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The Value of Intra-household Survey Data for Age-based Nutritional Targeting

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The design of nutrition interventions can be very susceptible to the level of aggregation of available information.

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Age is a good indicator for identifying at-risk population groups for interventions that focus on prevention rather than cure. But what is the ideal upper age limit for targeting interventions to minimize undernutrition?

Within the framework of upper-limit indicator targeting, Haddad and Kanbur addressed certain questions:

- How far wrong can one go using only household-level data on nutrition?
- How valuable is the extra information one gets from costlier intra-household surveys on nutrition?
- How far wrong can one go by neglecting the intra-household repercussions of nutritional interventions — for example, supplements to a child being nullified by equivalent reductions in food to the child in the home?
- How useful is it to know the caloric reallocation outcome if age is used as a targeting instrument?

Age proved to be a good indicator of undernutrition when researchers had data on individual nutrition and on the intra-household allocation of calories.

Age was *apparently* less useful as a targeting instrument when only household-level data on caloric adequacy were used. The errors in age-based targeting were therefore significant.

Food sharing rendered age *truly* less useful as a targeting instrument because of leakage within the household. Calories targeted to the younger household members end up reaching the older individuals.

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1. INTRODUCTION

Nutritional interventions exist in many developing countries. They are of course to be found as emergency relief programs after disasters or famines, but regular supplementary feeding programs are also widespread. A key question for these programs is targeting. Since resources are limited, some method has to be adopted of making sure that nutritional supplements are given to those who need it most. The most effective method is to evaluate the nutrient shortfall from a given standard for each individual and to supply exactly this amount of supplement and no more. But such fine targeting is not possible on the ground, and practitioners rely on more easily observable indicators. Examples of such methods are levels and trends in anthropometric indicators such as weight-for-height, weight-for-age, and upper arm circumference. However, if the intervention is focussed specifically on prevention rather than cure, age is acknowledged to be one of the better ways of identifying at-risk population groups (Kennedy and Alderman 1986).[1]

Accepting that age may fulfill the role of a useful targeting indicator, this still leaves open the exact nature of its use. In many cases programs use an <u>upper age limit</u> for eligibility (Pfeffermann and Griffin 1989, Beaton and Ghassemi 1982, Timmons et.

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[1] How easy is it to assess an individual's age in cultures not dominated by calendars? Enumerators concerned with accurate age measurements under these circumstances are trained to construct a detailed calendar of local events based on, for example, climatic and crop cycle highlights (UN 1986).

al. 1983).[2] What should this upper age limit be, if the objective is to minimize undernutrition with given resources for the provision of nutritional supplements?

It will be recognized that the above question is part of the general class of indicator targeting problems, as developed by Akerlof (1978). We refer to it as the problem of upper-limit indicator targeting.

The first objective of this paper is thus to develop a framework for upper-limit indicator targeting, and to illustrate it for the case of age-based nutritional interventions using individual level, intra-household survey data from the Philippines. Although the data used provide only an approximation to individual nutritional achievements within the household, most surveys in developing countries do not provide even this information. How far wrong can one go with only household level data on nutrition? The second objective of this paper is therefore to provide a quantitative estimate of the value of the extra information that the costlier intra-household survey provides, when the objective is to design optimally targeted nutritional interventions. There is, however, a recognition in the nutrition literature that such interventions cannot be seen independently of the nature of the intrahousehold nutritional allocation, since a supplement to a child can be nullified by an equivalent reduction in

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[2] Infants in the age range 6-36 months are especially highly targeted as (1) they are vulnerable to undernutrition (low energy density weaning foods for example), and infection (the move from breast feeding to weaning foods, and increased toddler mobility for example) and (2) the functional consequences of poor health are more severe for this age group.

feeding at home (Alderman 1990). The third objective of the paper is therefore to provide a quantitative assessment of how far wrong one goes by neglecting the intrahousehold repercussions of a nutritional intervention. We start, however, with some basic theory on indicator targeting.

2. UPPER-LIMIT INDICATOR TARGETING: THEORY

Let ϕ denote a measure of nutritional adequacy (for example, the calorie adequacy ratio for an individual) and t the age of an individual. Let $f(\phi,t)$ be the joint density of the two variables in the population. If z measures a normatively given "adequate" level for ϕ, (e.g. $z = 1$ for calorie adequacy), then a measure of the extent of undernutrition in the population is given by

$$P_\alpha = \int_0^\infty \int_0^z \left(\frac{z-\phi}{z}\right)^\alpha f(\phi,t)\, d\phi dt \tag{1}$$

It will be recognized that this measure of undernutrition is analogous to the measure of poverty put forward by Foster, Greer, and Thorbecke (1984). Variants of it have been discussed in the context of undernutrition by Kakwani (1989) and Ravallion (1990). This will be the workhorse of our analysis of nutritional targeting—the object of policy will be to reduce the value of P_α as given by (1). The magnitude of α reflects value judgements on the view taken about the depth of undernutrition. When $\alpha = 0$ this depth is ignored and the P_0

essentially measures the fraction of population that is undernourished. When $\alpha = 1$, P_1 is the aggregate nutrition gap, suitably normalized. As α increases above 1, P_α gives greater and greater weight to those with lowest nutritional achievement. Most of our empirical analysis will concentrate on the values $\alpha = 0$, 1 and 2 as capturing this range of value judgements.

Before introducing policy, notice that P_α can be rewritten using the fact that

$$f(\phi,t) = a(\phi|t)\ h(t) \tag{2}$$

where $a(\phi \mid t)$ is the conditional density of ϕ given t and h(t) is the marginal density of t in the population. Using (2), (1) becomes

$$\begin{aligned} P_\alpha &= \int_0^\infty \left[\int_0^z \left(\frac{z-\phi}{z}\right)^\alpha a(\phi|t)\,d\phi\right] h(t)\,dt \\ &= \int_0^\infty P_\alpha(t)\ h(t)\,dt \end{aligned} \tag{3}$$

In other words, total undernutrition is simply the sum of undernutrition at each age level, weighted by the proportion of population at that age level.

We suppose that the policy maker has a total amount of nutritional supplement B to dispense. If each individual ϕ could be observed costlessly the policy program would be easy—simply find those for whom ϕ is less than z and administer the right amount of supplement. But on the ground this is impossible to do and other criteria are used. One such criterion is an upper age limit T such that only those with age less than or equal to T receive the supplement. If there exists a household survey that allows us to estimate the bivariate density $f(\phi,t)$, this could be used to choose the optimal value of T, such that P_α is minimized for the given amount of resources B. But how?

