welfare. Engel did not use (4) to estimate the scale (m). He preferred using nutritional information to calculate m because, he believed, this procedure would provide an invariant measure for comparison of real income across time and space (Muellbauer 1980).

An alternative approach considers that equivalence scales may not be the same for all commodity groups. Sydenstricker and King (1921) argued that Engel's use of a common scale for all commodities was too restrictive. Instead, they argued for estimating commodity-specific scales (m_i). This line of reasoning was revived and refined by Prais and Houthakker (1955). Introducing separate scales for each commodity and an overall scale for income, they estimated the following Engel equation:

$$\frac{p_i x_i}{m_i} = p_i f_i \left(\frac{Y}{m_0} \right) \qquad i = 1, 2, ..., n. \tag{5}$$

where m_i is the commodity-specific scale (for i^{th} good) and $m_0 = m(m_1, m_2, \ldots m_n, Y)$ is the income scale. Prais and Houthakker did not develop their model from utility theory. It was Barten (1964) who presented a utility-based justification for the Engel function specification of the form given by (5). His idea was that utility depended on *per equivalent adult* consumption of commodities. The concept *per equivalent adult* implies except that different types of people are measured as portions of an adult. Under certain assumptions, Barten's model suggests an Engel function of the form

$$\frac{x_i}{m_i} = \phi_i\left(\frac{Y}{m_0}\right) \qquad i = 1, 2, \ldots, n, \tag{6}$$

which is identical to the Prais and Houthakker (1955) specification.

The two models represented by equations (5) and (6) have been used in many empirical estimations of the Engel function: Singh and Nagar (1973), Wales (1979), Tedford et al. (1986), and Goungetas and Johnson (1992). An excellent and relatively recent discussion of the issues and an empirical application can be found in Deaton, Ruiz-Castillo, and Thomas (1989). However, as Muellbauer (1975) proves, the Engel equation of the form (6) is not identified if estimation is done with cross-section data. Without a priori information or an ad hoc assumption about one of the scales, the equivalence scales can not be identified from cross-section data. This identification problem can be circumvented by making an explicit assumption about one of the equivalence scales or income scale, for example, by fixing one of the scales. Alternatively, time-series/cross section data can be used to overcome the problem (Muellbauer 1975).

Functional Form. The next important issue in estimating the Engel function is that of specifying the functional form relating consumption expenditure, income, and household characteristics. The following are the commonly used functional forms:

1. *Linear*: $$\frac{p_i x_i}{m_i} = a_i + b_i\left(\frac{Y}{m_0}\right)$$

2. *Semi-logarithmic*: $$\frac{p_i x_i}{m_i} = a_i + b_i Ln\left(\frac{Y}{m_0}\right)$$

3. *Double-logarithmic*: $$Ln\left(\frac{p_i x_i}{m_i}\right) = a_i + b_i Ln\left(\frac{Y}{m_0}\right)$$

4. *Log-reciprocal*: $$Ln\left(\frac{p_i x_i}{m_i}\right) = a_i + Ln\left(\frac{m_0}{Y}\right),$$

where Ln denotes natural logarithm.

These different functional forms suggest different effects of income on expenditure. The last three specifications generally provide more realistic parameter estimates, but they lack theoretical basis because they violate the Engel aggregation condition. The linear function satisfies the Engel aggregation condition. Prais and Houthakker's general conclusion is that the semi-logarithmic form yields the *best* results, especially for food commodities.

Economy of Scale. Another factor that may be incorporated in estimating the Engel function is the existence of potential economy of scale from family size. Economy of scale in consumption may arise from two sources: larger households may utilize food more efficiently and larger households may be able to obtain price discounts through bulk purchases. Economy of scale in consumption exists if the consumption expenditure increases at a decreasing rate as household size increases (for example, with housing). In terms of our notation, such economy of scale exists for the i^{th} commodity for the k^{th} household characteristics if $\frac{\partial (p_i x_i)}{\partial \theta_k} = 0$ and $\frac{\partial \left[\frac{\partial (p_i x_i)}{\partial \theta_k}\right]}{\partial \theta_k} < 0$. In this paper, equations have been estimated both where the potential for such economy of scale is taken into account and where it is ignored (i.e., assumed to equal zero).

