Factors affecting milk consumption pattern in Southern Anatolian Region: An application of a two-stage econometric model

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Einflussfaktoren des Milchkonsums in Südanatolien: Eine Anwendung des zweistufigen ökonometrischen Modells

1 Introduction

Milk is a rich source of minerals such as calcium, potassium, sodium, phosphor, vitamins, and other nutrients. Milk and its products are important intake for human development in early and late ages. Daily requirement of calcium is about 1200 mg for breasting moms and children while this requirement for adults in general is about 800 mg. The daily calcium intake without milk and its products can not exceed 300 mg (METIN, 2001).

In recent years the popularity of soft drinks rose whereas milk consumption declined in western countries and a significant proportion of US children and especially adolescents fails to meet the recommended level of calcium intake which is primarily source of milk (YEN and LIN, 2002). Daily higher intake of calcium during 1–25 years and early adulthood strengthens peak bone mass and teeth structures and delays the onset of bones fracture as known osteoporosis seen in females later in life (USDHHS, 1988). It has also been cited that the improved dietary intake save in $ 5.1 billion and $ 10.7 billion each year in US in medical care costs and premature deaths associated with osteoporosis-related hip fractures (BAREFIELD, 1996).

Last few decades, a rapid population growth due in fact to irrigation system built in 1994 was observed in Southern Anatolian Region (SAR). A higher population movement of migration took place in Sanliurfa Province where the major irrigation system located in is of importance. The urban population was around 550 thousand in 1990 and this number was estimated to be 840 thousand in 2000 approximately 4.2 % growth rate per year (TURKISH STATE DEPARTMENT OF STATISTICS, 2003). Assuming the accumulated growth rate, the current population may be around one million in the city. A rapid population growth brought

Zusammenfassung

In diesem Beitrag wird eine zweistufige Entscheidungsmodellierung eingesetzt, um die Milchkonsummuster in der Region Südanatolien (SAR) zu schätzen. Die Anwendung der Modelle offenbart, dass ein zweistufiges Cragg-Modell besser für die Fragestellung geeignet ist als ein einstufiges Tobit-Modell, welches von der Annahme ausgeht, dass die Entscheidung Milch und Milchprodukte zu kaufen die gleiche ist, wie die Entscheidung über die konsumierte Menge. Die meisten der demographischen und ökonomischen Faktoren spielen eine wichtige Rolle für die unterschiedlichen Verbrauchsmuster bei Milchprodukten. Individueller Geschmack und Vorlieben bestimmen das Niveau der Milchnachfrage.

Schlagworte: Milchverbrauch, Nachfrageanalyse.

Summary

In this paper, we use a two-stage decision choice modeling to estimate milk consumption demand patterns in Southern Anatolian Region (SAR). The models reveal that a two-stage Cragg model is more appropriate than a single Tobit model which assumes the decision to purchase milk and its products to be the same as the decision for the quantity consumed. Most of demographic and economic factors play important role in milk product consumption pattern. Individual tastes and preferences are pole in determining the level of milk quantity demanded.

Key words: Tobit, cragg, probit, milk consumption, demand analysis.

many changes including a change in lifestyle, a huge number of vendors supplied more differentiated products to consumers, thus a change in tastes and preferences contrary to prices and income and etc. The change in tastes and preferences becomes a pole in determining the product choice as consumers face. To incorporate socio-economic characteristics which are assumed to underpin such preferences into analysis of milk consumption patterns within the region is required micro level data of households.

In this paper we analyze the factors affecting milk consumption pattern in Sanliufa Province as an example for the region using censored demand models. The problem with cross-sectional data set is that the zero consumption on dependent variable occurs due to either sociological reasons or corner solution (e.g., prices and income are such that prevent consumption) or both. In such case, the Tobit and Cragg models are deemed appropriate when facing zero observations on the left hand side.

In the subsequent section, the model will be outlined. In the third section empirical parameter estimates are discussed. The last section outlines the implication and policy recommendations.

