UNIVERSITAT POMPEU FABRA

Economies of Scale, Location, Age, and Sex Discrimination in Household Demand

Antoni Bosch

Economics working paper 2. June 1991

Economies of scale, location, age, and sex discrimination in household demand

Antoni Bosch
Universitat Pompeu Fabra

June 1991

Abstract

Upper limits to household equivalence scales are computed, using data from a survey of more than 23,000 Spanish households, to establish: the existence of economies of location, cost differentials due to age and sex discrimination. The results question the use of some common measurements of income distribution and poverty, and should be taken into account in setting the standards for public welfare payments.

Acknowledgements: This research was carried out at the Instituto Universitario Ortega y Gasset, Madrid. I am grateful to Alvaro Escribano for his help with econometrics and to Javier Ruiz-Castillo for his insightful comments.

1 Introduction and summary

In the literature dealing with household demand, it is frequently mentioned that large households may benefit from economies of scale in consumption. The existence of economies of scale means that as the household size increases, the cost per person of maintaining a certain standard of living decreases. This cost may differ among households due to other factors. Location of the household, as well as sex and age of its members, are obvious candidates. That the cost per person of maintaining a standard of living varies according to changes in these characteristics bears on the determination of the incomes needed by households of various sizes and compositions to reach a certain standard of living. This is also important in the measurement of income distribution and poverty, as well as in setting the standards for public welfare payments. In this context, the notion of equivalence scales arises naturally. These are the scaling factors that allow well-being comparisons among households of different characteristics.

There have been many computations of equivalence scales, but their use has traditionally been limited to taking care of such elements as the cost of children or the magnitude of the economies of scale. In this paper we compute equivalence scales, in order to reveal not only the prevalence of economies of scale, but the existence of economies of rural living, and sex discrimination [see Sen (1984)].

We compute equivalence scales using Engel estimates. The plausibility of Engel estimates of household equivalence scales is based on the empirical evidence Engel (1857)[1] that: a) the food share varies inversely with total expenditure (income) and b) the food share varies directly with the household size. This does not imply that equal food share means "equal material standard of living" as Engel suggested, but it gives some plausibility to the assertion. In fact, it has been proved [see Deaton and Muellbauer (1986)] that, under fairly general conditions, the Engel equivalence scales are too large, i.e., that a change in the vector of characteristics of a household requires a compensation, to restore the food share to its original level, that actually increases the household welfare. This means that what results from these calculations are "upper limits" to the equivalence scales.

Consequently, we do not have a theoretical basis to justify the Engel procedure for computing equivalence scales. But, so far, the theoretical, and empirical, grounding does not seem to be very firm in any other attempt at computing equivalence scales. In fact, in some cases, as when comparing household welfare in per capita terms, a theoretical justification has not even been attempted. Even so, the theorem by Deaton and Muellbauer (1986) mentioned above lends plausibility to our conclusions. These conclusions are that on the basis of the behaviour of Spanish households, we can state: a) the existence of powerful economies of scale; b) the greater importance

[1] The empirical evidence occasionally seems to violate Engel laws, especially the second one. See Thomas (1986). Barrabes et al. (1989) find empirical confirmation of both laws in a subsample of the same Spanish data on which we base our results

of economies of scale in rural areas; c) the sexual discrimination against girls of school age, particularly in small villages and among the poor; d) the lower cost of children: the cost of the first child may have an upper limit at 45% to 75% of the cost of an adult, depending on age and sex[2] while the cost of further children drops very quickly.

Even though it is not known to what extent the Engel estimates of the equivalence scales overstate them, this does not affect our conclusions. Recall that, in the present context, a higher equivalence scale means a smaller differential impact on the household standard of living of the vector of characteristics considered. Consequently, obtaining "upper limits" significantly smaller than one questions the plausibility of the per capita analysis of household expenditure behavior, income distribution and poverty. It also questions poverty alleviation programs that base the allocation of their resources on the per capita income or expenditure. In addition, when applied to the characterization of poverty, it also seems to imply that rural poverty may have been overstated, at least in countries like Spain.

2 Engel estimates of equivalence scales

This method of estimating equivalence scales rests on the assumption that the household well-being (or the welfare of the household head, if decisions are made by him/her, or of each of its adult members in more harmonic settings) is correctly ascertained from the household food share of expenditure. Therefore, the cost of an additional member can be measured by the compensation that would have to be given to the household to restore the previous food share.