Model Specification, Estimation, and Results

In order to design an efficient social and economic policy it is necessary to know the pattern of demand for various categories of commodities. Furthermore, food constitutes the most important category of household expenditure. In fact, expenditure on food accounts for between one third and more than one-half of total household expenditure. Such large share of food in total expenditure suggests that special attention be paid to the structure of demand for various food commodities. Hence this paper focuses on the factors determining food demand. Since we are restricted to cross-section data, we estimate a set of Engel functions rather than a system of standard demand equations.

Engel functions are estimated for eight different food groups: grains, vegetables, meat and meat products, dairy products, eggs, fish, vegetable oils, and confectionery items. The equations are estimated twice. First, only family composition is taken into account. In the second stage, the potential effect of household size on expenditure through economy of scale is incorporated. Regional, occupational, and gender distribution are not considered. The age groups that are included are:

1. Children up to two years;
2. Children between three and six;
3. Children between seven and 11;
4. Children people between 12 and 17;
5. Adults between 18 and retirement age (55 for women and 60 for men); and
6. Retired people.

Model Specification

As has been mentioned, Engel functions are estimated twice: once without incorporating household size effect and once incorporating it.

Family Size Effect Not Incorporated. In the empirical analysis, the following Engel functions are estimated:

Linear:

$$C_i = m_i\left[a_i + b_i\left(\frac{Y}{m_0}\right)\right] \tag{7}$$

Semi-logarithmic:

$$C_i = m_i\left[a_i + b_i Ln\left(\frac{Y}{m_0}\right)\right] \tag{8}$$

Double-logarithmic:

$$C_i = m_i A_i\left(\frac{Y}{m_0}\right)^{b_i} \tag{9}$$

where $C_i = p_i x_i$ is the annual household expenditure on the i^{th} good, m_i is the household composition parameter specific to commodity group i (a commodity-specific scale), m_0 is the household composition parameter specific to income (income scale), and Y is the income, measured by the total household expenditure. The specification for the commodity-specific scale, m_i, is

$$m_i = \sum_{g=1}^{6} \delta_{gi} n_g \tag{10}$$

where g = 1, 2, 3, 4, 5, 6, for the six household composition groups and i = 1, 2, ..., 8 for the commodity groups. Here δ_{gi} is the weight of an individual of the g^{th} age group, measured on a scale appropriate for the i^{th} food group, and n_g is the number of people in the g^{th} age group. The weight of the adult is set equal to unity. That gives m_i the natural interpretation as the number of equivalent adults in the household, appropriate for the i^{th} food group.

As has been mentioned earlier, estimation of Engel equations (7) through (9) using cross-section data involves an identification problem. This problem is circumvented here by making the assumption that the income scale, m_0, is equal to the size of the household, N. Now substituting (10) in equations (7) through (9) and manipulating, we get the equations:

Linear:
$$C_i = \sum_{g=1}^{6} \gamma_{gi}\left[n_g\left\{\nu_i + \left(\frac{Y}{N}\right)\right\}\right] \quad (11)$$

where $\gamma_{gi} = b_i\delta_{gi}$, and $\upsilon_i = (a_i/b_i)$.

Semi-logarithmic:
$$C_i = \sum_{g=1}^{6} \gamma_{gi}\left[n_g\left\{\nu_i + Ln\left(\frac{Y}{N}\right)\right\}\right] \quad (12)$$

where $\gamma_{gi} = b_i\delta_{gi}$, and $\upsilon_i = (a_i/b_i)$.