2 Materials and methods

2.1 Model

The zero consumption is usually handled using censored or truncated regression models. For instance, the standard Tobit model with its varieties has been widely for the data that are censored. Heckman two-stage, double-hurdle, and infrequency-of-purchase models are of example of Tobit-type models used for censored and truncated data when a single commodity case is present (GOULD, 1992; GOULD, 1996; DEATON and IRISH, 1984; SU and YEN, 2000; SHONKWILER and YEN, 1999; HEIEN and WESSELLS, 1990). PUDNEY (1989) gives an excellent summary of the general framework of the above models. Recently, an extension of the double-hurdle model is used by researchers (DONG et al., 1998; DONG and GOULD, 2000). Box-Cox double-hurdle model has been used for a censored data such as estimating the demand for alcoholic beverages in the U.S. (YEN, 1994). A two-stage estimation technique for a system of equation as an alternative to a two-stage procedure for a single equation has got recently intention of researchers (HEIEN and WESSELLS, 1990; SHONKWILER and YEN, 1999; CHEN and YEN, 2005; YEN, 2005).

For illustration, standard Tobit, and the double-hurdle Cragg models for zero consumption problems are briefly discussed. Latent and observed variables for the i^{th} individual underlying the censored model:

$$y_i = y_i^* \quad \text{if} \quad y_i^* > 0$$
$$y_i = 0 \quad \text{if,} \quad y_i^* \le 0, \tag{1}$$

where y_i is the natural log of the observed quantity demanded of that particular product.

The corresponding latent consumption variable is:

$$y_i^* = x_i\beta + \varepsilon_i, i = 1,\ldots,n, \tag{2}$$

where y_i^* is the corresponding latent milk quantity variable for y_i in natural logarithm, x_i is a vector of exogenous variables responsible for the quantity consumed, β is a vector of unknown confounder parameters to be estimated, and ε_i are random errors, independently and normally distributed with mean zero and a common variance σ^2. This model is known as Tobit model basically applied for estimating the demand for durable goods. The Tobit model is a typical censored normal regression model in which is not observed for the entire sample. The maximum likelihood technique is applied to obtain parameter estimates as:

$$L = \left[\prod_0 \Pr ob\left(y_i^* \le 0\right)\right]\left[\prod_1 \Pr ob\left(y_i^* > 0\right)\right] \tag{3}$$
$$= \left[\prod_0 (1 - F_i)\right]\left[\prod_1 \frac{1}{(2\Pi\sigma^2)^{1/2}} \exp\left(-\frac{1}{2\sigma^2}(y_i - x_i\beta)^2\right)\right]$$

where the first product comprises of observations for which and the second product is formed from observations for which , and the probability of consuming the product, $F_i = \Phi_i = \int_{-\infty}^{(x_i\beta/\sigma)} \frac{1}{(2\Pi)^{1/2}} \exp(-\frac{t^2}{2})dt$. Taking the natural logarithm of the maximum likelihood results in:

$$LogL = \left[\sum_0 \log(1 - F_i)\right] + \left[\sum_1 \log\left(\frac{1}{(2\Pi\sigma^2)^{1/2}}\right) - \sum_1 \frac{1}{2\sigma^2}(y_i - x_i\beta)^2\right] \tag{4}$$

where $\sum_0$ is the summation for individuals without milk consumption, and $\sum_1$ is the summation for individuals with milk consumption. The parameter estimates can be obtained by maximizing equation (4) with respect to β and σ^2 (MADDALA, 1983; GREENE, 2000; 2002; BILGIC, 2001).

A true corner solution occurs when zero expenditure is present. One of the drawbacks of the Tobit model is, how-

ever, that the decision to participate in the milk market and the decision to demand quantity of the product are both the same. The variables and their corresponding estimates that determine the probability of participation in the milk market also determine the quantity demanded of the product. In the general sense, this is not compatible with the market framework (YEN and SU, 1995).

To overcome this strong restriction, the double-hurdle model is used instead (CRAGG, 1971; HAINES et al., 1988; BLISARD and BLAYLOCK, 1993; YEN and SU, 1995), The double-hurdle model assumes two different determinants, one of which is responsible for the probability of the participation in the milk market and the other is responsible for the quantity demanded of the product in question. In the first equation, a binary probability model usually probit or logit determining the decision to participate in the market is used, while in the second equation truncated least squares is used.

