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Estimating Household Expenditure Economies of Scale in Iran

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Abstract:

Households differ from each other concerning size, age, gender and other properties, and it is expected that households with different properties have different consumption patterns. In this study, economies of scale of Iranian households (Mashhad City) were estimated using Engel approach of food consumption and Barten approach for 8 different commodity groups. In Engel approach, economies of scale was equal for all the commodities, so the estimated economies of scale indicator was over estimated. In Barten approach, the indicator estimated more accurately, and it was different for commodity groups. The results showed that food, housing, clothing, transportation and communication have economies of scale. The smallest and the largest of economies of scale were related to food as a private and housing as a public commodities, respectively. Economies of scale for exclusive commodities and miscellaneous commodities were greater than one, and there was diseconomies of scale. Overall economies of scale indicator was equal to 0.79; it showed that 21% of absolute expenditure in larger households could be reduced without changing their standard of living.

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Households differ from each other concerning size, age, gender and other properties, and it is expected that households with different properties have different consumption patterns. In this study, economies of scale of Iranian households (Mashhad City) were estimated using Engel approach of food consumption and Barten approach for 8 different commodity groups. In Engel approach, economies of scale was equal for all the commodities, so the estimated economies of scale indicator was over estimated. In Barten approach, the indicator estimated more accurately, and it was different for commodity groups. The results showed that food, housing, clothing, transportation and communication have economies of scale. The smallest and the largest of economies of scale were related to food as a private and housing as a public commodities, respectively. Economies of scale for exclusive commodities and miscellaneous commodities were greater than one, and there was diseconomies of scale. Overall economies of scale indicator was equal to 0.79; it showed that 21% of absolute expenditure in larger households could be reduced without changing their standard of living.

Keywords: Engel approach, Barten approach, Economies of scale, Private commodities, Public commodities

Introduction

There is a potent negative correlation between household size and per capita consumption in developing countries; it leads to the fact that larger families tend to be poorer. It is misleading to say that household size affects the standards of living. People live in households of different sizes and compositions, and they consume various types of commodities including private and public commodities. Public commodities can be shared among household members where two or more people

would obtain the equal pleasure as a single person consuming the same commodities. Private commodities such as food, clothing and healthcare are awarded to each person in the household (Mok et al, 2011; Horowitz, 2002; Logan, 2007).

The concept of household economies of scale emerged from consumption of public commodities in the household. Doubling the household size, there is no need for two fold increase in the consumption expenditure to maintain the equal standard of living (Deaton and Paxson, 1998; Vernon, 2004). The extra resources from the sharing commodities can be allocated to the consumption of private and public commodities.

Many commodities have some private and some public properties. Clothing can be shared amongst family members (Kakwani and Son 2005). This can be considered a saving for low-income households, so comparing the consumption of different households will not be a good measure of welfare without considering the economies of scale (Mok et al, 2011). Economies of scale can be deliberated a measure of the public or private nature of commodities (Browning et al, 2006).

The economies of scale in consumption are estimated based on two approach: Engel's approach and Barten's approach. The Engel's approach has been widely used in the study of household economies of scale due to its simplicity; this approach has one demand equation and uses food share as welfare indicator for households with different sizes (Deaton and Muellbauer 1980, Lanjouw and Ravallion 1995, Gan and Vernon, 2003).

The Engel's approach assumes that the household economies of scale lead to a larger household with the equal per capita expenditure; thus, smaller households have better welfare status. So, this would yield a lower food share for the larger households. If per capita expenditure is constant, it happens when food expenditure per capita decreases (Engel, 1895; Deaton and Paxson, 1998).

Several studies have been conducted to estimate the economies of scale, such as Benus et al (1976), Lanjouw and Ravallion (1995), Lazear and Michael (1980), Nelson (1988), Gibson (2002), Vernon (2003), Logan (2007), Lanjouw and Ravallion (1995), Kakwani and Son (2005), Parpiev (2011), Parpiev and Yusupov (2011), and Negahdari et al (2014). These researches considered economies of scale using different method and in their studies focused on some different aspects of theoretic, estimated limitations of the approach and the effect of errors in the data used.

Few studies have been conducted to estimate economies of scale indicator in Iran. Most studies have estimated the household size for poverty line using utility function. For example, Negahdari et al (2014) estimated absolute and relative poverty lines based on the economies of scale indicator using Stone-Geary approach for urban households of Iran.