We have to specify how the supplement is distributed to those who meet the criterion. The simplest model, and also the most practicable method, is to distribute the supplement equally among those "let through the door" on the criterion that their age be less than or equal to T. There are H(T) individuals of age less than or equal to T where $H(\cdot)$ is the cumulative distribution of the density $h(\cdot)$. Thus each individual who satisfies the criterion gets an amount B/H(T) and the new level of undernutrition is given by

$$P_\alpha(B,T) = \int_0^T \Big[\int_0^{z-B/H(t)} \left[\frac{z-\phi-B/H(T)}{z}\right]^\alpha a(\phi \mid t)\Big]\, h(t)dt$$
$$+ \int_T^\infty \Big[\int_0^z \left[\frac{z-\phi}{z}\right]^\alpha a(\phi \mid t)\Big] h(t)\, dt \qquad (4)$$

The central question is what happens to P_α (B,T) when T changes for given B. Differentiating (4) with respect to T we get:

$$\frac{dP_\alpha(B,T)}{dT} = \frac{\alpha}{z} \cdot \frac{Bh(T)}{[H(T)]^2} \int_0^T P_{\alpha-1}(B,T \mid t)h(t)dt + [\, P_\alpha(B,T \mid t) - P_\alpha(0,T \mid T)\,]h(t) \tag{5}$$

The two terms on the right hand side of (5) capture the conflicting effects on undernutrition when the upper age limit is increased at the margin, so that more people are drawn into the net. These new people get a supplement so their nutrition improves—this is the second term on the right hand side of (5). But with the new people there is less to go around, and those already in the net lose out. This "infra-marginal" effect is captured by the first term on the right hand side of (5). As shown in Kanbur (1987), the impact of a small decrease in transfer on P_α is proportional to $P_{\alpha-1}$ and this term consists precisely of expressions of this type.

Further insight into (5) can be derived by specializing to the case of $\alpha = 1$. Then (5) becomes

$$\frac{dP_1(B,T)}{dT} = \frac{1}{z} \cdot \frac{Bh(T)}{[H(T)]^2} \int_0^T P_0(B,T \mid t)h(t)dt + [P_1(B,T \mid T) - P_1(0,T \mid T)]h(T) \tag{6}$$

Further manipulation on P_1 (B,T | T) and P_1 (0,T | T) leads to

$$\frac{dP_1\,(B,T)}{dT} = \frac{1}{z}\cdot B\cdot\frac{h(T)}{H(T)}\,[P_0\,(B,T\mid t\leq T) - P_0\,(B,T\mid T)] - h(T)\int_{z-B/H(T)}^{z}\left(\frac{z-\phi}{z}\right)a(\phi\mid T)\,d\phi \qquad (7)$$

From (7), the impact of a change in T on undernutrition as measured by P_1 depends on two factors. First, there is the extent to which the incidence of undernutrition for those with age less than or equal to T exceeds or falls below the incidence of undernutrition for those at age T. Second, there is the extent of original undernutrition of those of age T who stop being undernourished with the intervention. While the second term is somewhat convoluted, the first term is intuitive—it is the difference between the marginal and the infra-marginal incidence of undernutrition for given T.

The optimal value of the age cut-off occurs when (5) is zero. Denote this by T^*. But it can be seen that this leads to a complex equation for T that cannot be solved in closed form. A numerical analysis is required, and we now turn to that in the context of a specific data set.

3. OPTIMAL AGE CUT OFFS FOR NUTRITIONAL TARGETING: AN APPLICATION TO PHILIPPINE DATA

The data set used here comes from a household survey in the Philippines. The data and methods of collection are described fully in Bouis and Haddad (1990). The data contain information on nutrition among 448 households in the southern Philippine province of Bukidnon, collected and averaged over four rounds to account for seasonality and other fluctuations. The distinctive feature of the data is that the food intake of each individual in the household was obtained. The 24-hour recall method was used (for an evaluation of this method, see Bouis and Haddad, 1990). This intake can be converted into calories using standard conversion factors. In addition, we can calculate the calorie requirement for each individual based on 32 age-gender-pregnancy status categories. For this reason, the data are to be viewed as illustrative rather than definitive measures of individual-level nutrient adequacy.[3] The calorie adequacy ratio, the ratio of intake to requirement, is our measure of undernutrition in this application, and we use a calorie adequacy ratio of one as our benchmark (i.e. $z = 1$, in terms of the formulae in the previous section). We will refer to this as a "poverty line", although it is clear that in our application it is an "adequate nutrition line".

The food energy deficit in our sample, namely the sum of the individual difference between intake and requirement, is 1,048,631 calories for the 2880 individuals in the 448 households.[4] As in the previous section, let ϕ be an individual's calorie adequacy ratio. If we did not have individual level data, we would be forced to assign a households calorie adequacy ratio to each individual in that household. Donate this variable by $\hat{\Phi}$. Figure 1 shows that the mean

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[3] For a finer analysis, individual energy requirements would in addition be based on body weight and activity patterns.

[4] All programmes for Tables 1, 2, 4 and Figures 1-7 were written in Microsoft Fortran version 3.1.

of ϕ in an age group increases, by and large, with age, but that the mean of $\hat{\Phi}$, does not. This insensitivity of $\hat{\Phi}$ to age is also brought out by figure 2. Here poverty indices as given by equation (1) are calculated for each age grouping based on ϕ and $\hat{\Phi}$. Again, age is a sensitive predictor of $P_1(\phi)$ but not $P_1(\hat{\Phi})$. This insensitivity of $\hat{\Phi}$ and its transforms drives many of our results in the following section. The sensitivity of ϕ to age may suggest a prima facie case for an upper age limit to calorie supplements through feeding programs and the like. But what is the optimal age cut off?

Figure 3 shows the behavior of $P_{\alpha\phi}$ (B, T) as a function of T for various values of B with α set at 1. The top line is for B = 0, which obviously shows no effect on P_α of changes in T. The lowest line is when B = 1 million calories, just about the amount necessary to eliminate the energy deficit if it could be targeted only to those with deficits. But when this is not possible, the curve shows the best that can be achieved with age-based targeting. As the upper age limit of eligibility increases, from low values of T, undernutrition falls. Thus the marginal effect of bringing more people into the net dominates the infra-marginal effect of spreading resources more thinly over the existing beneficiaries. However, as figure 3 shows, eventually this balance is reversed, and there is an optimal T. We call this our scenario 1.

How does the optimal T, T^*, depend on α and B, the parameters of the problem? Table 1 presents values of the optimal upper age eligibility for various values of α and B and figure 4 plots this surface. It is seen that, by and large, T^* increases in α and in B.

The fact that T^* increases in B is intuitive - when there are more resources, more people can be optimally brought into the net. The fact that T^* increases in α is related to a greater depth of undernutrition at the margin rather than infra-marginally. At lower age eligibilities there are so few who qualify for supplement that those within the net are pushed far above the poverty line, therefore there is no inframarginal undernutrition, and as α increases, undernutrition at the margin is weighed more heavily, and the optimal T is reached at higher ages.

4. THE VALUE OF INTRA-HOUSEHOLD INFORMATION

The analysis of the previous section is based on a survey that collects information on individual nutrition within the household. But most surveys available to planners in developing countries collect food consumption information only at the household level. The usual method of proceeding is then to calculate a measure of household calorie adequacy, and to attribute this to each individual in the household. Intra-household inequality is therefore ignored.