Double-logarithmic:
$$C_i = \sum_{g=1}^{6} \gamma_{gi}\left[n_g\left(\frac{Y}{N}\right)^{b_i}\right] \quad (13)$$

where $\gamma_{gl} = A_i\delta_{gi}$, and A_i is defined in (9).

Estimation

It is evident that equations (11) through (13) are nonlinear in the parameters. The parameter estimation may be performed in alternative ways. The estimation method used in this paper is a Nonlinear Algorithm available in SAS (Statistical Analysis System). Specifically, a nonlinear method (PROC NLIN) has been used to estimate (11) through (13), using the Gauss Marquardt algorithm. The initial values for γ_i and υ_i have been obtained in the following manner:

1. Estimates are obtained by applying OLS to (7) through (9), using household size, N, in place of m_i and m_0. This procedure is equivalent to regressing per capita expenditure for each commodity group on per capita income.
2. Estimated a_i and b_i are used to obtain the initial values of υ_i equal to the ratio of a_i to b_i. Also, estimated a_i and b_i are used to linearize (11) through (13). The initial values of γ_i are estimated by regressing C_i on $\left[\nu_i + \left(\frac{Y}{N}\right)\right]$ for the linear model, $n_g\left[\nu_i + Ln\left(\frac{Y}{N}\right)\right]$ for the semi-logarithmic model, and $n_g\left(\frac{Y}{N}\right)^{b_i}$ for the double-logarithmic model. These linearized equations are estimated by OLS.
3. The OLS estimates of γ_{gi} are used as initial values for respective coefficients in the PROC NLIN procedure.

Results

Results from the estimation of equations (11) through (13) by PROC NLIN, using Latvian household survey data, are reported in Table 15. Since the estimated coefficients are similar, only the coefficients from the semi-logarithmic functional form are reported. (Estimated coefficients for the other functional forms are available on request from the authors.) The regression equations do not include intercept terms. Without an intercept term in the regression equation, the coefficient of determination (R^2) is not bounded between zero and unity and, therefore, loses its usefulness as an indicator of goodness of fit (Schmidt 1976). So, the statistics such as sum of squares error and sum of squared regression are not reported.

The nonlinear estimation process using the Gauss-Marquardt algorithm yielded nice convergence for all estimated equations. The asymptotic t-ratios are statistically significant for all coefficients. All of the γ- coefficients are positive, implying positive weights of all age groups. The positive signs of the weight coefficients are consistent with what one would normally expect. The estimates imply that, other things remaining the same, additions to the household in any age group lead to higher expenditure for all food categories.

Income Elasticity and Adult Equivalence Scale

The income elasticities are obtained from estimated equations (11) through (13) as follows:

Linear function:
$$\eta_y = \frac{1}{\left[1 + \nu_i (\frac{Y}{N})\right]}$$

Semi-logarithmic function:
$$\eta_y = \frac{1}{\left[\nu_i + Ln (\frac{Y}{N})\right]}$$

Double-logarithmic function:
$$\eta_y = b_i$$

For the linear and semi-logarithmic functions, income elasticities are calculated with N equal to the average family size and Y equal to mean expenditure for the entire population. Adult equivalence scales are obtained by dividing γ_{gi} for each age-group by the estimated coefficient corresponding to the adult age group (γ_{5i}).

