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The demand for dairy products in Turkey: The impact of household composition on consumption

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Abstract

This study estimates different Engel Curves (in the forms of "Working-Leser", AIDS with unit value, and double-log) for different dairy products in Turkey. The study provides expenditure elasticities for four dairy products (milk, yogurt, cheese and butter). Own-price elasticities are also calculated for cheese and butter. Household composition effects on cheese and milk consumption are determined by the study. Results indicate that addition of an extra person to a household has a negative impact on per capita cheese and milk expenditure. This negative impact increases with age.

1. Introduction

A commonly used food demand projection method is the double-log specification that employs income elasticity and population growth, particularly in developing countries. This method may generate biased food demand projections if population composition and other demand shifters (relative commodity price, urbanization, education, etc.) are also changing rapidly. This is the current trend in Turkey as in many middle income developing countries. On the other hand, intelligent policy design for indirect taxation and subsidies requires knowledge of price and

income elasticities for taxable commodities (Deaton, 1988). This information would normally be obtained through the analysis of time-series data for aggregate demand, prices, and incomes.

Unfortunately, in Turkey as well as in many other developing countries, time-series food disappearance data is not readily available to economists; however, many developing countries regularly collect high-quality household survey data on expenditures and quantities purchased for a wide range of commodities. In principle, these household surveys contain information about the spatial distribution of prices so that, if this information could be recovered in the usable form, there is great potential for estimating the demand responses required for policy making (Deaton, 1988). If unit values, obtained by dividing expenditure by quantity, are adjusted for quality differences, then this data permits the estimation of food demand at disaggregated levels, which is of interest to public policy makers, agribusiness industries, and producer organizations.

In Turkey, the State Institute of Statistics (SIS) conducted large-scale household consumption expenditure surveys in 1979, 1987 and 1994. Unfortunately, SIS did not make the survey results available to users at the individual household level. The published form of the consumption expenditure survey data is aggregated in income percentiles.

This study estimates household dairy product demand at a disaggregated level with household composition variables and quality - adjusted unit values using data from the *1994 Household Consumption Expenditure Survey Results for Selected Province Centers* (SIS, 1997).

2. The model

A form of the Engel curve, which has performed well in the empirical analysis of cross-section data, expresses budget share as a function of the logarithm of income (Young and Hamdok, 1994):

$$W_i = \alpha_i + \beta_i \ln y \qquad (1)$$

where W_i is the budget share of the i^{th} good in income, and y is household income; α_i and β_i are parameters to be estimated. This form, often known as the 'Working-Leser' curve, is consistent with the Almost Ideal Demand System when prices are constant (Chesher and Rees, 1987).

Deaton (1997, 231) and Young and Homdok (1994) introduced household size and household composition by re-defining household income in per capita terms and by re-specifying the intercept term to allow for the influence of household composition as follows:

$$W_i = \alpha_i + \sum_{k=1}^{k-1} \alpha_{ik} \left(\frac{n_k}{n} \right) + \beta_i \ln \left(\frac{y}{n} \right) + \delta_i \ln(n) \qquad (2)$$

where n denotes household size, and three household member type are distinguished (k=1,2, and 3), n_1 is the number of children less than 12 years old, n_2 is the number of teenagers aged between 12 and 17 years, and n_3 is the number of adults aged 18 and over; α_{ik}, β_i and δ_i denote parameters to be estimated. In equation (2), the household composition variables act as explicit demand shifters. Household size (n) enters as a separate explanatory variable (in log form), as well as in per capita income term. This is to ensure that the way in which income affects behaviour is unrestricted (Young and Homdok, 1994). Equation (2) may further be improved by means of introducing a unit value proxy for the price term (it is obtained by dividing expenditure by quantity purchased of the goods):

$$W_i = \alpha_i + \sum_{k=1}^{k-1} \alpha_{ik} \left(\frac{n_k}{n} \right) + \beta_i \ln \left(\frac{y}{n} \right) + \delta_i \ln(n) + \gamma_i P^* \qquad (3)$$

where P* is the unit value of the i^{th} good that needs to be adjusted if the aggregate quantity of the goods is obtained from heterogeneous products.