Intra-household information on nutrition is costly to collect and it would be useful to know the benefits from its collection. In particular, how useful is it in targeting? With our data set, we can provide an answer to this question. As before, let ϕ be the true individual calorie adequacy ratio and denote by $\hat{\Phi}$ the individual calorie consumption adequacy ratio when each individual is simply allocated the household's calorie adequacy ratio. Without information on individual intakes, we would be forced to use the bivariate distribution of $\hat{\Phi}$ and t, $\hat{f}(\hat{\Phi}, t)$, to calculate the optimal upper age eligibility. We call this our scenario 2. Denote the optimal value of T as $\hat{T}^*$. Thus all those with age less than $\hat{T}^*$ will get nutrition supplement B/H($\hat{T}^*$). Undernutrition with this supplement is given by expression (4) with $T = \hat{T}^*$.

Figure 5 compares the behavior of $P_{\alpha\phi}(B,T)$ and $P_{\alpha\hat{\phi}}(B,T)$ as a function of T for 2 values of B at $\alpha = 1$. It is clear that T^* and $\hat{T}^*$ can be very different. In general, the $P_{\alpha\hat{\phi}}$ curves are flatter and lower than the $P_{\alpha\phi}$ curves. Intuitively, the flatness is a reflection of the flatness of the $\hat{\Phi}$ and $P_{\alpha\hat{\phi}}$ lines evaluated within each age group (see figures 1 and 2). The suppression of intrahousehold inequality as represented by $\hat{\Phi}$ results in age being a much poorer correlate with observed undernutrition and hence a poorer targeting instrument. The marginal undernutrition reduction effect dominates the inframarginal effect until much higher levels of T are reached. In addition, the lowness of the $P_{\alpha\hat{\phi}}$ curve reflects the shallowness of observed poverty, at all age groups, once intrahousehold inequality is suppressed.

The difference between $P_{\alpha\phi}$ (B,T^*) and $P_{\alpha\phi}$ $(B, \hat{T}^*)$ is the difference in undernutrition when the wrong information is used. A measure of this difference in calorie terms can be derived as follows. If B_e is the solution of the following equation:

$$P_{\alpha\phi}(B,T^*) = P_{\alpha\phi}(B_e,\hat{T}^*),$$

the difference between B_e and B represents the *extra* calories (or equivalent gain[5])that would be needed to achieve the same level of undernutrition reduction with the 'wrong' age cutoff, $\hat{T}^*$, as was achieved with the correct age cutoff, T^*. Table 2 presents equivalent gains for various values of B and α. The costs to not having accurate individual level calorie adequacy information upon which to identify T^*, when expressed as percentages of the original interventions, can exceed 30%. The calorie costs are substantial precisely because actual calorie adequacy *is* strongly associated with age, and suppression of intrahousehold calorie information deprives us of a useful targeting instrument.

5. INTRA-HOUSEHOLD ALLOCATION, LEAKAGE AND THE IMPLICATIONS FOR TARGETING

The analysis so far has assumed zero sharing of the calorie intervention that the eligible individual brings into the household. Either because the intervention is divided within the household, or through reductions in non-intervention calorie intake of the eligible member, it is highly unlikely that intervention calories add, one-for one, to the total calories consumed by the eligible individual. What are the implications for the age-based targeting of calorie leakage from the eligible individual to his or her fellow household members? Does it still make sense? In general, this depends on the extent to which there is intrahousehold calorie allocation away from the

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[5] For a related use of the equivalent gain concept, see Ravallion (1989).

targeted group (TG), i.e. children. These tradeoffs are represented in Table 3.

Case numbers 4 and 3 represent scenarios 1 and 2 respectively, and case 8 represents the third scenario, food sharing. If within-household food sharing is substantial but intrahousehold food allocations are skewed away from those with the lowest calorie adequacies, age-based targeting is not feasible. Calories directed to the younger household members end up in the hands of the older individuals.

Specifically, our data set allows us to provide an answer to the question 'how useful is it to know the calorie reallocation outcome if age is used as a targeting instrument?'. As before, let ϕ be the true calorie adequacy ratio, and let each eligible individual receive B/H(T) calories. Now, however, the individual <u>shares</u> the calories with the other household members. The arbitrary rule imposed here is that the ith individual's pre-intervention <u>share</u> of household calories, w_i, is unaffected by the intervention.[6] Thus the ith individual in the household receives $(B/H(T)).w_i$ calories. The upper age eligibility at which undernutrition in the entire sample is minimized is denoted by T_c^*. Figure 6 shows the behavior of $P_{\alpha\phi c}(B,T)$ as a function of T for various values of B with α set at 1. As with previous figures, the marginal/inframarginal relationship exists although it is not as smooth. In the previous scenarios individuals

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[6] This rule can be justified, however, by reference to certain principles of bargaining theory; see Selten (1978). For an analysis of intra-household bargaining over nutritional and other resources, see Haddad and Kanbur (1990b).

could only receive less calories as the net widened. In this scenario, however, individuals already in the intervention can receive <u>more</u> calories as the eligibility age is increased (if, for example, their households contain two children quite close in age). Thus $P_{\alpha\phi_c}(B,T)$, the undernutrition index, can go up and then down.

Figure 7 compares the behavior of $P_{\alpha\phi}(B,T)$, $P_{\alpha\hat{\phi}}(B,T)$ and $P_{\alpha\phi_c}(B,T)$ as a function of T at B=1 and $\alpha=1$. It is clear that T^*_c can be very different from T^* and $\hat{T}^*$. When the three functions are compared on the same vertical scale, we can see that $P_{\alpha\phi_c}(B,T)$ is the flattest and lowest of the three lines.

The <u>flatness</u> is because the original sampling design required each rural household in the Philippines survey contain at least one preschooler. Each household immediately receives calories even when the upper age eligibility is only 2. Therefore age is only a good targeting instrument if poor households contain more young children and intrahousehold allocations are not skewed away from them. The same analysis with a more demographically representative sample containing older, richer households with no children would produce a more curved $P_{\alpha\phi_c}(B,T)$.

The <u>low position</u> of the line results from (1) the objective function we have chosen to minimize: undernutrition across <u>all</u> individuals in the sample, and (2) the large absolute calorie interventions that are reaching adults who are close to the poverty line compared to smaller calorie interventions reaching children who are far below the poverty line. If we had placed larger weights in the objective function on the alleviation of infant undernutrition, the curve would be higher.

The difference between $P_{\alpha\phi c}(B,T^*_c)$ and $P_{\alpha\phi c}(B,T^*)$ is the cost in foregone undernutrition-reduction when no food sharing is assumed in the calculation of upper age eligibility, even though food sharing does indeed take place. Again, if B_e is the solution of the following equation:

$$P_{\alpha\phi c}(B,T^*_c) = P_{\alpha\phi c}(B_e,T^*),$$

the difference between B_e and B is a measure of the cost of making the wrong assumption on food sharing. Table 4 presents equivalent gains for various values of B and α. As can be seen, this cost is virtually zero since age is no longer closely associated with the delivery of calories to those who need them most.

6. CONCLUSION

The object of this paper has been, first to develop a framework for upper-limit indicator targeting, and to illustrate it for age based targeting of nutrition interventions using data from the Philippines. Second, we have provided quantitative estimates of the value of individual level information and of knowledge of the intra-household allocation of calories. For our sample, age proved to be a good indicator of undernutrition. However, this proved not to be the case with household level calorie adequacy which rendered age *apparently* less useful as a targeting instrument, at an often considerable calorie cost. Food sharing, on the other hand, truly rendered age impotent as a targeting instrument because of within-household leakage. This effect was strengthened because each household contained at least one preschooler. Therefore, getting the age "wrong" here had few consequences in terms of calorie foregone.