Table 15. Estimated coefficients and t-ratios for the semi-log Engel function

Estimated Coefficients	Grains	Fruits and Vegetables	Meat and Meat Products	Dairy Products	Eggs	Fish Products	Vegetable Oils	Confectionery Items
υ	-5.06	-7.12	-6.70	-5.67	-6.60	-5.47	-6.92	-6.61
t-ratio	(-11.78)	(-102.92)	(-77.07)	(-23.50)	(-40.25)	(-11.15)	(-53.65)	(-64.73)
γ_1	88.80	338.66	264.07	89.53	40.56	4.68	3.22	131.24
t-ratio	(4.77)	(6.01)	(6.32)	(5.44)	(4.28)	(1.31)	(1.47)	(6.91)
γ_2	67.97	265.08	203.18	69.20	27.42	5.24	5.75	101.44
t-ratio	(5.16)	(7.25)	(7.36)	(6.07)	(4.50)	(2.06)	(3.73)	(7.98)
γ_3	77.60	295.75	266.08	97.37	35.85	13.30	7.43	137.77
t-ratio	(6.01)	(9.58)	(10.73)	(8.18)	(6.41)	(4.24)	(5.58)	(11.26)
γ_4	75.21	298.87	280.76	84.01	42.09	13.70	10.56	112.73
t-ratio	(5.86)	(9.62)	(10.93)	(7.59)	(6.88)	(4.20)	(6.81)	(10.05)
γ_5	98.90	319.65	396.19	129.49	48.22	21.27	11.55	151.19
t-ratio	(8.36)	(19.90)	(21.77)	(12.31)	(12.18)	(6.47)	(12.81)	(19.43)
γ_6	142.82	391.03	451.37	173.46	63.52	25.96	13.57	171.87
t-ratio	(7.99)	(15.63)	(18.32)	(11.54)	(10.72)	(6.08)	(10.35)	(16.21)

Table 16. Estimated income elasticities

Food Category	Linear	Semi-Log	Double-Log
Grains	0.259	0.291	0.292
Fruits and Vegetables	0.719	0.731	0.711
Meat and Meat Products	0.528	0.559	0.559
Dairy Products	0.305	0.355	0.347
Egg Products	0.530	0.527	0.560
Fish Products	0.327	0.331	0.356
Vegetable Oils	0.587	0.636	0.610
Confectionery Items	0.494	0.531	0.523

Notes: Family size effects are not incorporated.
Elasticities are evaluated at mean family size and mean household expenditure

The estimated income elasticities and the adult equivalence scales are reported in Tables 16 and 17. It is evident from Table 16 that the income elasticities for various commodity groups are not significantly different for different functional forms. All food groups have income elasticity less than unity. Grains and dairy products have the smallest elasticity while that for fruits and vegetables is the highest, followed by meat and meat products. The general conclusion from these elasticity estimates is that all of these food categories are *necessary goods* (i.e., income elasticity less than one).

The estimated *adult equivalence scales* are reported in Table 17. It is evident from Table 17 that the *adult equivalence scales* are similar for the different functional forms used to estimate the Engel function. The general pattern of these scales is quite reasonable. However, the retired have higher *adult equivalence scales* than the adults which is rather puzzling. One possible explanation may be found in the way the consumption data are reported in the survey. Consumption data as reported in the sample survey pertain to consumption at home. Consumption of food by working adults at the workplace (for instance, in factory cafeteria) have not been included. It is likely that the retired do not eat lunch at the workplace while adults (working age population) eat a major meal outside of the home at least during the working days of the week. This may explain the higher estimated *adult equivalence scales* for the retired age group compared with those of the adults.

Family Size Effect Incorporated

Thus far, the possibility of households enjoying economies of scale from family size in consumption has not been incorporated in the model. To allow for such a possibility, an alternative specification for m_i is employed. In this specification, δ_{gi} is modeled as:

$$\delta_{gi} = \delta_{gi0} + \delta_{gi1} N. \tag{14}$$

Now negative values for δ_{gi1} would indicate that the weights δ_{gi} decrease in magnitude as family size increases. Substituting (14) into (10), we get

$$m_i = \sum_{g=1}^{6} \delta_{gi0} n_g + \sum_{i=1}^{6} \delta_{gi1} n_g N. \tag{15}$$