One problem associated with the model described by equation (3) is that the unit value, obtained by dividing expenditure by the quantity purchased, is not a direct substitute for the actual market price. Unit values not only reflect spatial variation in prices due to the transport cost differentials, they also reflect consumer quality choices in their purchases, and errors in measuring expenditures and quantities (Deaton, 1988). If unit values are used directly in demand estimation, the price elasticities are not standard elasticities of demand. They also reflect quality elasticities of demand (Theil, 1952; Houthakker, 1952; Cramer, 1973; Cox and Wohlgenant, 1986; Deaton, 1987, 1988 and 1990; Nelson, 1991; Park *et al.*, 1996; and Dong *et al.*, 1998).

The causes of cross-sectional price variation must be identified in order to interpret correctly the effects of prices in the analysis of household budget data (Prais and Houthakker, 1955, 110). Polinsky (1977) pointed out that failure to specify cross-sectional price effects adequately could result in biased and misleading demand elasticities. Thus, traditional Engel analysis may be inappropriate if the prices faced by individual consumers are not constant. According to Prais and Houthakker (1955), price variations across regions may be due to price discrimination, services bundled with the commodity, seasonal effects,

and quality differences caused by the heterogeneous commodity aggregate.

The opportunity costs of consumers' time, the marginal cost/benefit of information search, retailing strategies, and brand loyalty may also cause cross-sectional price differences. Among the above factors, quality differences caused by heterogeneous commodity aggregates may be more problematical in the estimation of demand functions (Cox and Wohlgenant, 1986). Quality effects in cross-sectional price variation result mainly from commodity aggregation (Houthakker, 1952). The potential distortion from not adjusting cross-sectional prices for quality effects will increase with heterogeneity of the commodity aggregate (Cramer, 1973).

The simple sum of physical quantities used as the demand in the quality literature is a theoretically arbitrary method of aggregation and is potentially a misleading measure of demand when goods are heterogeneous (Nelson, 1991). According to Nelson, the importance of properly adjusting for quality variation depends on the importance of quality effects in the data under examination.

This study adjusts the unit values in terms of income and household size. The unit values of the aggregated commodities are estimated using the following equation (Cox and Wohlgenant, 1986; Park *et al*., 1996) [1] :

$$P_i^u = \alpha_i + \beta_i y + \delta_i n + \varepsilon, \qquad (4)$$

where P_i^u is unit value of the ith aggregated commodity, y is household income, and n is the household size. It is commonly assumed that the intercept term of the hedonic price function reflects the quantity price. If we assume the average sample price is the intercept term of the hedonic price function, then the adjusted unit value can be obtained from equation (4):

$$P_i^a = \overline{P} + \varepsilon \qquad (5)$$

In equation (5) $\overline{P}$ is the average sample unit value, ε is residual from equation (4)[2], and P^u and P^a unadjusted and adjusted unit values.

Income and Marshallian price elasticities from the estimates of equation (3) are computed using following formulas (Green and Alston, 1991):

Expenditure Elasticity

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1 Deaton (1990) developed a different methodology to estimate food demand systems with cross-section data. This methodology applies cluster techniques to household data.

2 Cowling and Rayner (1970) used the error term of the hedonic price function for estimating the quality-adjusted price in their market share model for tractor brands.

$$\eta_i = 1 + \frac{\beta_i}{W_i} \tag{6}$$

Price Elasticity

$$\varepsilon_i = -1 + \left[(\frac{\gamma_i}{W_i}) - \beta_i \right] \tag{7}$$

As the way in which changes in family composition affect demand is quite complex (the addition of a family member of type j increases *n* as well as n_j), the parameters in (2) are difficult to interpret directly. Rather, for each commodity group, the impact on household expenditure of the addition of a household member of type r to the household, *ceteris paribus*, may be calculated as follows (Chesher, 1991).

$$\Delta W_i = \frac{\alpha_{ik}}{n+1} - \frac{1}{n(n+1)} \sum_{k=1}^{k-1} \alpha_{ik} (n_k / n) - (\beta_i - \delta_i) \ln\left(\frac{n+1}{n} \right) \tag{8}$$

where ΔW_i denotes the change in the budget share of good *i* (or equivalently, the change in expenditure *i* as a proportion of household income). It measures the 'total effect' of a change of household composition, i.e. the combined impact of the 'specific effects' and 'income effect' referred to above (Young and Hamdok, 1994).