The purpose of this study is to estimate Engel approach and economies of scale of households using Barten approach and Kakwani-Son's hypothesis (2005) for the household of Mashhad city. Survey data of households' expenditure-income was used for 2013 for 405 households in Mashhad city.

Data included monthly household income and consumption expenditure on 8 groups of food, clothing, housing, medicine, transportation, communication, durable commodities and miscellaneous commodities. Moreover, demographic properties of household members including the number of household members, gender, age and education of head of households were deliberated.

Methodology

1-The Engel approach

This method is based on the assumption that the budget share of food is a good indicator of welfare between different households; using this indicator, households with different demographic composition can be compared (Khalaji et al, 2007). Parametric analysis of Engel approach is often based on the approach introduced by Working (1943) who considered a linear relationship between the budget share of exclusive commodities and the logarithm of absolute expenditure. This approach was later extended to include demographic composition of the households. Lanjouw and Ravallion (1995) extended the Engel approach in their estimation of household economies of scale using a Working-Leser approach as follows:

$$w_f = \alpha + \beta \ln(x/n^{1-\sigma}) + \sum_{r=1}^{R-1} \delta_r a_r + \eta \cdot z + u \quad (1)$$

Where w_f is the budget share of food, x defines absolute expenditure, n defines household size, $a_r = n_r/n$ is the proportion of persons in household in r demographic group, z is a vector of the household properties and u is an error term.

Parameters to be estimated are α , β , δ , σ and η (Mok, 2009). σ indicates household economies of scale and is achieved from the ratio of coefficient of logarithm of household size to logarithm of per capita consumption expenditure.

Using Engel approach has various restrictive assumptions: elasticity of household size is independent of the utility, and prices are independent of household size. So, when larger households buy cheaper food through bulk discounts and price elasticity of demand for food is less than unity, Engel approach would underestimate the elasticity of household size. The existence of public commodities creates substitution effects in consumption of private commodities other than food. Thus, households can be exactly compensated in consumption for an increase in household size. Therefore, if utility is constant, increased household size leads to decreased food share. As a result, the size elasticity of welfare would be underestimated. In Engel approach, only one demand equation estimates, so it is widely used because of its simplicity (Gan and Vernon, 2003, Mok et al, 2011).

2-Barten approach

Barten (1964) extended household economies based on utility theoretic approach. Deaton and Paxson (1998) used a similar food share approach to equation (1) with regard to public and private commodities which households consumed. If per capita consumption expenditure was constant, an increase in the household size led to decreased expenditure due to sharing of public commodities, and this released expenditure could be spent on both private and public commodities. Thus, there was a negative substitution effect and a positive income effect on the demand for private commodities such as food. So, food shares would increase with household size because of two reasons: Firstly, as food had fewer substitutions, its own-price elasticity would be lower than the income elasticity in the absolute value. That is right especially in developing countries with lower incomes. Secondly, food had smaller economies of scale than housing as shown in equation (4). Therefore, the food share of budget would increase, assuming that it was a normal commodity. This approach is inconsistent with the Engel's Law which predicts that as household size increases, the food budget share will decrease (Mok, 2009).

Deaton and Paxson extended Barten's approach as follows:

$$w_f = \alpha + \beta \ln(x/n) + \gamma \ln n + \sum_{r=1}^{R-1} \delta_r a_r + \eta \cdot z + u$$

(2)

Where w_f is the budget share of food, x defines absolute expenditure, n defines household size, $a_r = n_r/n$ is the proportion of persons in household in r demographic group based on gender and age, z is a vector of the household properties and u is an error term. Parameters to be estimated are α , β , δ , γ and η (Mok, 2009).

Previous studies estimated the economies of scale for exclusive commodities using the price information (Lazear and Michael 1980, Nelson 1988). If price data is not available, households will be matched with the market prices of commodities. Kakwani-Son showed that it caused a problem due to the complications of matching the commodities between the survey and price data. They rejected this assumption that households faced the equal prices and developed an approach which estimated economies of scale for exclusive and general commodities without using price information.

Kakwani-Son defined economies of scale which stated that an increase in λ percent of all persons in different demographic group must be less than λ percent of income to keep the equal level of utility as before for the i th commodity. The change in budget shares for different commodities depends on household's expenditure and composition. They proved that economies of scale differed across commodities.