Let d_i be the dummy variable for the decision to participate in the milk market and d_i^* be its corresponding latent variable for i^{th} individual. Also let y_i be the true quantity demanded of the milk product for the i^{th} individual and y_i^* be its corresponding latent variable. The two latent variables are thus:

$$d_i^* = X_i\alpha + u_i \qquad (5a)$$

$$y_i^* = X_i\beta + v_i \qquad (5b)$$

where X_i is a vector of independent variables, α and β are conformable parameter estimate vectors, and u_i and v_i are independent random errors with distribution $N(0,1)$ and $N(0,\sigma_i)$, respectively.

The observed positive milk consumption in household relates to the two latent variables and as:

$$\begin{aligned} y_i &= y_i^* \quad \text{if } y_i^* > 0 \text{ and } d_i^* > 0 \\ &= 0 \quad \text{otherwise.} \end{aligned} \qquad (6)$$

The likelihood function for double-hurdle model is then:

$$\log L = \sum_0 \log\left(1 - \Phi\left(\frac{X_i\beta}{\sigma_i}\right)\Phi(X_i\alpha)\right) + \sum_+ \left[-\log\sigma_i + \log\phi\left(\frac{y_i - X_i\beta}{\sigma_i}\right) + \log\Phi(X_i\alpha)\right] \qquad (7)$$

where $\sum_0$ is the summation for individuals without milk consumption, $\sum_+$ is the summation for individuals positive quantity consumption, and ϕ and Φ are the standard normal density function and the cumulative normal distribution function, respectively.

The double-hurdle model reduces to the Tobit model when the probit function (*i.e.,* $d_i^* > 0$) is not used in the first step, and $\Phi(X_i\alpha) = 1$. The Likelihood Ratio test justifies for a selection between the Tobit and its competitor, the double-hurdle model (BILGIC, 2001).

2.2 Data

Primary data were collected during 2003 through a survey of household food consumption behavior. Questionnaires were distributed to 300 households across the Sanliurfa province yielding 197 completed questionnaires. Questionnaires were delivered in person by enumerators to households and collected one week later. **Questions in the survey elicited** weakly consumption of milk and milk products and we asked for demographic and socio-economic characteristics of respondents and their households.

On contrary to the western countries, the Turkish beverages market is changing in the last few decades. This change is due in large part to increasing number of vendors taking place in most of cities and supply more differentiated product opportunities to consumers. The total consumption of milk, yogurt, and cheese per person has changed from 2.4 lt, 1.3 kg, 0.65 kg in 1994 to 2.8lt, 1.54, and 0.43 in 2002, respectively (STATE STATISTICS INSTITUTE, 2004). The major changes are in milk and yogurt despite a decline in cheese consumption.

Table 1 shows the mean values and their standard errors. The weekly mean consumption quantity of milk was considerably higher than that of country's milk consumption level. The consumption of milk per person was also higher than that of country's level. Average milk share expenditure was 6 % obtained as the weekly expenditures spent on milk divided by the weekly total expenditures spent on food. We categorize 6 different income groups as average monthly income per household 1 if is 1–250 million TL, 2 if is 251–500 million TL, 3 if is 501–750 million TL, 4 if is 751–1 billion TL, 5 if is 1–1.5 billion TL and 6 if is above 1.5 billion TL.

Medium and high-income groups are expected to differ from the low-income groups if they behave as units restricted by available budgets. The mean average income groups were between 500- and 751-million TL.

