"Is Everything Relative?"
The Role of Equivalence Scales in Poverty Measurement

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Introduction

Counting the poor is conceptually a rather simple procedure. First, a determination of the household's needs is made. The household's resources are then counted to see if they are sufficient to meet these needs. If they do not, then the household is counted as being poor. While the household's resources can be objectively observed and enumerated, the same cannot be said of their needs. At what point in the continuum of household consumption does a household move from "not having enough" to "having enough"?

While policy makers may wish for a "scientific" approach to setting poverty thresholds, science informs us that the choice of thresholds is inherently an arbitrary pursuit. There does not exist a "natural law" for poverty thresholds. Science can not determine which set of thresholds is appropriate for a society. At best, science can only help us decide which thresholds are consistent with our general knowledge about the economic status of households as well as the consequences of making alternative choices. Ultimately, poverty thresholds will be viewed as reasonable or not based upon the nation's collective common sense or its political judgment.

But how are thresholds ever to gain legitimacy? Borrowing a criterion from the legal profession, we could ask that the thresholds have a "rational basis." That is, have the thresholds been created by a process which is internally consistent. From this perspective, it is the process more than the thresholds themselves which determines whether or not a set of thresholds will be viewed as "rational." In many respects, this a rather weak criterion. Consider the rather likely situation where there exists more than one process for setting thresholds which has a "rational basis." How are we to judge between such processes? At this point, some judgment must be made with respect to the "reasonableness" of the thresholds which were created by the process. At best, a rational basis criterion can only rule out possible thresholds. It can not be the sole basis upon we which we select our thresholds.

Consider the following situation where we have agreed upon a process to set the threshold for a given family size, say the family of four composed of two adults and two children. Let us further assume that this process has a rational basis and that it yields a reasonable threshold for this family type. How are we to

derive thresholds for other families? One possibility is to replicate for other family types, the process we employed for setting the family of four's threshold. The rationale for following this procedure would be that if the process was "rational" and it yielded a reasonable threshold for the reference family which was arbitrarily chosen, it should yield reasonable thresholds for other family types.

To examine whether or not it does yield a set of thresholds which are reasonable relative to each other, we could create a set of ratios of poverty thresholds for different family compositions relative to a given reference family type. Economists have denoted these ratios as "equivalence scales." These scales represent the consumption needs of any family type relative to the needs of a reference family, usually a single individual. Since these scales have been empirically examined by numerous social scientists, we could compare the implicit scales which resulted from replicating the process used to determine the threshold for the reference family with the empirical literature on equivalence scales to see if they were consistent. Consistency with this external information would then be the used as a basis to determine whether or not the process yielded a set of reasonable thresholds for all other family types.

An alternative procedure would again start by adopting a process to select a threshold for some reference family type but instead of replicating the process used to select this threshold, we would employ what is considered a "reasonable" set of equivalence scales to construct thresholds for different family compositions. In this case, there is not a set of external scales to compare with these thresholds since they have been incorporated into the thresholds directly. The advantage of this strategy is that we have incorporated into the thresholds our accumulated knowledge about the relative consumption behavior of alternative family compositions.

This discussion underscores the role of equivalence scales can play in the setting of poverty thresholds. They will either be used as a basis to judge whether or not a set of thresholds are reasonable or they will be directly used in setting of the thresholds. But clearly, this implies that a "reasonable" set of scales must exist. This paper addresses this question in a three part fashion. First, we examine the scales implicit in the current poverty thresholds and ask, are they reasonable? Second, we will turn to the more thorny question, what are reasonable equivalence scales? Finally, we will explore the consequences of alternative scales on perceptions of who is considered poor.

A. Derivation of the Current Scales

While the problems with the current poverty thresholds are well known, it is useful to review how the current poverty thresholds were constructed in order to better understand what has caused the scales implicit in the current thresholds to deviate from what might be considered "reasonable." In the original construction of the poverty lines, Molly Orshansky started by computing the minimum food needs of a family of type i using the 1961 Economy Food Plan. Let us denote this amount by F_i which would differ by the sex and age composition of the family as well as the total number of family members. To illustrate this calculation, let us use the 1983 Department of Agriculture Thrifty Food Plan. The basic parameters which are used in this calculations are minimum monthly food allotments which are differentiated by the age and sex of the member and a family size adjustment. Both sets of these parameters are displayed in Table 1.