Suggested economies of scale for different commodities are achieved from the elasticity of Hicksian demand equations through the Marshallian demand equations; Marshallian demand could be obtained from household survey data. The relationship between the Hicksian and Marshallian demand elasticity is achieved through the Slutsky equation. These economies of scale indicator are written as follows:

$$\phi_i^* = \varepsilon_i \phi^* + \theta_i + \sum_{j=1}^n \theta_j \varepsilon_j \quad (3)$$

Where ϕ_i^* shows economies of scale for the i th commodity, ε_i is the income elasticity, ϕ^* is the overall economies of scale, θ_i is the absolute elasticity of household composition (m) with respect to the number of people in the r th

demographic (α_r) for the i th commodity, θ_j is the absolute elasticity of household composition (m) with respect to the number of people in the r th demographic (α_r) for the j th commodity, ε_{ij} is the Marshallian price elasticity of i th commodity with respect to the price of the j th commodities. If $\phi_i^* < 1$, then the i th commodities creates economies of scale for the household, but if $\phi_i^* = 1$, the i th commodities does not create economies of scale. If $\phi_i^* > 1$, diseconomies of scale exist in consumption. An increase in a_r changes all the prices which have income and substitution effects on household consumption. Next differentiation of the Marshallian demand with respect to a_r gives:

$$\eta_r = \delta_{ir} + \sum_{j=1}^n \varepsilon_j \delta_{jr} \quad (4)$$

Where η_r shows the Marshallian elasticity of demand for the i th commodities with respect to a_r , δ_{ir} is the elasticity of m_i with respect to a_r and δ_{jr} is the elasticity of

m_j with respect to a_r . Thus, $\phi_i = \theta_i + \sum_{j=1}^n \theta_j \varepsilon_j$

(5)

$$\phi_i = \sum_{r=1}^R \eta_{ir}$$

Where

Substitute equation (5) into equation (3) gives:

$$\phi_i^* = \varepsilon_i \phi^* + \phi_i \quad \forall i = 1, \dots, 8 \quad (6)$$

The economies of scale for exclusive commodities (ϕ_i^*) are obtained from the estimation of overall indicator of economies of scale (ϕ^*) and parameters ϕ_i and ε_i . Two latter parameters are estimated from the Marshallian demand equations. If it is shown that commodities is completely private (it has not economies of scale) then, $\phi_i^* = 1$, so it can estimate overall economies of scale (ϕ^*) through equation (6). To estimate ϕ^* , it is necessary to have information about nature of commodities. If such information is not available, the estimation of economies of scale is not possible. If we assume ϕ_i^* that is equal for all commodities, then the overall economies of scale is calculated as follows:

$$\phi^* = \frac{\phi_i}{(1 - \varepsilon_i)} \quad (7)$$

Where ϕ^* is calculated from Marshallian demand equation for each commodities. It is not clear that demand equation of which commodities should be used to estimate ϕ^* . It is possible to estimate ϕ^* from demand equation of each of n commodities, then average of these n estimations is used. Kakwani-Son (2005) suggested that it could be assumed that medicine expenditure had completely private consumption, so ϕ_i^* for medicine expenditure is equal to one. By replacing this value in equation (6) and having values of ε_i and ϕ_i for medicine expenditure, overall economies of scale indicator can be calculated. Then, having this indicator for other commodities, economies of scale indicator can be calculated. In this study, to calculate overall economies of scale indicator, the suggested method of Kakwani-Son (2005) was used.

Kakwani-Son computed the Marshallian elasticity based on the Working-Leser approach called Kakwani-Son expenditure system:

$$w_i = \alpha_i + \beta_i \log x + \sum_{r=1}^R \gamma_{ir} a_r + \mu \quad (8)$$

Where w_i is the budget share of the i th commodities, x is the absolute household expenditure, a_r is the number of individuals with r th properties in the household and μ defines the error term. Equation (8) can be estimated using Zellner's (1963) seemingly unrelated regressions method (Kakwani-Son, 2005). The income elasticity and Marshallian elasticity are, respectively, derived as follows:

$$\varepsilon_i = 1 + \frac{\beta_i}{w_i} \quad (9)$$

$$\eta_{ir} = \frac{\gamma_{ir} a_r}{w_i} \quad (10)$$

where w_i the weighted average value of the budget share is devoted to the i th commodities, and a_r is the weighted average number of people with the r th properties in the household.