Most of households, 68 %, have at least one kid under age 11. The presence of an additional worker in household is very low. Weekly mean food expenditure was about 73 million TL which could be said that it is above average medium population. We built a health index variable in order to

Table 1: Descriptive Statistics
Tabelle 1: Beschreibende Statistik

Variables	Definition	Unit	Mean	Standart Dev.	Min	Max
Milk	Weekly milk consumption per household	Lt	4.06	3.94	0.00	30.0
Amilk	Average weekly milk consumption per person	Lt	1.07	1.24	0.00	7.00
Amexp	Market share of milk expenditure	%	0.06	0.05	0.00	0.27
Lnprice	Natural log of milk prices		0.03	0.37	-1.79	1.95
Age	Age of head of household	Year	36.63	10.17	18.00	64.00
Gender	If the head of household is female, 0 otherwise	0/1	0.17	0.37	0.00	1.00
Education	head of household's education in years	Year	9.50	4.36	0.00	15.00
Income	Income levels in category	Categorical	2.98	1.44	1.00	6.00
Kids1	1 if the kids under age 11 are present, 0 otherwise	0/1	0.68	0.47	0.00	1.00
Kids2	1 if the kids age 11–20 are present, 0 otherwise	0/1	0.41	0.49	0.00	1.00
Kids3	1 if the kids over age 20 are present, 0 otherwise	0/1	0.20	0.40	0.00	1.00
Mstatus	1 if the head of household is married, 0 otherwise	0/1	0.88	0.32	0.00	1.00
Working	1 if additional working person is present, 0 otherwise	0/1	0.13	0.33	0.00	1.00
Tradesman	1 if the individual is tradesman, 0 otherwise	0/1	0.37	0.48	0.00	1.00
Pmilk	1 if the household purchases packed milk, 0 otherwise	0/1	0.57	0.50	0.00	1.00
Holiday	1 if the individuals views that religuos holidays that affect the weekly milk consumption	0/1	0.43	0.50	0.00	1.00
Hindex	Health index about the knowledge of milk	0/1	2.69	1.17	0.00	4.00
Expend	Food expenditure in Turkish Liras	Million TL	72.96	43.59	10.00	400.00
Beverage	Beverage expenditure in Turkish Liras	Million TL	4.12	6.50	0.00	74.00

measure the nutritional knowledge level of household. The health index variable measures the individual's knowledge about the nutrient content of milk based on 1 if yes he/she is aware of the milk product content, 0 otherwise.

Prices are calculated as weekly expenditure on the product in question divided by the quantity consumed of the particular product in question. Notice that prices are not available if the household did not consume the product. However, to use a record to the estimate quantity equations, observations on all unit prices must be available. This is a common problem with this type of disaggregate data. Often, a simple sample mean of in-sample observations is used as a proxy for the missing data. We attempt to improve on this proxy by using conditional means (predicted values) based on parameters from a preliminary regression using the records with all data are available in conjunction with the corresponding values of explanatory variables for the records with missing data. For this preliminary regression, the natural log of price is the dependent variable, and it is regressed on individual characteristics including income, food and other beverage expenditure variables. Estimated parameters are then used to predict the missing unit prices for those who did not consume that particular product.

3 Results and discussions

The results of estimating the models on the cross sectional data set are given in Table 2. Before proceeding on discussion of parameters, the discriminative selection of the models is of importance. Whether the zero observations to be generated by two processes or by a single process (the Tobit Model) is carried out by using Likelihood Ratio test (LR) as LR=2[Log Likelihood of Probit + Log Likelihood of Truncation – Log Likelihood of Tobit] and distributed with ¯Ç with 18 degrees of freedom for milk. The test reveals that the zero observations are the results of both abstentions and corner solutions for product in question, that is to say in a regular demand framework, prices and income are such that milk is unaffordable as well as social barrier considered. This is true where the majority of population is below poverty line as compared to the medium- and high-income classes. Thus, the individual may decide first to participate in purchasing of the product and then rationalize the quantity demanded of the product based on prices and income. In doing such, we will in turn focus on discussion of the two stage Cragg model parameter estimates and their implications only for the milk product.

Parameter estimates are given in Table 2. Notice that the Cragg model is a combination of two process: whether an individual participates in the activity or not and the quantity demanded of the product consumed given that the individual participated in the activity.