Table 1

1983 Thrifty Food Plan
(1982 Dollars per Month)

Monthly Food Allotments

	Age : 0-2	3-5	6-8	9-11	12-14	15-19	20-50	51 and Older
Male	$40.20	$43.30	$53.00	$62.30	$66.30	$69.10	$73.30	$67.40
Female	$40.20	$43.30	$53.00	$62.30	$66.20	$66.20	$66.60	$66.30

Family Size Adjustments

Family Size						
1	2	3	4	5	6	7 and More
1.20	1.10	1.05	1.00	.95	.95	.90

For a single male adult, the monthly food allotment is equal to $73.30 times the family size adjustment of 1.20 or $87.96 per month. If the unit was a married couple without children, the food allotment would be equal to the sum of $73.30 and $66.60 (= $139.90) times the family size adjustment of 1.10 or $153.89. The addition of the wife would increase food needs by 75 percent. Expressed as an equivalence scale

where the reference family is a single adult male, the scale for the couple would be 1.75. If we wished to adopt a gender neutral food allotment, we could average the food needs by gender and only differentiate by the age of the family member. In this case an adult less than 51 years old would need $69.95 per month. If they lived alone, they would be given a food allotment $83.84 (= $69.95 * 1.20). If they lived with another adult, the allotment would rise to $153.89 implying a 83 percent rise in the food needs of the family compared to living alone.

These calculations provide not only an illustration of how to compute food allotments but an insight into the equivalence scales. Whether or not we differentiated the family's needs by the gender of its members affects the equivalence scales. In general, we can expect that the demographic factors which are factored into the thresholds to have a impact on the scales. While nutritionists tell us that children need less food than adults, older adults need less than younger adults, and females need less than males, it becomes a social or policy decision which differences across families should be reflected in the equivalence scales.

The next step in Orshansky's procedure was to account for the needs of the family other than food. She reasoned that if food was on average θ_i percent of the families after-tax income then $1/\theta_i$ (which we denote as M_i, the multiplier for ith family type) times the family's food needs would represent the family's total needs. Based upon her analysis of the 1955 Household Food Consumption survey, she determined that the multiplier for families with three or members was 3.00 (food was roughly 33% of after-tax income of these families). For families of two, the multiplier was 3.70 which corresponds to a 27 percent food share. To set the threshold for a single adult, she chose not replicate her multiplier procedure but to adopt a threshold for a single individual which was roughly 80 percent of the corresponding two person family. She offered no documentation or empirical evidence for this deviation from her established procedure for families of two and more, other than she felt it was a reasonable assumption to make.

However, it is this 80 percent assumption which is crucial in how we view the implicit scales in our current poverty thresholds. To compute the "implicit" multiplier or food share for a single individual that is consistent with this assumption, let T_i denote the threshold for the ith family type as

$$T_i = M_i F_i$$

where M_i and F_i have been defined above. Given the Orshansky assumption,

$$T_1 = M_1 F_1 = .80 \times T_2 = .80 \times M_2 \times F_2 = .80 \times 3.70 \times F_2$$

or

$$M_1 = 2.96 \times \frac{F_2}{F_1} \ .$$

If we use the relative scales of 1.83 for food implicit in the Thrifty Food Plan for F_2/F_1, we arrive at a value for the multiplier of 5.42 for the single individual . This would be consistent with a food share of 18 percent for a single individual. To determine how much of a deviation this assumption is from her primary methodology, we will consider the following data from the 1989 Consumer Expenditure Survey (CEX) and the assumptions that Orshansky used in deriving her thresholds.