In this study following equation was used for estimation of Engel approach:

$$w = \alpha_1 + \alpha_2 \ln hs + \alpha_3 \ln \exp + \alpha_4 m4 + \alpha_5 m9 + \alpha_6 m14 + \alpha_7 m29 + \alpha_8 m54 + \alpha_9 m55 + \alpha_{10} f4 + \alpha_{11} f9 + \alpha_{12} f14 + \alpha_{13} f29 + \alpha_{14} f54 + \alpha_{15} f55$$

(11)

Where w is the budget share of food, $\ln hs$ defines logarithm of the household size, $\ln exp$ defines logarithm of the absolute expenditure, $m4$ is the number of men 0-4 years old in household, $m9$ is the number of men 5-9 years old in household, $m14$ is the number of men 10-14 years old in household, $m29$ is the number of men 15-29 years old in household, $m54$ is the number of men 30-54 years old in household, $m55$ is the number of men above 55 years old in household, $f4$ is the number of women 0-4 years old in household, $f9$ is the number of women 5-9 years old in household, $f14$ is the number of women 10-14 years old in household, $f29$ is the number of women 15-29 years old in household, $f54$ is the number of women 30-54 years old in household, $f55$ is the number of women above 55 years old in household. Then Barten approach and Kakwani-Son's hypothesis (2005) were used for estimation of economies of scale.

Results

Descriptive statistics of variables have been reported in Table (1). The highest share of monthly household expenditure on average 47% was related to food expenditure (inside and outside home). After that, the largest share of monthly household expenditure was related to housing (23%), exclusive commodities (13%) and transportation (5%) respectively. Expenditure on other consumption groups covered 12% of absolute expenditure. The average number of household members was 3.5 people. The average age of head of household was 50.87 years and the average education of head of household was 1.448, indicating head of households on average were middle-aged and they were undereducated. On average, the number of men and women aged 30-54 was higher than that of other age groups.

Table (1): Descriptive Data

<i>Variables</i>	<i>Mean</i>	<i>SD</i>
Food share	0.471	0.214
Housing share	0.231	0.143
Clothing share	0.014	0.032
Transportation share	0.050	0.034
Communication share	0.026	0.015
Medicine share	0.036	0.059
Miscellaneous share	0.015	0.016
exclusive commodities share	0.133	0.188
Ln per capita food expenditure	13.840	1.221

Ln per capita expenditure	16.017	0.957
Household size	3.523	1.635
Ln household size	1.139	0.520
Age of household head	50.874	16.059
Education of household head*	1.448	1.319
Number of men in household	0.509	0.241
Number of women in household	0.482	0.244
Number of men 0-4 years old	0.125	0.374
Number of men 5-9 years old	0.165	0.444
Number of men 10-14 years old	0.145	0.380
Number of men 15-29 years old	0.465	0.681
Number of men 30-54 years old	0.585	0.550
Number of men above 55 years old	0.329	0.481
Number of women 0-4 years old	0.106	0.346
Number of women 5-9 years old	0.113	0.407
Number of women 10-14 years old	0.119	0.346
Number of women 15-29 years old	0.483	0.685
Number of women 30-54 years old	0.584	0.606
Number of women above 55 years old	0.260	0.445
Observations	405	

*Education of household head: 1=undereducated, 2=Middle school, 3=high school, 4=university education

To estimate Engel approach, 2sls approach was used. Hausman test was used to check the endogeneity of logarithm of per capita expenditure; it showed that it was an endogenous variable (see Table A in appendix). Also, Sargan test was used; it showed validation of the instrumental variable (see Table A in appendix). The overall results of the estimate Engel approach were presented in Table (2).

Table (2):Engel approach for food (2sls approach)

<i>Variables</i>	<i>Coefficients</i>	<i>SD</i>
Ln household size	-0.073	0.040
Ln per capita expenditure	-0.289	0.125
R ²	0.572	
Household economies of scale	0.368	

Refer to Table B in the Appendix for detailed estimates.

The above results are based on the assumption that economies of scale are equal for all commodities. Kakwani and Son (2005) showed that economies of scale were not equal for different commodities and different households. Income and Marshallian elasticity of different groups of commodities have been reported in

Table (3), and economies of scale for different groups of commodities have been reported in Table (4) using Kakwani and Son approach (2005).