Table 2: Parameter Estimates of Censored Models for Milk Consumption
Tabelle 2: Parameter Schätzungen unterschiedlicher ökonometrischer Modelle für den Milchkonsum

	Tobit Model				Cragg Model	
			Marginal Effects		Probit (1st stage)	Truncation (2nd stage)
Variables	Parameters	Heteroscedasticity	Parameters	Heteroscedasticity	Parameters	Parameters
Individual Characteristics						
Constant	-0.855		-0.815		-2.610	0.167
	(-0.89)		(-0.89)		(-0.56)	(0.34)
Age	0.000		0.000		-0.091	0.031
	(0.01)		(0.01)		(-0.37)	(1.19)
Age-Squared	0.000		0.000		0.002	-0.000
	(0.00)		(0.00)		(0.53)	(-1.41)
Gender	0.374[a]		0.356[a]		-1.708[b]	0.324[a]
	(2.23)		(2.25)		(-1.85)	(3.31)
Education	0.031[a]		0.030[a]		-0.041	0.024[a]
	(2.13)		(2.13)		(-0.59)	(2.56)
Income	0.106[a]		0.102[a]		0.961[a]	0.017
	(2.25)		(2.25)		(3.09)	(0.60)
Kids1	0.190		0.182		0.072	0.056
	(1.18)		(1.17)		(0.11)	(0.56)
Kids2	0.107		0.102		0.168	0.110
	(0.72)		(0.72)		(0.27)	(1.35)
Kids3	-0.159		-0.152		-0.381	-0.046
	(-0.84)		(-0.84)		(-0.43)	(-0.39)
Marital Status	-0.035		-0.034		-0.109	0.102
	(-0.15)		(-0.15)		(-0.12)	(0.83)
Additional Worker	0.300[b]		0.287[b]		0.792	0.168
	(1.74)		(1.74)		(1.16)	(1.44)
Tradesman	0.226[b]		0.216[b]		-0.021	0.233[a]
	(1.65)		(1.66)		(-0.04)	(2.92)
Quality Characteristics						
Pmilk	0.738[a]		0.704[a]		20.005	0.077
	(6.40)		(6.28)		(0.00)	(0.95)
Holiday	0.414[a]		0.395[a]		1.711[a]	0.121[b]
	(3.66)		(3.65)		(3.17)	(1.75)
Hindex	0.091[b]		0.087[b]		0.174	-0.003
	(1.73)		(1.73)		(0.89)	(-0.10)
Lnprice	-1.532[a]	0.165	-1.461[a]	-1.451[a]	-6.399[a]	-0.910[a]
	(-6.55)	(0.67)	(-6.51)	(-6.55)	(-3.77)	(-8.29)
Food Expenditure	0.003[a]	0.001	0.003[a]	0.003[a]	0.007	0.001[b]
	(1.98)	(0.53)	(1.97)	(2.00)	(0.88)	(1.75)
Beverage Expenditure	0.003	-0.032	0.003	0.001	0.057	-0.000
	(0.46)	(-2.72)	(0.46)	(0.15)	(0.98)	(-0.08)
Sigma	0.672[a]					0.387[a]
	(5.69)					(17.38)
Log-likelihood	-187.888				-27.077	-72.796

Note: Values in paranthses are t-statistic values.
[a] significant at the 5 % level, [b] significant at the 10 % level

We first discuss the estimate results obtained from the binary probit model. Among individual characteristics gender and income are only statistically significant variables at 10 and 5 percent levels, respectively. Among quality characteristics we observed holiday and log-price variables are statistically significant at 5 percent levels. Kids under 11 and 20 have insignificant positive effects on the probability of participation in the milk consumption. The probability of participation in the milk consumption is reduced when kids advance in age. This could be true because the milk consumption is believed as kids' consumption by a common belief among people in the country. Packed milk,

health index and food and beverage expenditures increase the probability of participating in the activity but they are also not statistically significant. A plausible finding is that those people knowing the nutrition contents of the milk well are more likely to participate in the milk market than those not having that information at all, as expected.