Calculation of this measure requires an estimated Engel curve for food. Following Deaton and Muellbauer (1986) we chose an extension of the Working- Leser equation that incorporates a vector of characteristics:

$$w_f = \alpha - \beta + ln\frac{x}{n}\sum_{j=1}^{J}\gamma_j n_j + \epsilon \qquad (1)$$

where w_f is the food share, n_j is the number of persons in category $j(j = 1, ..., J)$, n is the total number of persons in the household, x is total expenditure, α, β, γ are parameters and ϵ is a random error.[3]

The procedure for converting Engel curve estimates into equivalence scales is the following. At some arbitrary food share w_f^0, we compare the budget x^* that would

[2] A far cry from the 80-90% results obtained by Deaton and Case (1988) for Sri Lanka and Indonesia.

[3] Contrary to what is reported by Deaton and Muellbauer (1986), the fit of the equation is not significantly by the inclusion of a term quadratic in $\ln(x/n)$. R^2 varies from 0.3391 to 0.3406.

cause a household to have the same food share as a reference household with budget x^0. The difference $(x^* - x^0)$ is the additional expenditure required for the household to reach the same food share. This is, therefore, the cost associated with the different demographic characteristics of the household. The equivalence scale E is the ratio x^*/x^0. For the specific Engel curve given by (1), x^* is the expenditure required by household h to reach the same level of well-being as the reference household $h = 0$, with x^0 and $n_j^0 (j = 1, ..., J)$.

When the food shares are equal, x^* is defined by

$$\alpha - \beta ln\frac{x^*}{n^h} + \sum_{j=1}^{J} \gamma_j n_j^h = \alpha - \beta ln\frac{x^0}{n^0} + \sum_{j=1}^{J} \gamma_j n_j^0 \tag{2}$$

Rearranging and taking antilogs we find that

$$E^h = \frac{x^*}{x^0} = \frac{n^h}{n^0} \exp\left[\sum_{j=1}^{J} (\frac{\gamma_i}{\beta})(n_j^h - n_j^0)\right] \tag{3}$$

which is evaluated at the mean of food expenditure by the estimates of equation (1) as reported below.

Based on budget data from Spain in 1980-81 [INE (1983)] we obtain one regression equation (3) by OLS for the whole sample of 23,708 households, where number of male children under 6 (n_{cm1}), number of male children between 6 and 18 (n_{cm2}), number of female children under 6 (n_{cf1}), number of female children between 6 and 18 (n_{cf2}) and number of adults (n_a) characterize the demographics of the household.

$$\begin{array}{l} \hat{w}_f = 238.892 - 15.931 ln(x/n) - 3.007 n_{cm1} - 1.315 n_{cm2} - 2.959 n_{cf1} - 1.79 n_{cf2} - 1.147 n_a \\ \qquad (1.81) \quad (0.14) \qquad\quad (0.19) \qquad (0.12) \qquad (0.19) \qquad (0.12) \qquad (0.07) \\ \qquad R^2 = 0.342 \end{array} \tag{4}$$

t-tests indicate that coefficients are different from zero, but som small heteroscedasticity seems to be present.

From equation (3) we obtain the results in Table 1, for a reference household containing two adults. The cost of one child under 6 is 48% of that of an adult, while a child at school age (from 6 to under 18) costs 73% of that of the adult[4]. But the costs of the second or third child are much smaller. With three children under

[4] Actually, what we found is that the cost of the children are 24% and 36% of the cost of the reference household. If our reference household had been composed of one single adult, the cost of the additional child would have been smaller then stated, since we are now comparing the cost of the extra child with the cost of a household in wich some economies of scale are already effective

six, the average cost of one child is only 26% of that of an adult. With three children aged 6 or older, the average cost of one child is only 59% of that of an adult. Similarly, if the number of adults increases above the initial two, the cost of the additional adult is also smaller, as can be observed in Table 1.

These figures are higher, as they should be, than those obtained by Deaton, Ruiz-Castillo and Thomas (1989) using the Rothbarth method [5], at least for the first child. But the cost of an extra child drops very quickly, as can be seen from the figures in brackets in Table 1. In any case, they are much more reasonable than expected by Deaton and Case (1988). It may come as a surprise that the cost of an additional older child appears higher than the cost of an additional adult. This makes sense if additional adults are elderly people, as is often the case in Spain, where extended families frequently live in the same household[6]

In addition, we observe a noticeable sex discrimination against female children of school age when the whole sample is considered (see Table 2)[7]. When we restrict our sample to the "non-poor", the poverty line being defined as 50 per cent of the average per capita expenditure (see Bosch, Escribano and Sánchez (1989)), the discrimination almost disappears for school age children, although some discrimination is apparent regarding younger children. This observation indicates a stronger discrimination against females of school age among the poor. But no significant difference was observed when comparing estimated coefficients in a regression with one dummy variable.