Table 2

Food Shares (θ_i) and Multipliers (M_i) for Different Family Sizes

	Family Size :					
	One		Two		Three and More	
	θ_1	M_1	θ_2	M_2	θ_{3+}	M_{3+}
Orshansky	18.5%	5.42	27.0%	3.70	33.3%	3.00
1989 CEX	13.9%	7.19	13.6%	7.35	15.5%	6.45

As many other observers have noted, including Orshansky herself, the updating of the thresholds using more recent consumption data would increase the multipliers and hence the thresholds. But that is not point that I would raise with these numbers. For families of two, Orshansky utilized a multiplier which was 23 percent higher than the multiplier used for families of three and more. Using more recent consumption data, we would continue to see the multiplier for families of two to be larger than the multiplier for families of three or more although the percentage difference would be smaller, a 14 percent difference. The relative stability in the relationship between the multipliers between these two family sizes may provide insights into how significant a deviation was Orshansky's 80% assumption from what would have been implied by her multiplier methodology. In the 1989 CEX, we see that replicating her multiplier methodology for a single individual would imply a multiplier which was roughly equal to multiplier for a family of two. If this same pattern had held in her data, the multiplier she would have used for a single individual would have 3.70 instead of the implicit multiplier of 5.42 she did use. The corresponding threshold for a single individual would have been equal to

$$\frac{T_1}{T_2} = \frac{3.70 \times F_1}{3.70 \times F_2} = \frac{F_1}{F_2} = \frac{1}{1.83} = .54$$

or 54 percent of the threshold of a family of two as opposed to the 80 percent she had assumed. It is unfortunate that some explanation or evidence was not provided for such a significant deviation from what would have been implied by the methodology she employed for other family types.

Having now described how the current poverty thresholds were derived, let us now turn to the question of their implicit equivalence scales. It is frequently stated that the economies scales implicit in the current poverty thresholds are reflective of the economies of scale in food consumption since they are based upon food needs. However, as it should be evident from the above discussion, this is not entirely correct. Recall, the equivalence scales implicit in the poverty thresholds are simply the ratio of the threshold of any family type relative to the threshold for the reference family. In this discussion, we will choose the single individual as the reference unit. Let ES_i denote the equivalence scales for the ith family type in the current poverty lines which is equal to

$$ES_i = \frac{T_i}{T_1} = \frac{M_i F_i}{M_1 F_1} = \frac{M_i}{M_1} \times \frac{F_i}{F_1} .$$

As we have already noted, the current poverty thresholds assume that the multiplier falls with family size and hence the first term of the last expression, M_i/M_1, will always be less than one. This will imply the economies of scale in the current thresholds will be less than scale effect in food needs. Only if the multipliers were equal for all family sizes would the scales in the current thresholds be reflective of the economies of scale in food needs.

It is instructive to examine how the family's needs change when an additional member is added to the family. We will begin with a single individual, then added an second adult, and then continue to add children. After each member is added, we will compute the additional needs of the unit expressed in terms of the needs of a single individual, $ES_i - ES_{i-1}$. In Figure 1, I have plotted the increments to the family needs in the current thresholds derived by Orshansky (circle points) and three alternative sets of thresholds using different sets of assumptions: the 1983 Thrifty Food Plan with the same multipliers as in the current thresholds (diamond points); the 1983 Thrifty Food Plan along with the assumption that the multiplier for a single individual was constructed in the same manner as the multiplier for families two and more (square points); and the use of the 1983 Thrifty Food Plan with assumption that the multiplier for all family sizes are identical (triangle points).

From Figure 1, we can directly see the concerns that many analysts have about the current poverty thresholds. While the first child adds less to the family's needs than does the addition of the second adult, the additional needs of the second and third children each are more than either the second adult or first child. This pattern of needs is very hard to justify. Some researchers have suggested that this pattern of scales is an artifact of how Orshansky constructed the food needs of various family types. As we showed before, the food needs of the family depend upon the ages and gender of its members. Hence a family of two adults less than 51 years old with a daughter five years old will have different food needs than a family of two adults less than 51 years old with a son sixteen years old. To construct her thresholds which differentiated only on the basis of the number of adults and children in the family, Orshansky took a weighted average of the food needs of all possible family types that would be consistent with the number of adults and children in the family where the weights were constructed from Census data. Some analysts hypothesized that the "blip" in the scales for two adult units resulted from the having more older children in families where there two and three children.

