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ECONOMIES OF SCALE AND FAMILY FOOD EXPENDITURE PATTERNS IN EGYPT*

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I. INTRODUCTION

The purposes of this paper are (1) to investigate whether economies of scale exist in food expenditure patterns in Egypt, (2) to test for differences in income elasticities across family sizes and between urban and rural regions, and (3) to discuss some areas for future research and the potential importance of such work with respect to the Egyptian food policy system.

Economies of scale in food use exist if per capita consumption of food declines as household size increases; see, e.g., Rockwell (1959). George and King (1971, p. 75) state three reasons why such economies may arise. They are (1) holding household income constant, income per person decreases as family size increases with a higher number of children in such family units with different consumption patterns. This relates to the family composition factor; (2) there may be savings in expenditures per person associated with buying large quantities at lower unit prices; and (3) there may be a reduction in leftover food on a per-capita basis for large family units.

In reference to Egypt, if economies of scale in food use exist, why do they? The reasons why they exist may have important policy implications. If such economies exist because there exist more waste in smaller families, then the rationing system should not encourage this type of behavior by giving smaller families more. If however, they exist because of the family-composition factor then there may not be any justification for changing the present rationing system that distributes, for example, sugar, vegetable oils and rice on a per capita basis. Regardless, there may exist potential improvements in the food distribution policies in Egypt if economies of scale

in food consumption are present without altering any of the major objectives of the system (Abdou, 1979).

With respect to family food expenditure patterns in Egypt, some tests were run in order to determine if food consumption patterns differ across family sizes. In addition, tests were performed to find out if consumers in urban areas have different income elasticities than consumers in rural regions. If these differences exist, then any analysis of food consumption behavior in Egypt needs to take these considerations into account.

The plan of this paper is as follows. First, a description of the model is given. Next a discussion of the hypotheses tests performed is provided. A brief discussion of the data is followed by a report of the empirical results. Finally, some policy implications based on the empirical results are discussed as they relate to food distribution and pricing mechanisms in Egypt.

Economies of scale studies can either use expenditures or quantities consumed as the dependent variable. The use of expenditure data in the present study stems from data limitations on food consumption according to family size.[1] Previous studies (Institute of National Planning (1972)) and Mouselhy (1980) examining the effects of family size on food consumption, used per capita food, per capita total expenditure and average number of individuals in the family under each income category as the dependent and explanatory variables, respectively in an attempt to explain variations in per capita consumption or expenditure for the specific food commodity under investigation. However, no attempts were made to perform tests of hypotheses

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[1]A previous study (Mouselhy, 1980) indicated that quality effects for major food groups in Egypt are insignificant.

concerning the differences in expenditure elasticities across families nor to test for differences between urban and rural areas.

II. THE MODEL AND ESTIMATION METHODS

Expenditures for food consumed were used as dependent variables in estimating the Engel curves while total expenditures were used as the independent variables. The double-log model is given by

$$\ln e_{ih} = a_{oi} + a_{1i} E_h + v_{ih} \qquad (1)$$

where e_{ih} is per capita expenditure on the ith food commodity, E_h is per capita family expenditure and v_{ih} is a disturbance term, a_{oi} and a_{1i} are parameters to be estimated and ln denotes the natural logarithm. The subscript, "h" refers to the sample observation or the hth family unit.

Two equations were fitted using equation (1); one for urban areas and one for rural areas. In addition, equations were run for subsamples involving different family sizes. Four different family sizes or categories were considered: one individual, 2-3 individuals, 4-6 individuals and 7 or more individuals. The disturbance term was assumed to be independently and normally distributed.

Tests of hypotheses were performed to determine if differences in expenditure patterns exist for different family sizes. Also tests of hypotheses were run to find if there exist differences in expenditure elasticities between urban and rural areas. These were run for each family size and food group. Dummy variables were employed in the equations to obtain these tests. That is, the model is

$$\ln e_{ih} = a_{oi} + a_{1i} E_h + a_{2i} D \ln E_h + v_{ih} \qquad (2)$$

where $D = \begin{cases} 1 \text{ for urban areas} \\ 0 \text{ for rural areas.} \end{cases}$