An alternative way of presenting this information has been suggested by Deaton (1997, 235). He sets out a procedure for establishing the 'outlay-equivalent' of adding an extra person to the household, i.e., calculating how much the total budget would have to be changed in order to generate the same additional expenditure on good *i* as would the addition of one more person of a given type. Specifically, he defines dimensionless outlay equivalent ratios (π_{ir}):

$$\pi_{ix} = \frac{\partial E_i / \partial n_r}{\partial E_i / \partial y} \frac{n}{y} \tag{9}$$

where E_i denotes expenditure on good *i*; by definition $W_i = \frac{E_i}{y}$. The outlay-equivalent ratios indicate the change in total outlay *y* that would be equivalent to an additional person of type *r*, expressed as a ratio of per capita household income. Thus, for example, *a* value of π_{ir} of 0.2, where *i* denotes milk and n_r number of infants, signifies that the addition of an infant to the household has the same effect on milk consumption as an increase of 20% in household expenditure per person (Young and Hamdok 1994). Given estimates of coefficients, the outlay-equivalent ratios can be calculated:

$$\pi_{ir} = \frac{\alpha_{ir} - \sum_{k} \alpha_{ik}(n_k / n) + (\delta_i - \beta_i)}{\beta_i + W_i} \tag{10}$$

where, by convention, α_{ik} for the last demographic category K is zero.

The formula given by equation (10) can be easily fitted into the equation (3) as follows:

$$\pi_{ir} = \frac{\alpha_{ir} - \sum_{k} \alpha_{ik}(n_k / n) + (\delta_i + \gamma_i - \beta_i)}{\beta_i + W_i} \tag{11}$$

3. Data and estimation

The data for this study was obtained from the 1994 Household Consumption Expenditure Survey Results of the State Institute of Statistics (SIS). SIS provided an electronic copy of the *Household Consumption Expenditure Survey Results for 19 Selected Province Centers* aggregated into five income percentiles. The *1994 Household Consumption Expenditure Survey Results* include both consumption expenditures and quantities purchased for dairy products. The household composition variables used in the model were also provided in the electronic data set at the province and income-percentile level. In this study, expenditures and consumption quantity data are pooled across the 19 provinces and five income percentiles in each province.

Unit value and demand estimation, presented below, are done by OLS with the White correction for heteroskedasticity (Greene, 1997). Heteroskedasticity is a common problem in grouped cross-sectional data. We have inspected and found that the estimated variances were not constant across the sample. Since the source of the variation was not known, White's procedure was used to correct the covariance matrix for heteroskedasticity in our analysis.

4. Results

It is useful to provide some information about dairy consumption in Turkey in order to understand whether the empirical results are reasonable. Table 1 presents some information about dairy product consumption according to the geographic base and income percentile. The dairy consumption data show that per capita dairy product consumption varies across income percentiles and geographic base. As can be seen from Table 1, the data suggest that dairy product

consumption will be positively related to income growth, but it is inversely related to urbanization.

Descriptive statistics of the data used in this study are presented in Table 2. The standard deviations are considerably high for the unit values of cheese and butter. The descriptive statistics also indicate that both per household and per capita dairy product consumption vary across income percentiles and provinces.

Dairy product expenditures account for about 4 % of total income and this share also varies greatly across income percentiles and provinces. The magnitudes of the group expenditure shares show that dairy product expenditures are considerably important in household budgets.

Table 3 presents unit value estimates for cheese and butter. The estimation results for the heteroskedasticity-corrected model show that income and household size are very significant variables in explaining the changes in unit values. Coefficients of the explanatory variables have the correct and expected signs. The quality elasticity of cheese with respect to household expenditures and size are given at the bottom of Table 3. The quality elasticity with respect to income is 0.12 for cheese and 0.07 for butter. This means that households in the high-income percentile purchase more expensive (reflects quality) cheese and butter than those in the low-income percentile. The quality elasticity with respect to household size is also significant and has negative impact on cheese quality. The magnitude of this elasticity is –0.35.