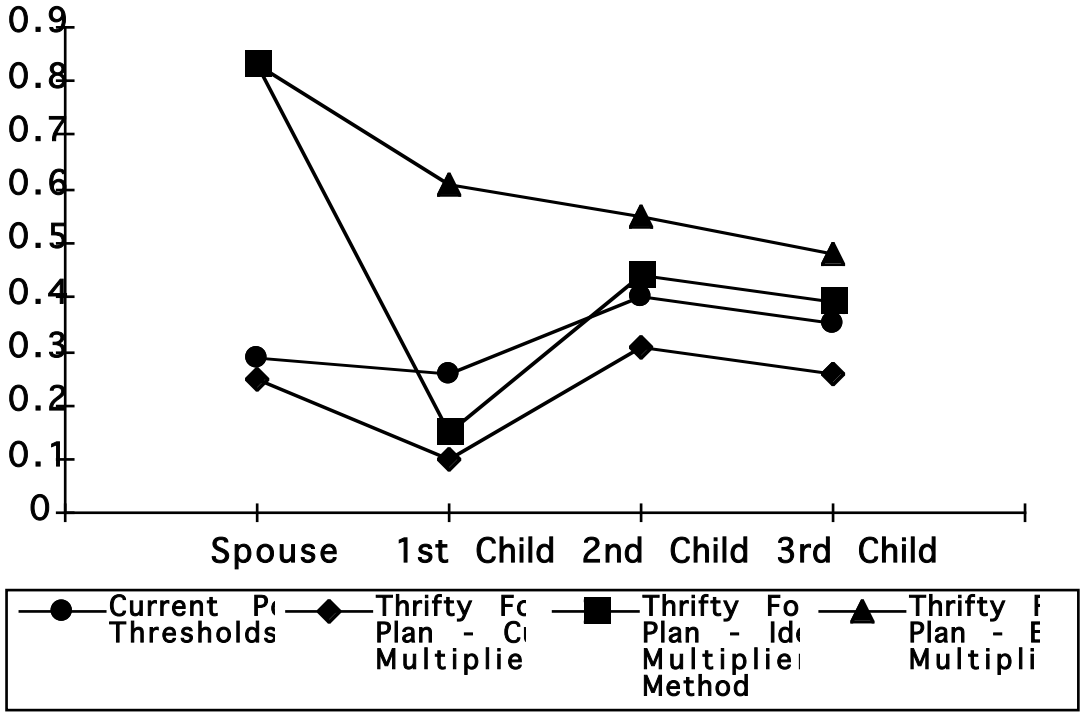

Figure 1

Incremental Impact on Family Needs
Due to the Addition of Family Members

To investigate this possible artifact, I computed the food needs of a single individual and two parent unit assuming that all adult food needs were $66.95 (the weighted average of adult food needs in the Thrifty Food Plan for those adults 20 to 50 years old) and that all children food needs were $55.45 (the weighted average of all child food needs in the Thrifty Food Plan) per month. Using these two figures for food needs along with the multipliers implicit in the current thresholds, I computed the incremental impact of additional family members (diamond points in Figure 1). I found roughly the same pattern of scale effects as in the current thresholds suggesting that the age composition of different family types had nothing to do with the irregularity in the scales.

To account for this irregular pattern of scale effects, let us next examine the impact of assuming that all the multipliers for all family types (M_i) are equal. In this case, the resulting thresholds will display scale effects which reflect the scale effects of the underlying food needs (the triangle points in Figure 1). As we see in Figure 1, the pattern of scale effects implicit in the Thrifty Food Plan are more consistent with what one might expect. Each additional member to the family requires less than the previous member. There are no "blips" in the pattern suggesting that the reason why there are is due to the multipliers used by Orshansky.