Thirty-two equations were estimated using equation (2) corresponding to eight food groups and four family categories. The coefficient, a_{2i}, represents the difference in expenditure elasticities between urban and rural areas for each food group. Thus, the null hypothesis that there is no difference in expenditure elasticities for a specific food group and given family size between urban and rural areas can be expressed as follows:

$$H_0: a_{2i} = 0$$

while the alternative hypothesis can be expressed as

$$H_1: a_{2i} \neq 0.$$

Cross section data from the Family Budget Survey of 1974/75 (CAPMS, 1977) are used to estimate the models and carry out the hypothesis tests. Data on family expenditure for major food groups and classified according to family size are used. The family income categories--16 categories--range from less than L.E. 50.0 to over L.E. 2000.0 for both urban and rural areas. These data are only available for major food groups. The major food groups considered in this study are grains (and starches), legumes (dry), vegetables (fresh and preserved), fruits (fresh and preserved), meat (including poultry meat), eggs, milk and dairy products, and sugar (and sweets).

III. EMPIRICAL RESULTS

Differences in average per capita family expenditure between consecutive family sizes are reported in Table 1. Economies of scale in food consumption appear to exist; however, few of the t statistics are statistically significant at reasonable significant levels. In urban areas, for example, the average per capita expenditure on grains and starches in families of 2-3 individuals is about L.E. 3.1 less than those for families of one individual; however, its associated t value is only 0.73. The reduction is the largest

Table 1: Differences in Average Per Capita Expenditures Between Family Sizes for Major Food Groups (L.E.)[1/]

Area	Urban			Rural		
Family Size (Individuals)	2-3[2]	4-6	7 and more	2-3[2]	4-6	7 and more
Food Item						
Grains	3.10 (0.73)[3/]	1.71 (1.48)	1.11 (1.09)	10.85 (2.47)	1.81 (0.45)	3.16 (1.81)
Legumes	0.08 (0.39)	0.52 (1.95)	0.28 (1.35)	1.36 (1.60)	0.64 (0.48)	0.71 (1.64)
Vegetables	3.90 (0.94)	1.67 (1.49)	0.97 (1.07)	2.54 (1.20)	1.46 (0.31)	1.24 (1.97)
Fruits	3.34 (0.64)	1.42 (1.22)	0.73 (1.27)	1.17 (0.66)	0.50 (0.80)	0.73 (1.69)
Meat	10.92 (0.53)	4.78 (1.31)	3.33 (1.18)	7.40 (1.16)	3.22 (1.06)	4.20 (1.42)
Eggs	0.67 (0.68)	0.87 (1.36)	0.25 (1.21)	1.40 (1.87)	-0.05 (0.48)	0.38 (1.35)
Milk & Products	4.20 (0.42)	2.33 (1.58)	1.01 (0.81)	1.34 (0.82)	0.67 (0.33)	1.14 (1.71)
Sugar	3.19 (1.33)	0.76 (1.46)	0.67 (1.26)	1.64 (1.47)	0.85 (0.69)	1.18 (1.75)

[1]A positive entry indicates a decrease in average per capita expenditure relative to related expenditure for next smaller family size.

[2]Decrease in average per capita expenditure relative to related expenditure for families of one individual.

[3]Values in parentheses are t ratios. They are calculated using the formula

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S_{x_1 - x_2}} \quad \text{where } S_{x_1 - x_2} = \sqrt{S^2(1/n_1 + 1/n_2)}, \text{ and}$$

$$S^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}.$$

for meat and the smallest for legumes. This result is logical and coincides with the food expenditure patterns in Egypt. In rural areas, the largest reduction in the per capita food expenditure is L.E. 10.85 for grains and starches followed by the meat and poultry-meat expenditure. The smallest reduction is in fruit expenditures.

In future studies, the following model could be used to test for economies of scale:

$$E_i/N = \beta_0 + \beta_1 E/N + \beta_2 N \qquad (3)$$

where E_i/N is per capita expenditure on the ith food commodity, E/N is per capita family expenditure and N is family size, i.e., the number of persons in the household. A negative value for β_2 would indicate that economies of scale in food use exist. Thus, a test for economies of scale would consist of testing the null hypothesis H_0: $\beta_2 = 0$ versus the alternative H_0: $\beta_2 < 0$.