The parameters of the demand model are given in Table 4. It can be seen from the estimated results that the coefficients of the explanatory variables are significant at the 1 or 5 % level. The R^2 of the model is high. In Table 5, the expenditure, price, household size elasticities for the dairy products are presented. Expenditure and own-price elasticities are of expected and reasonable size. The coefficients of the composition variables are also significant. These variables have negative effects on cheese and milk expenditure. The negative effects of the household composition get larger as the group gets older. The impact of household size on expenditure is positive in the yogurt and butter demand equation. But, its impact on expenditure is negative in the milk demand equation.

Table 1
Per capita Annual Dairy Product Consumption (Kg)

	Income Percentile					
	Lower	**Middle Lower**	**Middle**	**Middle Upper**	**Upper**	**Average**
Product						
Urban						
Milk	19.13	21.72	27.94	30.90	33.56	26.65
Yogurt	10.92	12.29	11.32	11.84	11.90	11.65
Cheese	5.11	8.40	7.20	7.96	9.69	7.67
Butter	0.51	0.78	0.82	1.24	1.33	0.94
Other Dairy Product	0.40	0.23	0.06	0.82	0.75	0.45
Rural						
Milk	25.36	27.83	33.55	29.72	32.41	29.78
Yogurt	18.67	20.59	21.76	20.90	21.72	20.73
Cheese	7.63	7.63	8.24	8.76	9.55	8.36
Butter	1.84	2.09	2.63	2.23	2.29	2.22
Other Dairy Product	0.24	0.38	0.11	1.32	3.06	1.02
Turkey						
Milk	22.52	25.84	28.76	30.23	33.57	28.18
Yogurt	15.63	16.66	16.47	15.84	15.15	15.95
Cheese	6.36	7.89	7.51	8.39	9.54	7.94
Butter	1.33	1.54	1.59	1.59	1.68	1.54
Other Dairy Product	0.32	0.55	0.10	1.58	1.38	0.78

Source: Authors' calculation from SIS 1994 Household Consumption Expenditure Data.

The elasticities evaluated at the sample mean are presented in Table 5. All elasticities are in accordance with our expectations in terms of their magnitudes. The size of the income elasticity of yogurt is lower than those of the other dairy products. This may be due to the fact that home production of yogurt is present in large numbers of households in Turkey.

Table 2
Descriptive Statistics for Data

	Average	Standard Deviation	Minimum	Maximum
Unit Value				
-Cheese	64.59	11.36	41.90	95.93
-Milk	10.65	1.98	7.98	16.47
-Yogurt	17.00	6.45	6.98	32.07
-Butter	94.97	16.91	56.94	146.86
Per Capita Consumption (Kg /Year)				
-Cheese	6.95	1.89	1.08	12.43
-Milk	26.18	9.01	6.53	50.34
-Yogurt	10.31	7.49	0.09	47.2
-Butter	1.29	1.32	0.09	6.44
Household Size	4.41	0.676	2.74	6.63
Age Distribution (%)				
0-4	0.093	0.033	0.050	0.296
5-12	0.183	0.032	0.100	0.259
13-17	0.126	0.024	0.071	0.174
18 and +	0.598	0.055	0.545	0.723
Share of Food in Income	0.353	0.143	0.105	0.728
Share of Food in Consumption Expenditure	0.365	0.085	0.171	0.581
Share of Cheese in Income	0.017	0.007	0.003	0.037
Share of Milk in Income	0.010	0.004	0.003	0.020
Share of Yogurt in Income	0.007	0.006	0.00003	0.027
Share of Butter in Income	0.004	0.006	0.00005	0.037

Table 3
Unit Value Estimates

	Cheese	Butter
Constant	79.76	88.45
	(12.79)	(30.59)
Total Household's Income	0.0026	0.0023
	(4.61)	**(2.72)**
Household Size	-5.163	
	(-3.99)	
R^2	0.31	0.08
Adjusted R^2	0.30	0.07
F Statistics	20.90	8.20
Quality Elasticity with Respect to		
Income	**0.12**	**0.07**
Household Size	**-0.35**	

Note: Equation was estimated with White heteroskedasticity correction procedure. In the parenthesis are t values and bold indicates that parameters are significant at 1 % significance level.