Substituting (15) into (7) through (9), and manipulating, we get

Table 17. Estimated adult equivalence scales

Food Groups	Age Groups > 2	3–6	7–11	12–17	Adult	Retired
Grains						
Linear	0.842	0.677	0.764	0.743	1.000	1.433
Semi-log	0.898	0.687	0.785	0.760	1.000	1.444
Double-log	0.886	0.688	0.781	0.758	1.000	1.441
Meat and Meat Products						
Linear	0.635	0.522	0.662	0.712	1.000	1.134
Semi-log	0.667	0.513	0.672	0.709	1.000	1.139
Double-log	0.656	0.521	0.669	0.713	1.000	1.135
Eggs						
Linear	0.836	0.602	0.754	0.906	1.000	1.315
Semi-log	0.841	0.569	0.743	0.873	1.000	1.317
Double-log	0.861	0.601	0.761	0.906	1.000	1.316
Vegetable Oils						
Linear	0.235	0.496	0.631	0.912	1.000	1.176
Semi-log	0.279	0.498	0.644	0.915	1.000	1.175
Double-log	0.245	0.490	0.630	0.904	1.000	1.173
Fruits and Vegetables						
Linear	1.035	0.873	0.939	0.980	1.000	1.221
Semi-log	1.059	0.829	0.925	0.935	1.000	1.223
Double-log	1.009	0.835	0.916	0.941	1.000	1.216
Dairy Products						
Linear	0.630	0.518	0.728	0.625	1.000	1.332
Semi-log	0.691	0.534	0.752	0.649	1.000	1.340
Double-log	0.673	0.531	0.745	0.642	1.000	1.336
Fish and Fish Products						
Linear	0.205	0.255	0.628	0.654	1.000	1.215
Semi-log	0.220	0.247	0.625	0.644	1.000	1.220
Double-log	0.230	0.260	0.635	0.657	1.000	1.218
Confectionery Items						
Linear	0.800	0.673	0.890	0.736	1.000	1.126
Semi-log	0.868	0.671	0.911	0.746	1.000	1.137
Double-log	0.832	0.672	0.900	0.739	1.000	1.130

Linear: $$C_i = \sum_{g=1}^{6} \alpha_{gi}\left[n_g\left\{v_i + \left(\frac{Y}{N}\right)\right\}\right] + \sum_{g=1}^{6} \beta_{gi}\left[n_g\left\{v_i + \left(\frac{Y}{N}\right)\right\}\right] N \quad (16)$$

where $\alpha_{gi} = b_i\delta_{gi0}$, $\beta_{gi} = b_i\delta_{gi1}$, and $\upsilon_1 = (a_i/b_i)$.

Semi-logarithmic: $$C_i = \sum_{g=1}^{6} \alpha_{gi}\left[n_g\left\{v_i + Ln\left(\frac{Y}{N}\right)\right\}\right] + \sum_{g=1}^{6} \beta_{hi}\left[n_g\left\{v_i + Ln\left(\frac{Y}{N}\right)\right\}\right] N \quad (17)$$

where $\alpha_{gi} = b_i\delta_{gi0}$, $\beta_{gi} = b_i\delta_{gi1}$, and $\upsilon_1 = (a_i/b_i)$.

Double-logarithmic: $$C_i = \sum_{g=1}^{6} \alpha_{gi}\left[n_g\left(\frac{Y}{N}\right)^{b_i}\right] + \sum_{g=1}^{6} \beta_{gi}\left[n_g\left(\frac{Y}{N}\right)^{b_i}\right] N \quad (18)$$

where $\alpha_{gi} = A_i\delta_{gi0}$, $\beta_{gi} = A_i\delta_{gi1}$.

The estimation procedure used here is exactly the same as in the previous section. In order to provide initial values for PROC NLIN, the following procedure is used.

1. In the first stage, per capita expenditure is regressed on per capita expenditure to obtain initial estimates of a_i and b_i, and hence, υ_i.
2. Using the estimates from the first stage, equations (16) through (18) are linearized and these linearized equations are estimated by OLS to get α_{gi} and β_{gi}.
3. In the final stage, PROC NLIN is used to estimate υ_i, b_i, α_{gi}, and, β_{gi} using the estimates from the first two steps as initial values in nonlinear procedure.