Estimated Expenditure Elasticities

Expenditure elasticities for each family size (four categories) and for each food group (eight groups) both in urban and rural areas are estimated. Engel curves are fitted in doule logarithmic form using the ordinary least squares method. Estimated Engel curves for urban and rural areas are presented in Tables 2 and 3, respectively.

All estimated elasticities are statistically significant at the 0.05 level of significance indicating the importance of per capita total expenditure in explaining variations in the per capita expenditure for major food groups within each family size category. The only exception is for legumes in families of one individual in urban areas. This finding agrees with known consumption and expenditure patterns in Egypt. Single persons

Table 2: Estimated Engel Curves for Major Food Groups According to Family Size in Urban Areas

Food Items	1 Individual				2 - 3 Individuals				4 - 6 Individuals				7 and More Individuals			
	a_0	a_1	t[1]	R^2	a_0	a_1	t	R^2	a_0	a_1	t	R^2	a_0	a_1	t	R^2
Grains	1.57	0.19	4.68	0.65	0.22	0.44	8.00	0.82	1.21	0.23	10.44	0.90	0.84	0.31	10.43	0.91
Legumes	0.72	0.01	0.04[2]	0.00	-1.67	0.49	10.48	0.89	-0.93	0.31	11.37	0.92	-1.27	0.37	4.55	0.65
Vegetables	-0.37	0.47	4.35	0.61	-2.04	0.77	13.30	0.93	-1.66	0.67	13.45	0.94	-2.00	0.75	26.69	0.98
Fruits	-4.13	1.09	17.85	0.96	-4.18	1.11	32.61	0.99	-4.88	1.24	17.49	0.96	-4.71	1.20	19.06	0.98
Meat	-1.95	0.93	22.37	0.98	-2.64	1.07	22.90	0.97	-2.52	1.04	33.52	0.99	-3.14	1.18	19.15	0.97
Eggs	-6.79	1.37	8.74	0.86	-3.55	0.82	6.78	0.77	-6.43	1.36	24.32	0.98	-4.89	1.02	3.75	0.56
Milk & Products	-2.47	0.86	10.30	0.90	-3.15	1.00	5.50	0.98	-3.45	1.03	12.88	0.93	-3.97	1.17	33.27	0.99
Sugar	-1.33	0.58	10.60	0.90	-3.08	0.87	8.70	0.91	-2.18	0.70	35.97	0.99	-2.00	0.65	26.49	0.98

[1]Student-t statistic associated with the expenditure coefficient.

[2]Statistically insignificant at 0.05 level of significance.

Table 3: Estimated Engel Curves for Major Food Groups According to Family Size in Rural Areas

Food Items	1 Individual				2 - 3 Individuals				4 - 6 Individuals				7 and More Individuals			
	a_0	a_1	t^1	R^2	a_0	a_1	t	R^2	a_0	a_1	t	R^2	a_0	a_1	t	R^2
Grains	-0.24	0.67	9.91	0.93	0.82	0.40	11.09	0.91	0.51	0.47	12.44	0.92	0.42	0.49	28.01	0.98
Legumes	-2.42	0.75	3.53	0.64	-2.00	0.62	12.55	0.93	-2.79	0.76	20.34	0.97	-2.49	0.93	8.38	0.84
Vegetables	-1.12	0.62	4.48	0.74	-1.88	0.73	14.48	0.95	-1.72	0.65	12.78	0.93	-2.90	0.92	14.81	0.94
Fruits	-4.86	1.21	10.54	0.94	-5.01	1.24	22.14	0.98	-3.80	0.97	12.06	0.92	-4.93	1.25	19.89	0.97
Meat	-1.87	0.96	14.04	0.96	-2.54	1.07	15.47	0.95	-1.76	0.88	13.27	0.93	-4.02	1.43	9.17	0.87
Eggs	-7.22	1.62	8.66	0.91	-4.85	1.04	6.17	0.76	-3.68	0.84	5.81	0.72	-2.05	0.43	2.19	0.27
Milk & Products	-3.38	0.99	6.34	0.85	-3.24	0.96	17.04	0.96	-2.91	0.89	9.83	0.88	-3.37	1.01	20.88	0.97
Sugar	-3.50	1.03	18.47	0.98	-2.48	0.81	13.16	0.94	-2.46	0.77	10.87	0.90	-4.29	1.22	10.85	0.90

[1]Student-t statistic associated with the expenditure coefficient.

usually consume ready-made broadbeans[2] which constitutes the largest proportion of legumes consumption in Egypt. This major ready-made commodity is not included in the data. Also, the positive signs associated with all estimated expenditure elasticities indicate that consumers view these commodity groups as superior. Grouping food commodities actually hides the result shown by previous studies (e.g., Institute of National Planning, 1972) that some food commodities are considered inferior by Egyptian consumers.