We conclude that the design of nutrition interventions can be very susceptible to the level of aggregation of available information. This is consistent with our findings in Haddad and Kanbur (1990a), that while poverty or undernutrition rankings of groups defined on household level characteristics were not sensitive to the level of aggregation, the rankings of groups defined on individual characteristics were very sensitive. Possibly the costs of collection of these intra-household data outweigh the benefits, but the experiments in this paper begin to answer questions about the costs of not collecting them.

Figure 1: Mean calorie adequacy within each age group for ø and øhat

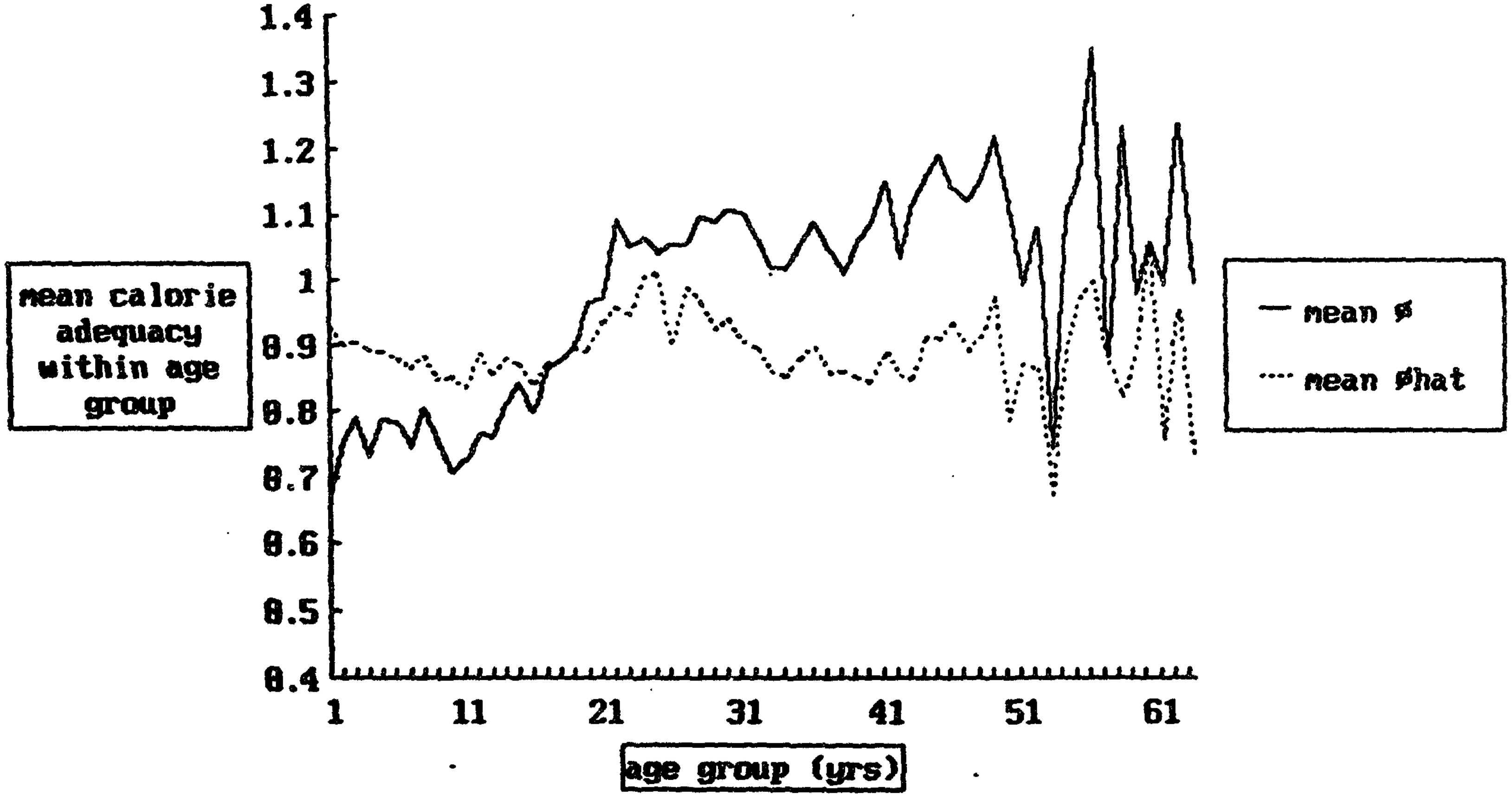

Figure 2: Poverty indices within each age group for ø and øhat

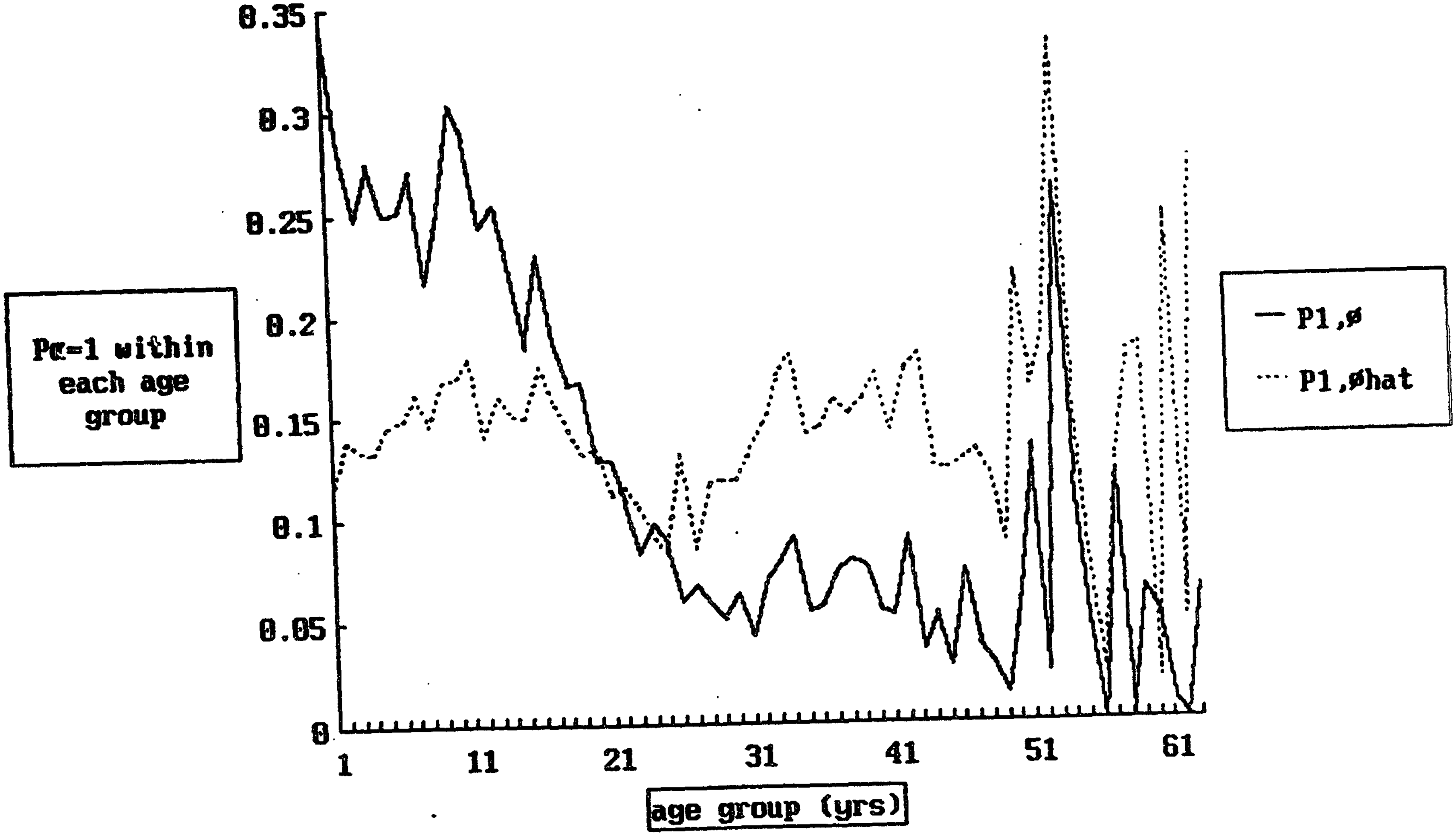

Figure 3: Undernutrition levels, $\alpha=1$, for different upper age cutoffs and calorie interventions (B=millions of calories)

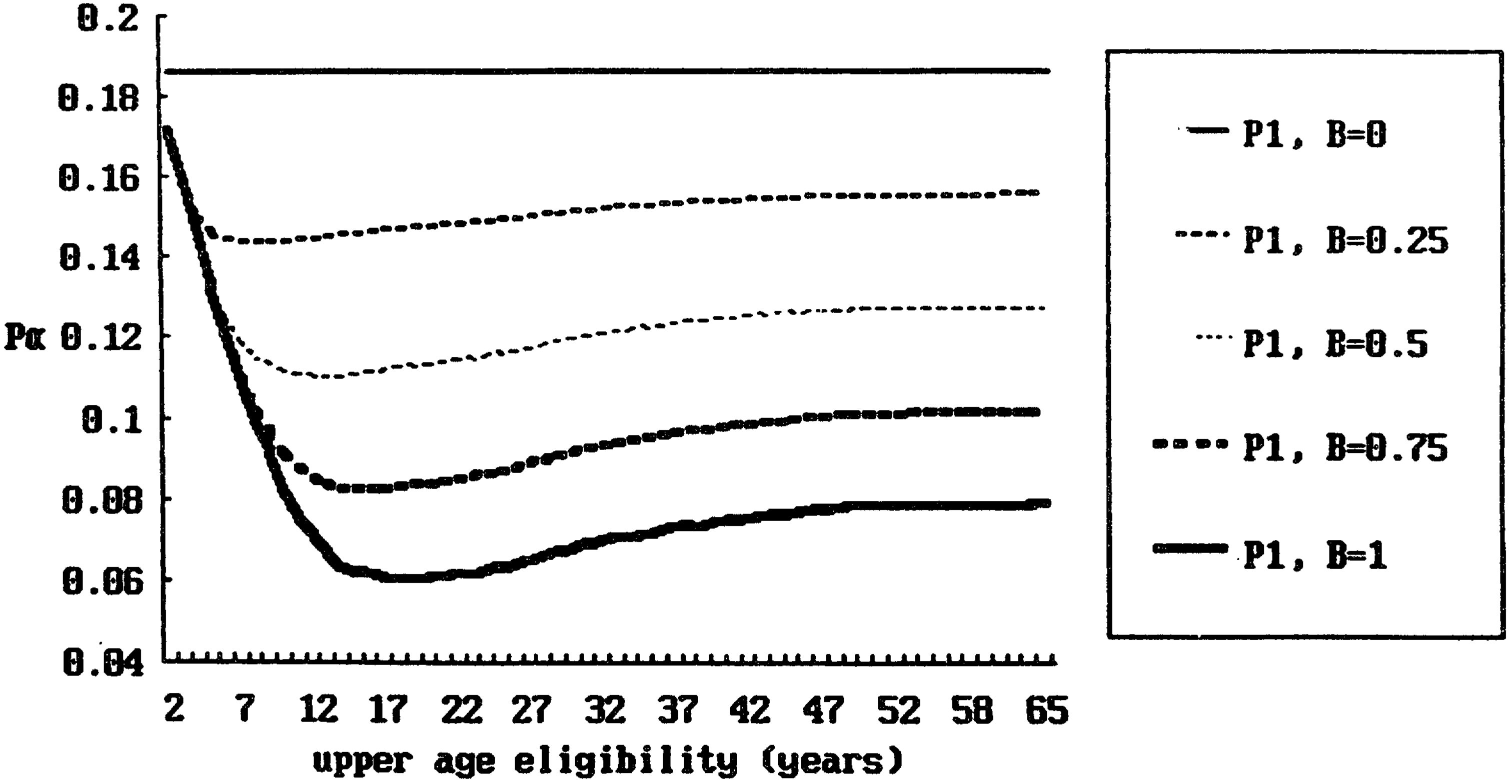

Figure 4: Surfaces of undernutrition-minimizing upper age eligibilities for different calorie interventions at different sensitivies to undernutrition