In the second stage, among individual characteristics the female headed of household who is in charge of regulating weekly food expenditure, income, and being a tradesman are all statistically significant. The nonlinearity of age variables indicates that as the head of household advances in age, the less consumption of the milk results in. A female headed of household significantly consumes more milk than a male headed of the household. As education and income levels increase, households tend to consume more milk. A direct explanation could be that wealthier with high human capital endowment consume more milk than those who are less educated and less income. All kid groups are positively related to the milk consumption level but they are not statistically significant. A plausible explanation is that the milk is a kids' consumption as a common belief in the country and more importantly mothers who stop breast-feeding their babies before the end of normal period usually buy milk, specially packed milk, for baby's feeding. It is really important to capture such pure effect of breast-feeding mothers in the model but unfortunately the survey is lacking data whether any female person suckling a baby is present in the survey time. Another possible explanation might be that vendors conveying the milk consumption may hand out promotions or possibly cereal crispy requires milk as a complement for daily intake.

The presence of an additional worker in the household increases household's milk consumption. This is due in part that an additional worker contributes an extra income which could be devoted to the food expenditures of the family. The household run by a tradesman has a insignificant positive effect on milk consumption. This could be also associated with income variable; the wealthier the person is the more quantity demanded of the milk is. Among quality characteristics, all except packed milk, health index and beverage expenditure variables are statistically significant. Households may easily have an access to purchase the product from nearby market/local stores which mostly have differentiated packed milk abundantly. Holidays (Ramadan month, other religious festivals) variable has a positive impact on milk consumption, as expected and statistically significant at 5 percent level. Healthy index variable has a surprisingly insignificant negative effect on milk consumption. This is a really important factor in the consumption of dietary calcium intake. In such case, those who have the nutrition knowledge of the product demand less than those who have no knowledge about the content of the product. This could somehow be a realistically true that the milk is traditionally viewed as indispensable source of dietary intake irrespective to its nutrient content. As the vendors intrigue intention of people about calcium intake in milk by more advertisements, the milk consumption is likely to increase.

Notice that the log-price variable here captures elasticity in the model. Marginal effect of that variable will be more reliable in explaining own-price elasticity. As 1 % induced in price, the quantity demanded of milk will increase or decrease by 0.96 %. In such case, a change in quantity demanded of milk is less than a change in price. The own price is inelastic indicating the change in the quantity demanded of the milk is not much price responsive. In this case, if vendors would like to generate more revenues, they should increase the milk price because of inelastic price elasticity. An increase in food expenditures increases the quantity demanded of the milk product, while an increase in beverage expenditures decreases the quantity demanded of the milk consumption.

We suspect three variables that could be associated with heteroscedasticity. Food expenditure variable is only statistically significant and ignoring such variable may lead to biased estimates and wrong policy implications.

4 Conclusions

In this paper concern has been put on explaining household behavior to explain non-participation in milk consumption. Given that some potential reasons for not purchasing milk are sociological and economics, the household's decision has been modeled by two-stage Cragg model, which both decisions factors are stemming from the two different data-generating processes: the decision to participate in the milk market and the quantity consumed of the product given that the individual has already participated in the market. The Cragg model which fits best to our data reveals another important point: prices, income and some other sociological reasons are the key in determining the decision to purchase and consume the milk product. In Sanliurfa Province, people tend to separate the decision to participate in the market from the quantity demanded of the product. Thus the factors to participate in the market are different from those affecting the quantity level of the product demanded.

We find that consumption of milk decreases when a child becomes older. This finding suggests great potential in promoting milk consumption by either non-profit organizations or State Healthy Department. Another important policy implication is that a vendor producing milk should spend on advertisement to knowledge households about the importance of the nutritional well being of adolescents and children in general. We found that kids under aged 11 have positive effects on both the decision to consume milk and the quantity demanded of the milk product. This is really important issues in general as vendors supply more product differentiations to consumers the more milk becomes complementary for other goods. For example, cereal products require milk as a necessary supplement for daily intake of kids. Thus, more differentiated products such as cereal products become dense in market the more the need for milk as a complementary product. Since the quantity demanded of the milk product is irresponsive to its own price, suppliers of the product should in general increase the product price to generate more revenues.

This study could be extended to more milk products or among milk differentiated vendor products to capture quality effects of milk where vendors supply to the market.

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Eingelangt am 1. März 2004
Angenommen am 8. Juni 2006