The statistical results show that estimated elasticities differ greatly in magnitude among the different family sizes. Although expenditure elasticities for grains, legumes, vegetables, and sugar are less than one--inelastic--for all family sizes they differ greatly in magnitude. Table 2 shows that expenditure elasticities for subsidized food commodities such as legumes (mainly beans and lentils), and sugar are very low for all family sizes in urban and rural areas. Most of the purchased quantities are obtained through the government rationing system at low prices. The effect of guaranteeing Egyptian consumers fixed quantity each month is reflected ins those low expenditure elasticities. Expenditure elasticities for grains ranges from 0.19 for one individual family to 0.44 for families of 2-3 individuals. Another interesting result reported in Tables 2 and 3 is that all expenditure elasticities for families of one individual are inelastic, except for fruits and eggs.

Estimation of Engel curves in rural areas indicate that expenditure elasticities for grains, legumes, vegetables, and milk and products are

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[2]Fool-medames is the Arabic name.

inelastic for all family sizes (except for families of seven and more individual for milk). The estimated elasticities range from 0.04 to 0.67 for grains, from 0.62 to 0.93 for legumes and vegetables, from 0.97 to 1.25 for fruits, from 0.88 to 1.43 for meat, and from 0.43 to 1.62 for eggs. Also, it is obvious from Tables 2 and 3 that expenditure elasticities differ greatly between urban and rural areas for the same family size. Statistical hypotheses will be tested to determine the significance of these above observed differences.

Testing the difference in expenditure elasticities across family sizes:

As previously discussed, a major objective of this study is to test two main hypotheses. This section discusses the results of the first hypothesis in both urban and rural areas. This hypothesis states that there is no difference in the expenditure patterns for a specific food group across family size categories. An F test (Chow's test) was used twice, once for urban areas and again for rural areas. The estimated Engel curves for urban and rural areas are reported in Table 4, while Table 5 shows the estimated F-values for the above mentioned tests.

The significance of computed F-values indicates the existence of statistically significant differences among expenditure patterns for the different family sizes for all food groups--except fruits and milk in urban and rural areas. Thus, the first null hypothesis is rejected for both urban and rural areas for all food groups except two. These results indicate that the expenditure elasticities for the major food groups reported in Tables 2 and 3 are preferred to those reported in Table 4.

A policy implication, based on these results, is related to the existing government distribution system for semi-rationed and subsidized food such as

Table 4: Estimated Engel Curves for Major Food Groups in Urban and Rural Areas for Family Sizes Combined

Food Items	Urban				Rural			
	a_0	a_1	t[1]	R^2	a_0	a_1	t	R^2
Grains	0.77	0.33	14.28	0.79	0.40	0.50	22.50	0.91
Legumes	-1.04	0.33	6.41	0.43	-2.94	0.81	18.76	0.87
Vegetables	-1.76	0.70	21.21	0.89	-2.29	0.80	21.09	0.90
Fruits	-4.46	1.15	48.48	0.98	-4.51	1.13	31.02	0.95
Meat	-2.56	1.04	47.44	0.98	-2.74	1.11	20.92	0.89
Eggs	-5.12	1.09	14.92	0.80	-3.80	0.88	9.71	0.65
Milk & Products	-3.26	1.00	34.89	0.96	-3.14	0.94	26.32	0.93
Sugar	-2.42	0.76	25.35	0.92	-3.19	0.95	21.51	0.90

[1]Student-t statistic associated with the expenditure coefficient.