All equations converged automatically. The estimated coefficients and t-ratios are presented in Table 18. Again, we report only the estimated coefficients of the semi-logarithmic functional form. It may be recalled that negative values of the β_j (j = 1, 2, ..., 6) coefficients would indicate the presence of economies of scale from family size with respect to corresponding food group. It is evident from these tables that economies of scale do not exist for all commodity groups. For example, the coefficient β_1 is negative for grains and fish products, while it is positive for all other food groups. However, the t-ratios of β_1 for all food groups are statistically insignificant, suggesting absence of significant economies of scale from additional children below the age of two. Similarly, the t-ratios for the coefficient β_4 are statistically insignificant for all food groups, indicating there are no economies of scale for children between 12 and 17.

The estimated coefficients suggest that for children between three and six there are diseconomies of scale for grains, meat and meat products, fish products, vegetable oils, and

Table 18. Estimated coefficients and t-ratios, semi-logarithmic Engel function

Estimated Coefficients	Grains	Fruits and Vegetables	Meat and Meat Products	Dairy Products	Eggs	Fish Products	Vegetable Oils	Confectionery Items
υ	-4.37	-7.14	-6.57	-5.16	-6.55	-5.00	-6.77	-6.77
t-ratio	(-6.53)	(-100.24)	(-60.21)	(-14.37)	(-35.47)	(-6.98)	(-39.65)	(-39.65)
α_1	77.60	282.72	85.63	66.90	6.87	9.52	1.29	1.29
t-ratio	(2.09)	(1.51)	(0.71)	(1.79)	(0.25)	(0.91)	(0.18)	(0.18)
α_2	14.80	355.83	66.52	29.94	21.73	-7.21	-2.03	-2.03
t-ratio	(0.63)	(3.08)	(0.86)	(1.20)	(1.21)	(-1.06)	(-0.45)	(-0.45)
α_3	48.03	138.58	154.79	28.43	5.41	5.07	12.10	12.10
t-ratio	(3.00)	(1.83)	(3.09)	(1.85)	(0.47)	(1.18)	(3.91)	(3.91)
α_4	58.01	206.66	350.92	84.75	39.53	7.26	9.35	9.35
t-ratio	(3.41)	(3.03)	(6.94)	(4.82)	(3.53)	(1.64)	(3.34)	(3.34)
α_5	106.83	348.23	438.15	143.91	62.94	24.97	13.20	13.20
t-ratio	(6.53)	(12.75)	(16.96)	(9.84)	(10.14)	(5.25)	(9.51)	(9.51)
α_6	151.74	526.06	478.70	186.27	70.33	27.28	15.61	15.61
t-ratio	(6.11)	(10.58)	(12.28)	(8.88)	(7.68)	(4.66)	(7.00)	(7.00)
β_1	-0.06	13.64	40.55	3.24	8.76	-0.97	0.65	0.65
t-ratio	(-0.01)	(0.32)	(1.50)	(0.41)	(1.41)	(-0.43)	(0.41)	(0.41)
β_2	11.89	-20.02	35.17	9.45	2.55	3.30	2.08	2.08
t-ratio	(2.14)	(-0.76)	(1.96)	(1.68)	(0.62)	(1.99)	(1.98)	(1.98)
β_3	5.14	41.18	27.11	14.80	8.34	1.86	-1.13	-1.13
t-ratio	(1.50)	(2.13)	(2.23)	(3.64)	(2.80)	(1.71)	(1.66)	(1.66)
β_4	3.06	25.88	-16.25	-0.55	1.83	1.61	0.39	0.39
t-ratio	(0.91)	(1.51)	(-1.45)	(-0.16)	(0.71)	(1.53)	(0.60)	(0.60)
β_5	-8.25	-7.86	-24.47	-11.59	-5.70	-2.24	-0.97	-0.97
t-ratio	(-3.79)	(-0.86)	(-3.81)	(-5.24)	(-3.83)	(-3.42)	(-2.65)	(-2.65)
β_6	-16.62	-72.17	-29.96	-19.86	-4.46	-2.47	-1.65	-1.65
t-ratio	(-3.17)	(-3.18)	(-1.90)	(-3.77)	(-1.23)	(-1.70)	(-1.81)	(-1.81)

confectionery items. For the other two food groups the effects are statistically insignificant. For young household members between 7 and 11, estimated coefficients suggest the presence of diseconomies of scale for fruits and vegetables, meat and meat products, dairy products, and eggs, while the effects of the age group are statistically insignificant for other food groups.