Table 4
Household Demand Estimation Results for Dairy Product

Dependent Variables

	*Expenditure Share of			Ln (Per Capita Consumption)
	Cheese	**Milk**	**Yogurt**	**Butter**
Constant	0.079	0.066	0.0017	-5.99
	(5.91)	**(17.25)**	(0.42)	**(-1.93)**
Ln (Income)	-0.0094	-0.0051	-0.0058	0.336
	(-13.25)	**(-11.65)**	**(-7.42)**	**(2.01)**
Ln (Cheese Unit Value)	0.0050			
	(2.03)			
Ln (Butter Unit Value)				-0.78
				(-1.57)
N2 /Household Size	-0.042	-0.045		
	(-2.61)	**(-3.78)**		
(N1) /Household Size	-0.020	-0.017		
	(-2.15)	**(-2.50)**		
(N2+N3)/Household Size				7.14
				(2.85)
Ln (Household Size)		-0.0045	0.0066	1.03
		(-1.92)	**(2.26)**	**(1.14)**
R^2	**0.74**	**0.77**	**0.48**	**0.27**
Adjusted R^2	**0.73**	**0.76**	**0.47**	**0.25**
F	**64.75**	**77.01**	**41.43**	**8.34**

**N1 indicates the number of infants in the household (aged 0-4), N2 indicates the number of children in the household (aged 5-12), N3 indicates the number of teenagers in the household (aged 13-17), and N4 the number of adults in the household (aged 18 and more). *The expenditure shares in the total household income. In the parenthesis are t values and bold indicates that parameters are significant at the 5 or 10 percent significance levels.

Table 5
Elasticities

	Price	**Income**	**Household Size**
Cheese	-0.69	0.42	
Milk		0.50	
Yogurt		0.14	0.97
Butter	-0.78	0.35	1.03

Note: Price elasticity is not calculated for milk and yogurt since the unit value of milk and yogurt is not used in the demand equations. Household size is not used as an explanatory variable in the cheese demand function.

Table 6 presents the impact of household composition on the expenditure on cheese and milk. When a new member is added to the household, that will have a negative impact on both cheese and milk expenditure. This negative impact gets bigger with age. These results suggest that, *ceteris paribus*, as the household composition changes from

children to teenager, cheese and milk expenditure of the household will decline. Of course, one can not expect a decline in all food items since, from standard microeconomic theory, for a given income and price, household needs to re-establish its food bundle to maximize utility.

Table 6

The Change in Budget Share with the Addition of a New Member

	Children	**Teenager**
Cheese	-0.006	-0.010
Milk	-0.003	-0.008

Note: The numbers are calculated using equation (8).

5. Conclusion

This study estimates Engel curves for dairy products with/without adjusted unit values. The hedonic model estimates for unit values are found to be significant for cheese and butter. The study provides income elasticities for cheese, milk, yogurt and butter. Price elasticities are also estimated for cheese and butter. The elasticities provided in this study must be used with caution, because the data employed in the model is aggregated into income percentiles. The Engel curves and hedonic price functions specified in the study can be further improved if SIS provides food expenditure and quantity data set at the individual household level. This individual household level data will make it possible to estimate Engel functions for different household types (two-adult households, households with one or more children etc.), allowing the measurement of the cost of children.

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Özet

Türkiye'de süt ürünleri talebi:
Hanehalkı nüfus yapısının tüketim üzerine etkisi

Bu çalışmada farklı süt ürünleri için farklı modeller tanımlanarak (Working-Leser, AIDS ve Çift-Logaritmik fonksiyon) Engel fonksiyonu tahmin edilmiştir. Çalışmada süt, yoğurt, peynir ve tereyağ için harcama esneklikleri hespalanmıştır. Peynir ve süt için fiyat-talep esneklikleri de tahmin edilmiştir. Çalışmada hanehalkı nüfus yapısının peynir ve süt tüketimi üzerindeki etkisi de belirlenmiştir. Sonuçlar haneye yeni bir birey dahil olduğunda peynir ve süt tüketim harcamasının azalacağını veya negatif etkileneceğini göstermektedir. Bu negatif etki bireyin yaşı ile doğru orantılı olarak artmaktadır.