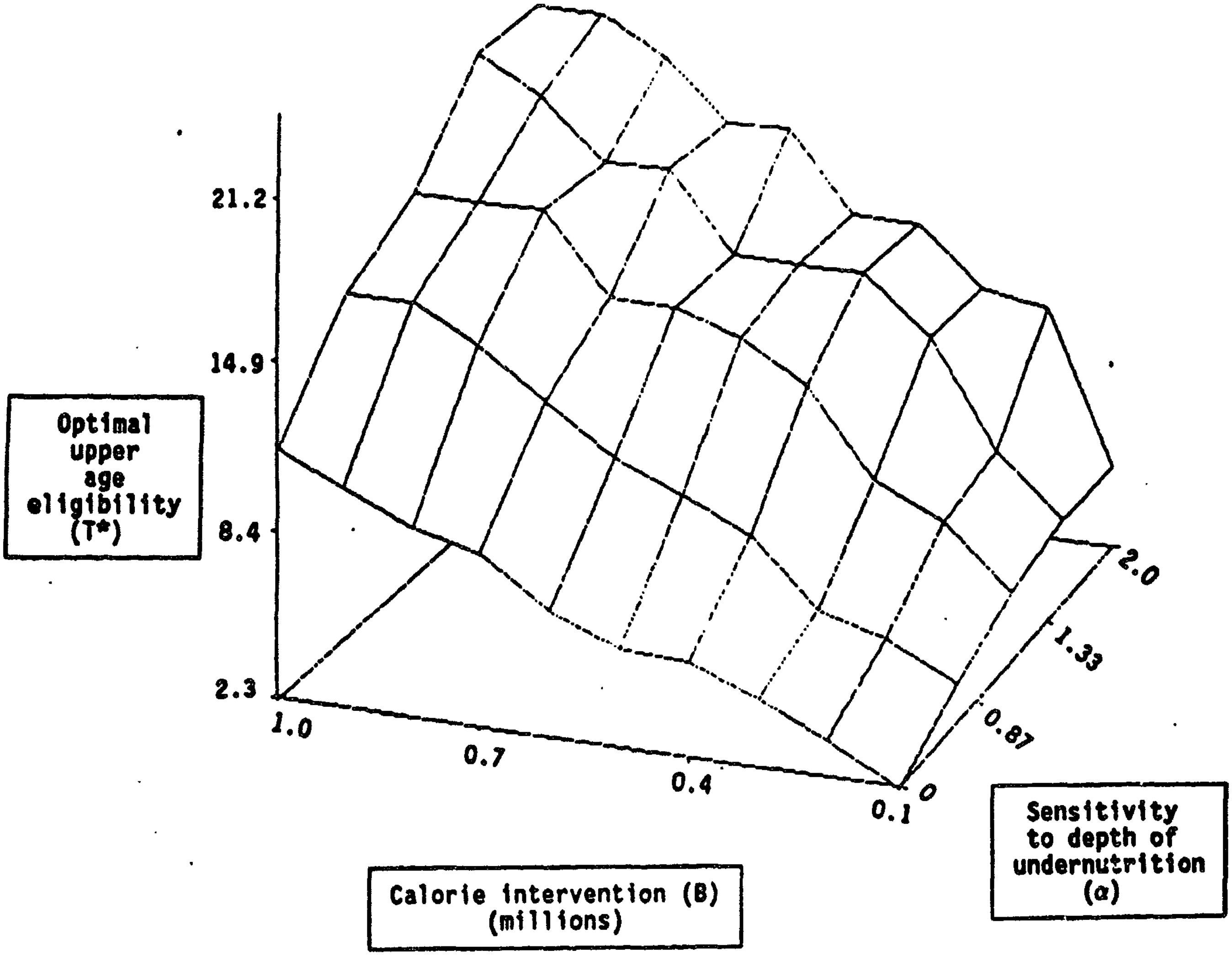

Figure 5: Undernutrition, α=1, individual (ø) versus household (øhat) level data

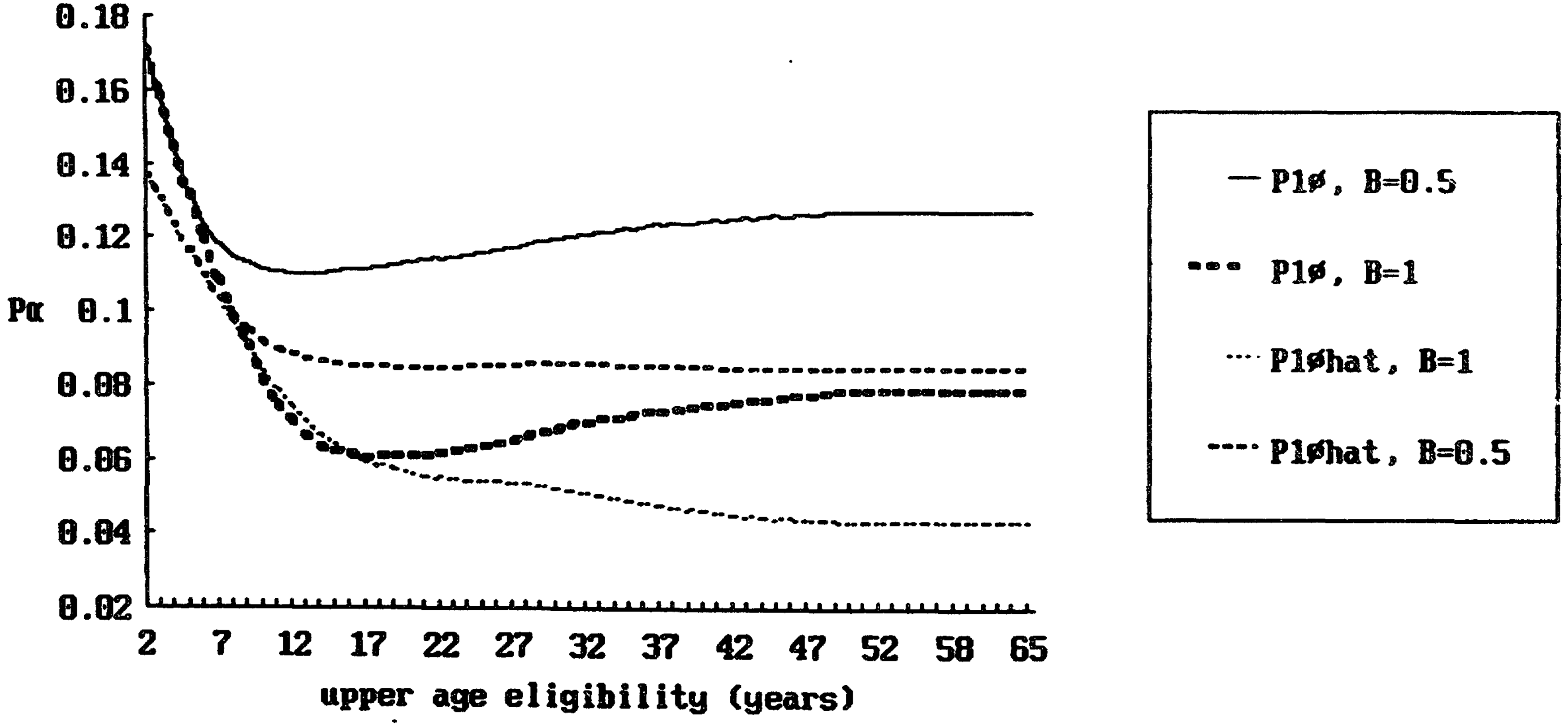

Figure 6: Undernutrition, α=2: intra-household calorie shares maintained

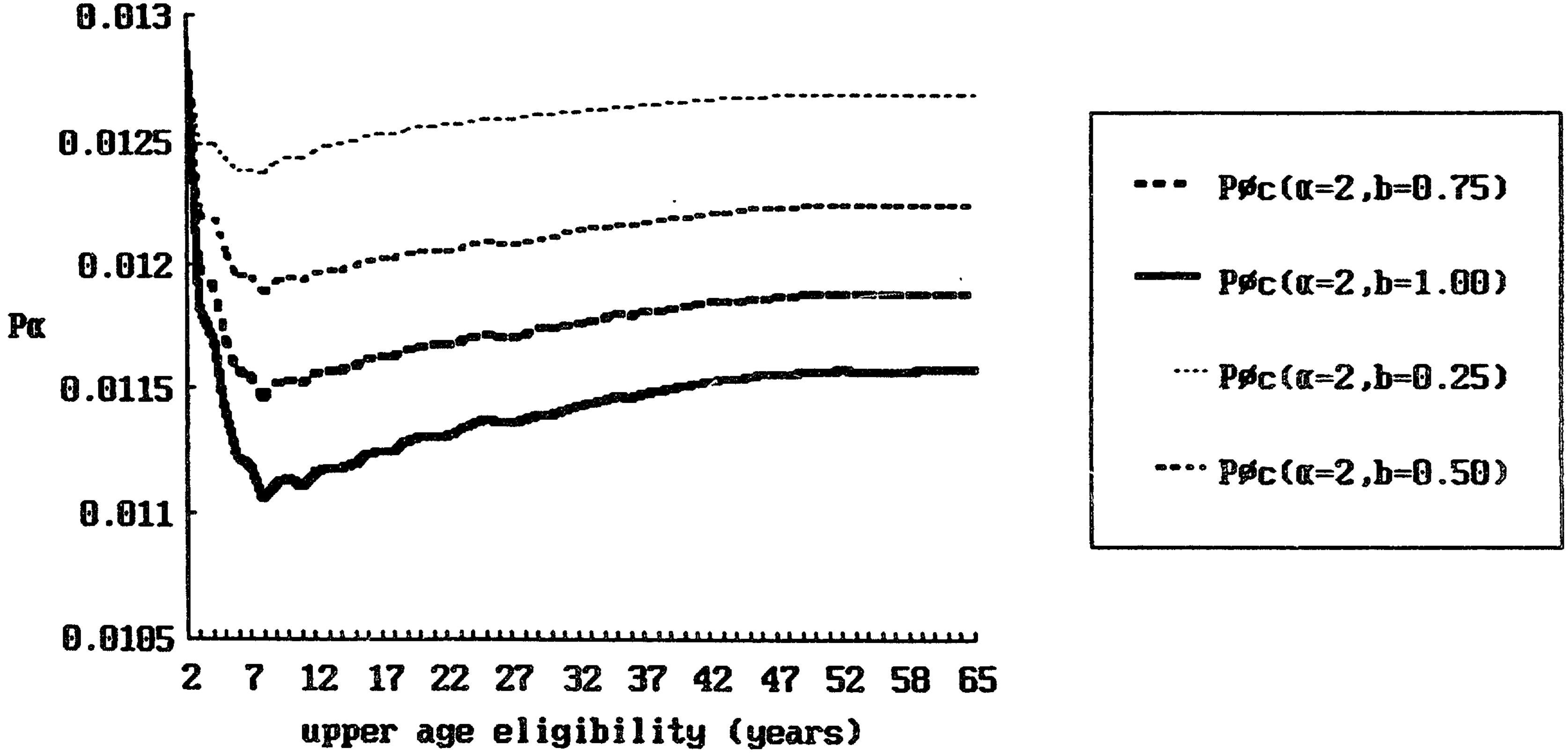

Figure 7: Undernutrition, α=1, for individual level (ø), household level (øhat), both no leakage, and individual level and leakage (øc)