Table (3): Income and Marshalian elasticity of different groups of commodities

<i>Consumption groups</i>	w_i	ε_i	η_{ir} (<i>men</i>)	η_{ir} (<i>women</i>)
Food	0.471	1.116	0.026	0.075
Housing	0.231	0.831	0.105	0.046
Clothing	0.014	0.928	0.002	0.137
Transportation	0.050	0.7	0.285	0.105
Medicine	0.036	0.972	0.113	0.120
Communication	0.026	0.730	0.137	0.111
exclusive commodities	0.133	1.112	-0.486	-0.594
Miscellaneous	0.015	0.8	0.276	0.160

Income elasticity (ε_i) showed that households in different income level had different consumption behaviors. Results showed that for their households, food and exclusive commodities were luxury commodities and other commodities were considered normal commodities. It can be due to the fact that (food was luxury commodities) in this study, expenditure of food included both inside and outside home expenditure food (expenditure on restaurant and fast food).

Table (4): economies of scale for different groups of commodities

<i>Consumption groups</i>	ϕ_i	ϕ_i^*	$1 - \phi_i^*$
Food	0.101	0.982	0.018
Housing	0.151	0.807	0.193
Clothing	0.139	0.872	0.128
Transportation	0.105	0.943	0.057
Medicine	0.233	1	0
Communication	0.248	0.824	0.176
exclusive commodities	1.08	1.95	-0.95
Miscellaneous	0.436	1.068	-0.068
Overall economies of scale indicator	0.79		

Overall economies of scale indicator were 0.79; it showed that 21% of absolute expenditure could be saved in the larger households of related deciles without impacting their standards of living. Economies of scale were estimated for 8 groups of commodities including food, housing, clothing, transportation, medicine, communication, exclusive commodities and miscellaneous. Results showed that food, housing, clothing, transportation and communication had economies of scale. In other words, 1.8% of food expenditure, 19.3% of housing expenditure, 12.8% of clothing expenditure, 5.7% of transportation expenditure and 17.6% of communication expenditure could be saved for larger households due to economies of scale. The lowest economies of scale were related to food, because food was generally considered private commodities. The highest economies of scale were related to housing which, in most studies, was considered public commodities for households. Economies of scale for exclusive commodities and miscellaneous were greater than one; it showed diseconomies of scale. In other words, as household size increased, consumption expenditure on exclusive commodities and miscellaneous increased too, and there was no economies of scale for these commodities.

These commodities can be considered completely private commodities. An example of these commodities is school bus fares.

Conclusions

People live in households with various sizes and compositions. It seems that larger households have economies of scale in consumption of commodities. Household economies of scale are considered an indicator of effects of properties of households on their consumption pattern. In this study, economies of scale of household was calculated using Engel approach for food and Barten approach for 8 different commodity groups. Results showed that food, housing, clothing, transportation and communication had economies of scale. The smallest economies of scale was related to food as a private commodities and the largest economies of scale was related to housing as a public commodities. Economies of scale for exclusive commodities and miscellaneous commodities was greater than one and there was diseconomies of scale. Overall economies of scale indicator was equal to 0.79; it showed that 21% of absolute expenditure in larger households could decrease without changing their standard of living. Due to economies of scale in using public commodities, a certain level of welfare does not increase as household

size increases, and larger household will have more welfare than smaller household. The results of this study can be used as an adjuster factor in comparing different household consumptions and can prevent problems caused by simplifying assumptions such as per capita income. Also these results can be used in policy-making related to allocation of subsidies for consumption of commodities and can be used in estimation of poverty line studies.

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Appendix

Table A: Instrumental variable test

<i>Test</i>	<i>Statistic</i>	<i>Prob</i>
Hausman	vhat=0.436	0.00
Robustness of instrumental variable	F=13.52	0.00
Validation of instrumental variable (Sargan)	$\chi^2 = 0.362$	0.36

Table B: Estimate of Engel approach

<i>Variable</i>	<i>Statistic</i>	<i>SD</i>
Ln per capita food expenditure	-0.289	0.125
Ln household size	-0.073	0.046

Number of men 0-4 years old	0.037	0.097
Number of men 5-9 years old	0.066	0.099
Number of men 10-14 years old	0.112	0.098
Number of men 15-29 years old	-0.047	0.066
Number of men 30-54 years old	0.063	0.105
Number of men above 55 years old	0.210	0.111
Number of women 0-4 years old	-0.035	0.106
Number of women 5-9 years old	0.047	0.094
Number of women 10-14 years old	0.253	0.106
Number of women 15-29 years old	0.045	0.064
Number of women 30-54 years old	0.034	0.076
Number of women above 55 years old	0.102	0.113
Const	3.477	1.938
R ²	0.572	

Notes: Education of household head variable considered as instrumental variable for logarithm of per capita food expenditure.