Recall that Orshansky deviated from the assumption of a constant multiplier in two instances. First, she utilized the data to derive a separate multiplier for families of two which was equal to 3.70, larger than the multiplier of 3.00 used for families of three and more. She also made the assumption that the needs of single individuals were 80 percent of the needs of two adults which we demonstrated implies a multiplier of 5.42 for single adults. If she had continue to utilized consumption data in constructing her multiplier for the single individual, I have suggested that the multiplier she would have estimated would have been much closer to the multiplier for families of two, 3.70. Using a multiplier of 3.70 for single individuals, the original multipliers for families of two and more, and the 1983 Thrifty Food Plan, I computed the incremental impact on family needs of additional family members. This are represented in Figure 1 with the "square" points. As the graph indicates, utilizing the identical methodology for the construction of all the multipliers has the effect of increasing the costs associated with adding the second adult to the family to a level that exceeds the costs of adding children. However, it is still the case that the incremental needs of the first child is less than that of the second and third child. This downward "blip" in the scales is the result of the combined effect of smaller needs of the additional member (a child as opposed to an adult) and the fall in the multiplier from 3.70 to 3.00. However, when the second child and third children are added, the multiplier remains constant at 3.00 and hence the incremental needs of the family will proportional to the incremental change in the food needs of the additional children.

These comparison have shown the important role played by the variation in the multipliers especially Orshansky's implicit assumption that the multiplier for a single individual was 46 percent higher than the multiplier for a family of two. But is this assumption justified? As we have noted before, it can not be justified by the data on the share of food of after-tax income. If we had chosen a multiplier based upon the same empirical methodology she had employed for other family sizes, we would have employed a multiplier for a single individual which was roughly of the same magnitude if not smaller than the multiplier utilized for a family of two. But perhaps a deviation from the primary methodology is justified based upon the belief that there is something really different between living alone as opposed to living with others.

The current thresholds imply that living with another adult is 29 percent more expensive than living alone. Is this figure reasonable? If food represents about 30 percent of the budget of a poor individual and food needs rise by 83 percent when a second individual is added, then for the 29 percent figure to be correct, all other needs of the family must be rising by only 4.1 percent. Even if we assume that housing needs represent 40 to 50 percent of the budget and they do not rise with the addition of an adult, this would imply that non food and non housing needs of the couple would rise by 13.7 to 20.5 percent compared to a single individual. It is difficult to believe that these needs would have larger economies of scale than food. If these needs were to double and they represented 20 to 30 percent of the budget, two adults would need 49 to 59 percent more income to meet their needs compared to a single individual.

These back-of-the-envelope calculations suggest that neither Orshansky's 80 percent assumption nor the continuation of her multiplier methodology would have lead to "reasonable" estimates of the equivalence scales between one and two adult units. Her assumption that a single person would require 80 percent of the needs of a two adult family requires us to believe that there are high economies of scales in consumption, perhaps higher than what is believable. On the other hand, continuing the use of the inverse of the average share of food of after-tax income as a multiplier for a single individual would have lead to the conclusion that the economies of scale in total needs was equal to the economies of scale in food consumption. This too leads to an unrealistic conclusion since it is unlikely that when a second adult is added to a household, the unit's housing needs will rise as much their food needs. In fact it is likely that housing needs will rise only slightly if at all leading to a much smaller increase in the overall needs of the unit.

While reasonable doubts can be raised about the relative scales between one and two adults, can similar doubts be raised about the impact of children on a family's needs? As we have noted above, the first child in the current scales is relatively free compared to the addition of the second and third child. The first child adds less proportionately than does the second adult but additional children each are assumed to

require consumption than either the second adult or the first child. While the first result seems reasonable, the latter implication is hard to justify. Focusing upon the second and third child, we see that their incremental impact on family needs is roughly 80 percent of their impact on the family's food needs. While it is reasonable that total needs of the family do not rise as fast as food, whether or not 80 percent is a reasonable figure is difficult to determine.