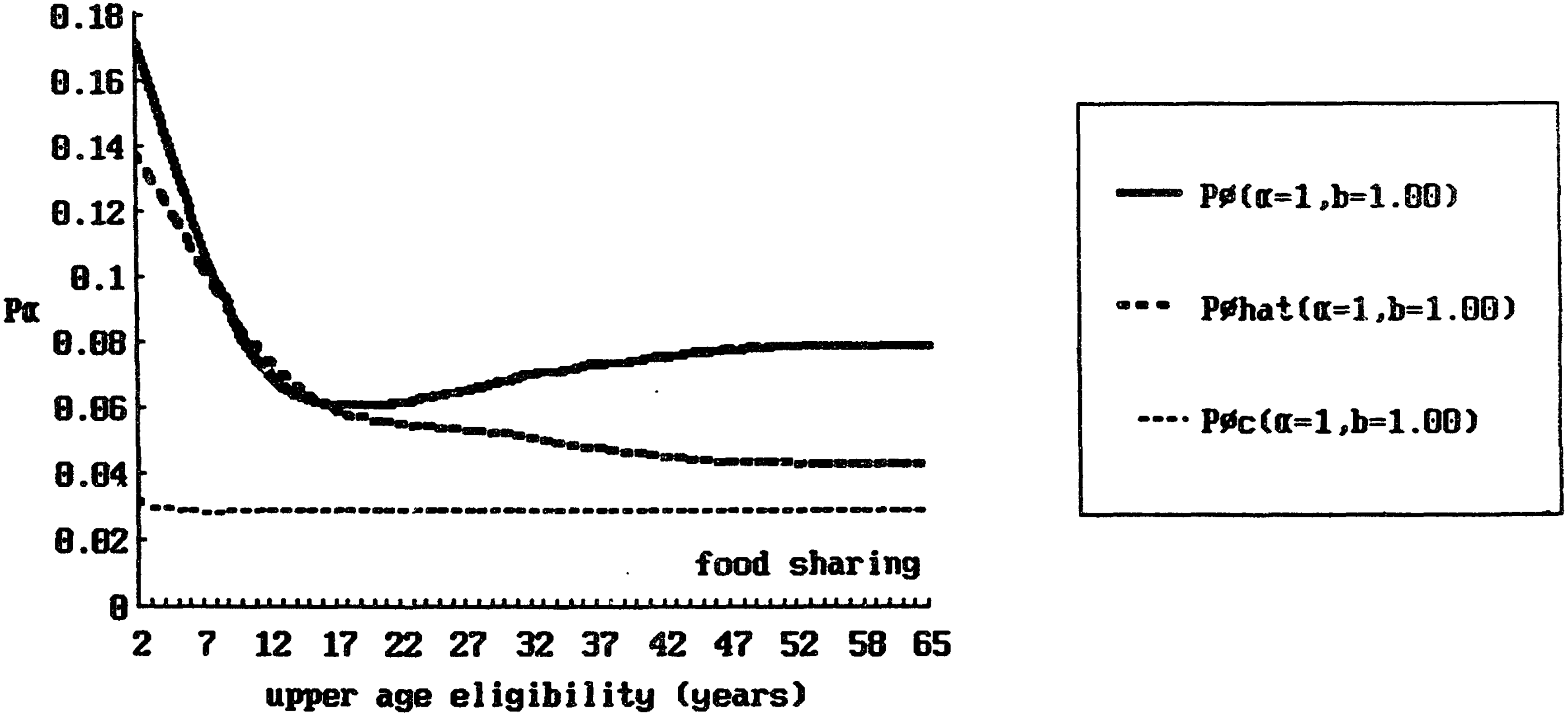

Table 1--Optimal age cutoffs (T^*) for various values of α and calorie intervention

	Intervention (millions of calories)		
α values	0.1	0.5	1
0	2.30	6.00	11.60
1	5.00	13.30	17.50
2	5.40	14.30	21.20

Table 2--The equivalent cost (in calories) of not having individual-level data with which to target