It is frequently reported in the literature on poverty that the probability of being poor increases if the household is located in a rural area. It seemed, therefore, interesting to verify if this result could be biased by the usual assumption of identical cost per person for the same standard of living, irrespective of household location. If we restrict our sample to households located, alternatively, in municipalities of less than 10,000 and above 50,000, we observe a sharp contrast between the estimated cost of children of school age, as appears in Table 3[8] .But more striking is the drop in the cost of an additional adult in small municipalities, a result that appears to be statistically significant comparing coefficient estimates in a regression with two dummy variables. In a society like that of Spain, where households formed by

[5] The cost obtained for children up to 8 years is about 23%. The cost obtained for children from 9 to 13, is about 33%. Notice that our category >5 includes children up to 18 years of age.

[6] For a more complete comparison of different economies of scale, see Buhmann et al (1988). If we express the economies of scale in terms of the equivalence elasticity e, where $\hat{x} = x/s^e$, x being expenditure, $\hat{x}$, "adjusted" expenditure and s size, we obtain for children under 6, elasticities that range from 0.86 for a couple with one child to 0.67 for a couple with four. These elasticities are higher, as expected, than the ones reported in Buhmann et al. This is due, but only in part, to taking a childless couple, not the single adult as our reference which results in having equivalence elasticities of 1 for both household size one and two.

[7] It may be recalled that neither Deaton (1988) nor van der Gaag (1986) seem to observe statistically significant sex discrimination from their samples

[8] Regression estimates of the parameters for these samples are all significantly different from zero and R^2 are .24 and .34 respectively.

extended families are fairly common, this result is not implausible. It implies that estimations based on per capita terms tend to exaggerate poverty in rural areas.

In conclusion, Engel estimates of equivalence scales based on a sample of 23,708 Spanish households lend support to the hypothesis of important economies of scale in household consumption, and give credibility to the assertion that the cost of children and additional adults is well below the costs of one adult. Therefore, they caution against the use of per capita income or expenditure in setting the standards for public welfare benefit payments, and question the policies that ignore the complexities of household composition. More interestingly, the results seem to indicate that ignoring rural or urban living in comparisons of household well-being leads to biased measurements. Finally, by showing sex discrimination against female children between 6 and 18 years of age, these results raise further doubts about the relation between household consumption decisions and individual utility maximization.

Table 1

Cost comparisons with different numbers of children and adults

	Cost of individuals as a proportion of the cost of one adult		Equivalence scales of households with two adults and	
no child			1	
1 child < 6	.48		1.24	(0.015)
1 child > 6	.73		1.36	(0.010)
2 children < 6	.37	**.26**	1.37	(0.032)
2 children > 6	.65	**.58**	1.65	(0.025)
3 children < 6	.28	**.10**	1.42	(0.051)
3 children > 6	.59	**.46**	1.88	(0.043)
1 add.adult	.70		1.35	(0.006)
2 add.adults	.62	**.54**	1.62	(0.014)
3 add.adults	.54	**.38**	1.81	(0.024)

In bold we show the marginal cost, and in brackets the approximate standard errors[a]

[a]The approximate standard errors of the estimates E^h, the equivalence scale of household h, have been obtained after several linearizations. If we call $E^h = g(\overrightarrow{x})$ in (2), we can express approximately the variance of E^h as follows. Var $(E^h) = (\delta g(\overrightarrow{x})/\delta \overrightarrow{x})' cov(\overrightarrow{x}, \overrightarrow{x})(\delta g(\overrightarrow{x})/\delta \overrightarrow{x})$. Recall that the differences between each household, h, and the reference household, $h = 0$, are only in one variable (e.g., households with a child under 6 are equal to the reference household in all other respects). Consequently, $(n_j^h - n_j^0)$ in (2) is zero except for one j. Therefore $\delta g(\overrightarrow{x})/\delta \overrightarrow{x}$ is a vector with zeros everywhere except for one place. This means that the only elements of interest in the matrix $cov(\overrightarrow{x}, \overrightarrow{x})$ are in the diagonal. To approximate these values, recall that the radom variable $x_j = \gamma_j/\beta$, from (2). Following Lindgren (1976) p. 140, we express $x_j = x_{0j} + \mu = \gamma_{0j} + \epsilon_j/\beta_0 + \epsilon_0$ and approximate $var(x_{0j})$ by $(1/\beta_0^2)var(\epsilon_j) + (\gamma_{0j}^2/\beta_0^4)var(\epsilon_0)$.