Estimated coefficients for adults and retired groups suggest that households do enjoy economies of scale for members of these groups for almost all food groups. Exceptions are fruits and vegetables for the working age adults, and eggs, fish and fish products, vegetable oils, and confectionery items for retired household members. One can calculate *adult equivalence scales* from the coefficients reported in Table 18. However, these scales will be specific to the adults from the particular family size that is set equal to unity. Consequently, adults coming from different family sizes may have different weights.

Concluding Remarks

The empirical estimation of the Engel functions, the relationship between income and expenditure, using household survey data from Latvia has been the focus of this paper. Food expenditures represent a relatively large share of total expenditures. The main conclusions of the paper may be summarized as follows. First, for Latvia, household income and demographic characteristics have significant effects on household food expenditure patterns. Family members of different age groups have different effects on expenditure. Furthermore, the effects of various age groups are different for different commodity groups. Second, there is some evidence in favor of economy of scale from family size. Specifically there is evidence for significant scale economies for adults and retired members of the households. For persons below the age of 18 years, there is little evidence in favor of existence of any economy of scale from family size. That is, with more adults and retired members in a household, members added to the household increase expenditures at a decreasing rate for most food groups. On the other hand, there is not enough evidence to suggest that households enjoy a similar benefit from adding of members below 18 years of age. Finally, estimated income elasticities for various commodity groups show that all the food categories are *necessary goods*.

The findings of this paper have implications for the design of food assistance programs and policies and for evaluating the impact of changes in household income. In designing food assistance schemes, per capita calculations mask the differences that appear in food consumption patterns of households with different demographic composition. For most food groups, including dairy, the presence of children in the household indicates increased expenditures, but not by the same amount as an adult. Almost all values indicate that members under 18 years increase expenditure by more than 0.6 or 0.7 times.

Estimated income elasticities for food commodities suggest the magnitude of the impact of changes in real household income that have occurred in Latvia. With relatively low income elasticities (estimated using 1991 data), declines in household income will not be met by significant reductions in food consumption. Although not estimated here, the changes in consumption patterns are likely to come about with shifts away from other commodities to food. The greatest decreases in household expenditure for food are likely to occur for fruits and vegetables (purchased in the market), meat, eggs, and vegetable oils.

It should be noted here that the empirical results of this paper are based on data for a year when there were rapid changes in the Latvian economy: prices increased rapidly, real income (purchasing power) of the households declined sharply, and the economy as a whole suffered widespread shortages of goods and services. By now, significant adjustment of the economy has taken place, and more recent data may generate estimates that are different from those reported in this paper.

APPENDIX A. UTILITY THEORY AND DEMAND FUNCTION

The decision problem facing an individual (person or household as a unit) is the maximization of utility via the optimal choice of a consumption bundle, given prices and income. In the standard neoclassical framework, it is assumed that the preference ordering of an individual agent can be expressed by an utility function. The utility function, U = U(**X**), is assumed to be strictly increasing, strictly quasi-concave and twice continuously differentiable with respect to its arguments (Johnson, Hassan, and Green 1984). The individual decisionmaker has a given income (Y), faces an exogenously given price vector, and has full information about the market. That is, a perfectly competitive market environment is assumed. The objective of the agent is to maximize utility subject to the budget constraint that total expenditure be less than or equal to the given income:

$$P \cdot X = \sum_{i=1}^{n} p_i x_i \leq Y \tag{A.1}$$

where Y is the given income, **P** is the vector of prices, X is the consumption vector, and x_i is the quantity purchased of good i (i = 1, 2, ..., n).