While we have been focusing upon relative scales between families with children and two adults, units with children and only one adult are of also of interest. The current thresholds imply that for families of four and less, single parents with children need more income than two parent units. For families of five and more, single parent families need less than multiple adult units with and without children. Let us begin by comparing two adults with a family of one adult and one child. The current thresholds imply that two adults less than 65 years old need 29 percent more than a single adult while a single parent with a child needs 32.5 percent more than a single adult. As we noted above, the addition of a second adult to a unit with an adult will increase food needs by 83 percent. Using the same figures from the Thrifty Food Plan, the addition of child to a single adult will increase food needs by 63 percent.[1] Thus if the total needs of a single parent family are to exceed those of two adults, then the non-food needs associated with the child must more than offset the differential food needs between children and adults. Perhaps it could be explained by differential housing needs. If we assume that when we add a child to an adult there is a 25 percent increase in housing needs of the unit which would roughly reflects the difference between one and two bedroom apartment rents.[2] If we assume that food and housing reflect 30 and 50 percent of the needs of the household and that all non-food and non-housing needs double when either an adult or a child is added, then the needs of the two adults will increase by 44.9 percent (= .30 x .83 + .50 x .00 + .20 x 1.00) while the needs of a child and an adult would rise by 51.4 percent (= .30 x .63 + .50 x .25 + .20 x 1.00) compared to a single adult. These calculations suggest that the current scales for single parent families may be justified using these somewhat "generous" assumptions about the child's needs relative to adult. But if differential housing needs of a child are not as great as we have stated or the non-housing, non-food needs of a child are not the same as an adult but less, then we could have easily found that needs of two adults to be greater than a single parent with a child. This another area where some more thought should be given.

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1 Here I assumed that a child adds $54.45 per month in food needs. This figure is the average across all gender and age categories in the Thrifty Food Plan. The 63 percent figure was derived from dividing the monthly food needs of one adult and one child (= 1.10 x ($69.95 + $54.45)) by the monthly food needs of a single individual (= 1.20 x $69.95).

2 This is an upper bound estimate, at least I think it is. This is something I would need to look at.

B. What Are Reasonable Scales?

Recapping our discussion of current poverty thresholds, we found that the equivalence scales implicit in the current thresholds to be questionable in the following areas :

- the relative scale between two adults and one adult families display a high degree of economies of scale than what might be deemed reasonable,
- the first child in two adult households increase family needs less than the second and third child, and
- the needs of single parent families are greater than two parent families with same number of family members.

In this section, we will try to develop a set of alternative scales which address these problematic areas in the current thresholds.

How can we judge whether or not any set of scales is reasonable? Take for example, the Orshansky assumption that the needs of a single individual are 80 percent of the needs of two adults. For many individuals including Orshansky, this assumption must have appeared to be a reasonable. On the other hand, logic implies that this 80 percent assumption is consistent with the statement that a two adult unit will need 25 percent more than a single individual. Hence if reasonableness is to walk hand in hand with consistency, this 25 percent figure should also be viewed as reasonable.

But based upon our earlier calculations, we were led to the conclusion that from the perspective of the single individual, two adults would need more than 25 percent more income to meet their needs. If we use the midpoint of the range created by our back-of-the envelope calculations, we would infer that two adults would need 55 percent more income than a single individual to meet their household needs. However this would logically imply that a single individual would need only 65 percent of the needs of two individuals. Now should we view this 65 percent figure unreasonable since we originally viewed the 80 percent figure as reasonable? Or should we view the 65 percent figure as reasonable and the 80 percent figure as unreasonable?

Traditional economic consumer theory would lead us to conclude that if one figure is reasonable the other can not be. However, traditional economic theory can not explain the empirical observation that individuals demand significantly more in compensation for a loss than what they would be willing to pay to avoid the same loss. The difference in welfare measures (compensating versus equivalent variation) can not be explained in terms of income effects thus some other explanation is needed. Tversky and Kahneman

(1991) have suggested that this behavior can be explained if individuals display what they denote as "loss aversion." Tversky and Kahneman denote an individual as loss averse if for the individual a potential loss in relationship to a reference point looms larger than corresponding gains.[3]

This concept can be applied to our situation. When we ask the individual how much more would he/she need if another adult was added to the unit, we are asking the individual to contemplate a potential loss in their economic well-being especially if additional resources are not also associated with arrival of the adult. On the other hand if we adopt the reference point of the two adult unit, subtracting an adult from this unit will leave the remaining individual with the prospect of a potential gain in well-being again holding the level of resources constant. Loss aversion implies that the loss in well-being contemplated when the single individual is employed as the reference point will loom larger in the individual's mind than the potential gain when the two person unit is employed as the reference point. Differences in reference points could lead to quite different valuations of the change in the living arrangements of the adults and in a predictable fashion. Loss aversion would predict that amount of compensation thought to be needed when the single individual is the reference would exceed the difference in the equivalent incomes when the two person unit is employed as the reference point. Hence from this perspective, it is quite possible for individuals to have apparent conflicting views on what is a reasonable differential needs between one and two adult units.