Table 2

Cost comparisons of male and female children

	Cost of individuals as a proportion of the cost of one adult		Equivalence scales of households with two adults and	
no children			1	
1 child m < 6	.48	**.39**	1.24	(0.015)
1 child f < 6	.49	**.33**	1.24	(0.015)
1 child m > 6	.76	**.71**	1.38	(0.010)
1 child f > 6	.68	**.72**	1.34	(0.010)

In bold we show the results when the sample is restricted to the "non-poor" households, and in brackets the approximate standard errors of the equivalence scales.

Table 3

Cost comparisons according to location

	Cost of individuals as a proportion of the cost of one adult		Equivalence scales of households with two adults and	
Municipality size	< 10.000	> 50.000	< 10.000	> 50.000
no children			1	
1 child < 6	.45	.55	1.23 (0.014)	1.27 (0.013)
1 child > 6	.64	.78	1.32 (0.013)	1.39 (0.009)
1 add. adult	.57	.77	1.28 (0.009)	1.39 (0.005)
2 add. adults	.47	.70	1.47 (0.021)	1.70 (0.011)
3 add. adults	.38	.64	1.57 (0.033)	1.96 (0.019)

References

BARRABES ET AL., 1989, "La pobreza en Avila desde 1973 hasta la actualidad. Las leyes de Engel, Universidad Complutense de Madrid, mimeo.

BOSCH, A. C. ESCRIBANO E I. SÁNCHEZ, 1989, "Evolución de la desigualdad y la pobreza en España" I.N.E., Madrid.

BUHMANN, B., L. RAINWATER, G. SCHMAUS AND T. SMEDING, 1988,

"Equivalence Scales, Well-Being, Inequality, and Poverty: Sensitivity Estimates across ten Countries using the Luxembourg Income Study (LIS) Database", *Review of Income and Wealth,* June, 34, 115–42.

DEATON, A. S., 1988, "The Allocation of Goods within the Household: Adults, Children and Gender", LSMS, Working Paper No. 39, The World Bank, Washington D.C.

DEATON, A. S., AND A. CASE, 1988, "Analysis of Household Expenditures", LSMS, Working Paper No. 28, The World Bank, Washington D.C.

DEATON, A. S., AND J. MUELLBAUER, 1986, "On Measuring Child Costs: With Applications to Poor Countries", *Journal of Political Economy,* vol. 94, num. 4, 720–744.

DEATON, A. S., J. RUIZ-CASTILLO AND D. THOMAS, 1989, "The Influence of Household Composition on Household Expenditure Patterns: Theory and Spanish Evidence", *Journal of Political Economy,* (1989), vol. 97, no. 1, 179–200.

ENGEL, E., 1857, "Die Productions und Compsumptionsverhaltnisse des Konigrechs Sachsen", reprinted as appendix to *Isi Bulletin,* (1895), vol. 9, 1–74.

VAN DER GAAG, J., 1986, "Intrafamily Allocation of Goods and the Cost of Children: Engel versus Rothbarth and Beyond", The World Bank, Development Research Department.

LINDGREN, BERNARD W., 1976, "Statistical Theory", 3rd ed., Macmillan, New York.

SEN, A. K., 1984, "Family and Food: Sex Bias in Poverty", in *Resources, Values and Development,* by

AMARTYA K. SEN, Harvard University Press, Cambridge, Mass.

THOMAS, D., 1986, "The Food Share as a Welfare Measure", Ph. D. Thesis, Princeton University.

RECENT WORKING PAPERS

1. ALBERT MARCET and RAMON MARIMON, *Communication, Commitment and Growth* (June 1991).

2. ANTONI BOSCH, *Economies of Scale, Location, Age, and Sex Discrimination in Household Demand* (June 1991).

3. ALBERT SATORRA, *Asymptotic Robust Inferences in the Analysis of Mean and Covariance Structures* (June 1991).

4. JAVIER ANDRES and JAUME GARCIA, *Wage Determination in the Spanish Industry* (June 1991).

UNIVERSITAT POMPEU FABRA
Balmes, 132
Telephone (93) 484 97 00
Fax (93) 484 97 02
Barcelona 08008