α	calorie intervention	$T^*(\phi)$ (yrs)	$T^*(\hat{\Phi})$ (yrs)	$P^*_\phi(T^*(\phi))$ (1)	$P^*_\phi(T^*(\hat{\Phi}))$ (2)	difference (2)-(1)	equivalent gain (cals)
0	100000	2.3	3.5	0.66736	0.67500	0.00764	20200
0	200000	3.7	5.1	0.63090	0.64028	0.00938	18300
0	300000	4.8	6.2	0.59688	0.60972	0.01284	23500
0	400000	5.8	8.3	0.56285	0.58576	0.02291	55500
0	500000	6.0	9.1	0.53125	0.54757	0.01632	39800
0	600000	7.0	10.5	0.50104	0.51910	0.01806	51100
0	700000	8.8	11.4	0.46840	0.49236	0.02396	60700
0	800000	9.4	13.4	0.43368	0.46944	0.03576	96900
0	900000	10.5	15.7	0.40799	0.44549	0.03750	100000
0	1000000	11.6	18.7	0.38194	0.42014	0.03820	109800
1	100000	5.0	9.1	0.16722	0.16865	0.00143	2500
1	200000	7.3	11.5	0.15112	0.15270	0.00158	3700
1	300000	8.5	14.2	0.13661	0.13809	0.00148	3200
1	400000	11.8	18.8	0.12289	0.12589	0.00300	14600
1	500000	13.3	55.0	0.11008	0.12735	0.01727	153500
1	600000	14.2	65.4	0.09803	0.11679	0.01876	176900
1	700000	14.2	65.4	0.08729	0.10655	0.01926	192800
1	800000	17.5	65.4	0.07745	0.09683	0.01938	205700
1	900000	17.5	65.4	0.06835	0.08764	0.01929	217500
1	1000000	17.5	65.4	0.06047	0.07893	0.01846	221700
2	100000	5.4	11.9	0.05681	0.05748	0.00067	0
2	200000	11.4	18.3	0.04882	0.05013	0.00131	4000
2	300000	11.9	54.9	0.04173	0.04878	0.00705	113400
2	400000	14.2	54.9	0.03560	0.04341	0.00781	140700
2	500000	14.3	65.4	0.03044	0.03860	0.00816	163800
2	600000	17.5	65.4	0.02617	0.03410	0.00793	175000
2	700000	17.5	65.4	0.02230	0.03000	0.00770	187800
2	800000	19.8	65.4	0.01904	0.02627	0.00723	194500
2	900000	21.2	65.4	0.01622	0.02291	0.00669	198300
2	1000000	21.2	65.4	0.01387	0.01988	0.00601	195600

Note: the tolerance for (2)-(1) is 0.001, with increments of 1000 calories.

Table 3--Targeting individuals: Desirability and feasibility

Case	Desirable		Feasible				
	(1) Are consequences of failure to meet nutrient adequacy more severe for TG?	(2) Does TG have lower nutrient adequacy?	(3) Is there substantial household food substitution activity?	(4) Is there significant intrahousehold nutrient inequality away from TG?	(5) Any measured intra-household inequality?	(6) Does it make sense to target interventions at an individual scenario level?	Scenario
1	yes	yes	no	no	no	desirable, feasible	
2	yes	yes	no	no	yes	desirable, feasible, wrong age	
3	yes	yes	no	yes	no	desirable, feasible, wrong age	2
4	yes	yes	no	yes	yes	desirable, feasible	1
5	yes	yes	yes	no	no	desirable, feasible	
6	yes	yes	yes	no	yes	desirable, apparently infeasible	
7	yes	yes	yes	yes	no	desirable, apparently infeasible, wrong age	
8	yes	yes	yes	yes	yes	desirable, not infeasible	3

Notes:

1 Most would agree that the answer to question (1) is 'yes'. Many micro data sets find lower calorie adequacies for preschoolers suggesting that the answer to (2) is also 'yes'. The latter result could be true or false. Falseness could come from measurement errors on the intake side (have preschoolers been fully weaned? do they exhibit snacking behavior?) or the requirements side. On the other hand, the results could be a true reflection of a lack of a reference norm for a health preschooler.

2. Q(3) is difficult to answer, but a strong possibility exists for sharing of a preschooler's food increment, or a reduction in regular food to preschooler if the increment is child-specific.

3. Q(4): Research with this data set suggests that inequality exists, although measurement problems mean that although the answer to (5) is 'yes', the answer to (4) could be 'no'.

4. Q(6): The answer to this question depends on a whole host of logistic and cost variables that we have conveniently abstracted from, but *ceteris paribus*, how does the answer to this question depend on the answers to questions 1-5?

Table 4--The equivalent cost (in calories) of assuming no leakage when computing optimal upper age eligibilities

α	calorie interv	$T^*_c(\phi)$ (yrs)	$T^*(\phi)$ (yrs)	$P^*_{c\phi}(T^*_c(\phi))$ (1)	$P^*_{c\phi}(T^*(\phi))$ (2)	difference (2)-(1)	equivalent gain (cals)
0	100000	5.3	2.3	0.67535	0.68160	0.00625	1000
0	200000	11.0	3.7	0.65382	0.65903	0.00521	1000
0	300000	13.1	4.8	0.63194	0.63889	0.00695	1000
0	400000	3.8	5.8	0.61042	0.61979	0.00937	1000
0	500000	4.5	6.0	0.58611	0.59167	0.00556	1000
0	600000	4.8	7.0	0.56424	0.57257	0.00833	1000
0	700000	4.4	8.8	0.54410	0.55035	0.00625	1000
0	800000	7.3	9.4	0.52431	0.52674	0.00243	1000
0	900000	8.0	10.5	0.50382	0.50868	0.00486	1000
0	1000000	9.0	11.6	0.48403	0.48993	0.00590	1000
1	100000	12.1	5.0	0.17562	0.17630	0.00068	0
1	200000	13.9	7.3	0.15535	0.16607	0.00072	0
1	300000	13.9	8.5	0.15550	0.15652	0.00102	1000
1	400000	13.9	11.8	0.14608	0.14662	0.00054	0
1	500000	18.4	13.3	0.13702	0.13734	0.00032	0
1	600000	18.4	14.2	0.12835	0.12860	0.00025	0
1	700000	20.4	14.2	0.12010	0.12045	0.00035	0
1	800000	20.4	17.5	0.11221	0.11252	0.00031	0
1	900000	20.4	17.5	0.10470	0.10504	0.00034	0
1	1000000	20.4	17.5	0.09758	0.09793	0.00035	0
2	100000	13.9	5.4	0.06236	0.06296	0.00060	0
2	200000	18.4	11.4	0.05750	0.05762	0.00012	0
2	300000	18.4	11.9	0.05297	0.05305	0.00008	0
2	400000	18.4	14.2	0.04876	0.04886	0.00010	0
2	500000	18.4	14.3	0.04485	0.04499	0.00014	0
2	600000	18.4	17.5	0.04123	0.04131	0.00008	0
2	700000	18.4	17.5	0.03787	0.03796	0.00009	0
2	800000	18.4	19.8	0.03477	0.03487	0.00010	0
2	900000	18.4	21.2	0.03190	0.03200	0.00010	0
2	1000000	18.4	21.2	0.02927	0.02935	0.00008	0

Note: the tolerance for (2)-(1) is 0.001, with increments of 1000 calories.

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