The fundamental problem facing the agent is one of maximizing his/her utility subject to the budget constraint. In other words, the problem is:

$$\begin{aligned} &\text{maximize } U = U(X) \\ &\text{subject to } \sum_{i=1}^{n} p_i x_i \leq Y \end{aligned} \tag{A.2}$$

Under some regularity conditions, the optimization problem may be solved by forming the Lagrangian

$$\Psi = U(X) + \lambda[Y - P \cdot X] \tag{A.3}$$

and then obtaining the Saddlepoint solution to this Lagrangian. The parameter λ in equation (A.3) is the unknown Lagrangian multiplier and has a common interpretation as the marginal utility of income. Assuming an interior solution, the first-order conditions for optimization of equation are:

$$\frac{\partial \psi}{\partial x_i} = \frac{\partial U(X)}{\partial x_i} - \lambda p_i = 0 \qquad \forall_i,\ i = 1, 2, ..., n.$$
$$\frac{\partial \psi}{\partial \lambda} = Y - \sum_{i=1}^{n} p_i x_i = 0 \tag{A.4}$$

where $\frac{\partial U(X)}{\partial x_i}$ is the marginal utility of the i^{th} consumption good. Satisfaction of the second-order condition is guaranteed by our assumptions about the utility function. Given that the second-order condition is always satisfied, we may use the *Implicit Function Theorem* to solve for the endogenous

$$x_i^* = x_i(p_1, p_2, ..., p_n, Y) \qquad \forall_i,\ i = 1, 2, ..., n. \tag{A.5}$$

variables in terms of the exogenous variables:

$$\lambda_i^* = \lambda(p_1, p_2, ..., p_n, Y) \tag{A.6}$$

Furthermore, from our assumptions about the utility function, we can be assured of the uniqueness of the solutions given by (A.5) and (A.6). Equation (A.5) represents the familiar demand function expressing the quantity demanded of a good as a function of prices and income. The demand functions that are derived from the utility maximization problem satisfy certain restrictions (Phlips 1974). These are:

Engel Aggregation: $\sum_{i=1}^{n} p_i \frac{\partial x_i^*}{\partial Y} + Y = \sum_{l=1}^{n} \frac{\partial (p_i x_i)}{\partial Y} = 1.$

Cournot Aggregation: $\sum_{i=1}^{n} p_i \frac{\partial x_i^*}{\partial p_j} = \sum_{i=1}^{n} \frac{\partial (p_i x_i)}{\partial p_j} = -x_j.$

Homogeneity: $\sum_{i=1}^{n} p_j \frac{\partial x_i^*}{\partial p_j} + Y \frac{\partial x_i^*}{\partial Y} = 0.$

Symmetry Condition: $\frac{\partial x_i^*}{\partial p_j} + x_j^* \frac{\partial x_i^*}{\partial Y} = \frac{\partial x_j^*}{\partial p_i} + x_i^* \frac{\partial x_j^*}{\partial Y}.$

Denoting $k_{ij} = \frac{\partial x_i^*}{\partial p_j} + x_j^* \frac{\partial x_i^*}{\partial Y}$, we may write $\sum_{j=1}^{n} k_{ij} p_i = 0, \quad (i = 1, 2, ..., n)$. Furthermore, demand functions satisfy the condition that $k_{ii} < 0$.

The first two restrictions follow directly from the fact that the budget constraint must be satisfied. The third restriction implies *absence of money illusion*. The fourth, and the condition that follows from it, is the well-known *Slutsky-Hicks* equation and is also known as *the fundamental equation of the theory of value*. This set of restrictions is true for any demand system derived from utility maximization. These restrictions, in addition to generating certain testable propositions, greatly reduce the number of parameters to be estimated in empirical work and thus improve the efficiency of the estimates.

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