Table 5: Estimated "F" Values for Differences Between Expenditure Elasticities for Major Food Groups Across Family Sizes in Urban and Rural Areas[1]

	Urban	Rural
Grains	4.76	8.35
Legumes	10.66	2.77
Vegetables	3.67	7.64
Fruits	1.34	2.44
Meat	2.78	3.98
Eggs	12.87	3.98
Milk	2.44	0.32
Sugar	4.54	4.40

[1]F values were computed using the values of the error sum of squares computed with all the family sizes combined and the sum of the separate error sum of squares associated with individual family size category equations (see, e.g., Johnston, 1972).

lentils and beans. The existence of differences in food consumption patterns across family sizes should be considered more carefully in setting the distribution policies for these commodities in times of shortage. With the existence of significant differences in expenditure elasticities among different family sizes, this distribution policy seems to favor certain family types over others. More research needs to be done regarding these findings.

Testing differences in expenditure elasticities between urban and rural areas:

In this section the second major hypothesis is examined for each food group. The differences in expenditure elasticities for each family size between urban and rural areas are examined. The major results are reported in Table 6. Examining the computed "t" values indicates that there is a significant difference for expenditure elasticities for grains and meat between urban and rural areas for families consisting of one individual. For families of 2-3 individuals the difference is significant for grains, legumes, fruits, milk, and sugar groups. Expenditure elasticities also differ significantly for grains and vegetables for families consisting of seven and more individuals.

The above analysis shows that the expenditure patterns and elasticities seem to be similar for small and large-size families. They differ greatly for medium size families, 4-6 individuals. Also, the results of the above tests indicate that regional differences should be considered together with economies of scale in order to establish sound distribution policies for rationed and semi-rationed food commodities in Egypt.

Table 6: Computed "t" Values for Testing Differences in Expenditure Elasticities Between Urban and Rural Areas for Each Family Size

Food Items	1 Individual	2-3 Individuals	4-6 Individuals	7 and More Individuals
Grains	5.71*	5.03*	5.46*	6.71*
Legumes	2.00	3.51*	1.65	0.06
Vegetables	0.02	0.01	2.35*	2.78*
Fruits	1.06	2.58*	1.00	0.36
Meat	3.83*	1.41	0.36	0.67
Eggs	3.65*	1.14	2.26*	1.64
Milk & Products	1.71	3.45*	0.79	0.69
Sugar	1.07	2.16*	0.69	0.22

*Statistically significant at 0.05 level of significance.

IV. CONCLUSIONS

This study investigated and examined the existence and the effects of economies of scale in food consumption in Egypt. Also differences were tested in the estimated expenditure elasticities for different family sizes between rural and urban areas. Data from the Family Budget Survey of 1974/75 were used. The per capita total annual expenditure and per capita expenditure on eight major food groups were calculated and used for four family sizes (1 person, 2-3 persons, 4-6 persons, and 7 and more persons). Expenditure elasticities were estimated for grains, legumes, vegetables, fruits, milk and products, eggs, meat and poultry-meat, and sugar and products for each family size in both urban and rural areas.

Two major hypotheses were stated and tested. The first stated that there are no differences among the estimated expenditure elasticities for each food group for each family size. The second hypothesis stated that there are no differences among the estimated expenditure elasticities in urban and rural areas for each specified family size. Chow's test or an F-test was ued to examine the first hypothesis. A regression model using a dummy variable to allow for differences in elasticities (slopes) between urban and rural areas was specified and statistically estimated. This model was used to examine the second hypothesis.

The study indicates that statistically significant differences occur in most elasticities among family sizes, and for each family size between the urban and rural areas. Economies of scale in food use may exist; however, the t-tests were not significant. The policy implications of these effects on expenditure elasticities were discussed.

Further research needs to be done in order to obtain a better understanding of food consumption patterns in Egypt. For example, different

functional forms for the Engel curves need to be estimated. Different functional forms imply different properties. Furthermore, different econometric techniques need to be used. For example, accounting for heteroscedasticity of the disturbance terms may result in vastly different parameter estimates. Some of these methods have already been employed for wheat and wheat products in Egypt (Moustafa, et al., 1982). Use of household equivalence scales and a more detailed analysis of the effects over family life-cycles are other areas for further research. But the most important area for future research lies in determining the underlying economic reasons that cause these differences to exist in food consumption patterns in Egypt. Being able to find answers to these questions would have important policy implications in regard to how to improve the present food rationing system.

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