While loss aversion may provides a possible explanation for the apparent inconsistency, we are still left with the question of which perspective or reference point should chosen to judge the reasonableness of the scales implicit in the poverty thresholds? There is no definitive way to answer this question and I will admit that my choice of using the single individual as the reference unit to compare with all other units is open to debate. My rationale for this choice is one of ensuring consistency in the scales. By choosing the "lowest common denominator" of family types, the single individual, all other family types will contain more family members and hence greater needs than the single individual. There will always be an implied loss in comparing any family type with the single individual. Had we select the family of two adults as the reference, there would had been a mixture of gains and losses embodied in the scales. For comparison with the single individual, there would had been an implied gain. For families with more members, there would had been an implied loss in the comparison. There would not had been a consistent comparison employed in the construction of the set of reasonable scales.

To narrow the debate of what would constitute a reasonable set of scales, I will suggest that we confine our attention to a specific parameterization for the equivalence scales. The primary advantage of this

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[3] See also Kahneman (1992), and Kahneman, Knetsch, and Thaler (1991).

approach will be that we can ensure that there will be a consistent relationship between the scales for different family types and we avoid the "blips" which are present in the current scales. The particular parameterization for the equivalence scale relationship which I will propose is

$$S(A,K) = (1 + a(A-1) + pK)^F$$

where A is the number of adults, K is the number of children in the unit. The formula contains three parameters: a is the needs of secondary adults relative to a single adult, p is the relative needs of children relative to the single adult, and F represents the economies of scale in consumption or the elasticity of family needs to the number of equivalent adults in the family. All three parameters are assumed to lie between zero and one.

This formulation provides a convenient formulation to contrast several suggested alternatives to the scales implicit in the current poverty thresholds. The most often suggested proposal was originally made by Watts who proposed that the square root of the family size be used to generate scales. In this formulation, a and p would both equal one, while F would be set to .50. Proponent of these scales cite many reasons for their adoption. While simplicity is frequently mentioned, one major improvement is that these scales emphasize the importance of children's needs by counting children as adults. An important consequence of counting children as adults is that the needs of single parent families with children will be identical to two parent families with same number of total family members. Canada in their Low-Income thresholds employ the 40-30-30 rule which begins by setting the single individual to one and adding .40 for the second individual (adult or child) and .30 for each additional family member. Comparing the Canadian scales with the Watts scales, we see that for family sizes less than five members, the Canadian scales provided a good approximation to the Watts scales.

The OECD countries have utilized a 70-50 formula which begins by setting the single individual to one and adding .70 for each additional adult and .50 for each child in the unit. The OECD formula can be captured by setting a to .70, p to .50 and F to 1.00. Even though the economies of scale factor, F, has been set to one, the OECD formula still displays some economies of scale in consumption since the needs additional members are assumed to be less than the first adult in the family.

The Canadian and the OECD formulations which rely upon counting additional family members less than a single adult are attempts to capture economies of scale in the household needs without having to rely upon the use of the exponent, F. I believe that this was done in order to provide an easy to understand description of the scales. For example, the Canadian method of simple weighted adding of the number of family members is easier to grasp for most individuals than the concept of square root of family size. Since

both methods yield approximately the same scales, there may be some who would prefer the "simpler" approach and hence the appeal for a Canadian or OECD formula although with slightly different values. But just because this approach may provide an easier way to convey a description of the scales does not mean that the scales are more reasonable. Personally, I would not place much weight on a scale's simplicity of a set of scales in deciding whether to favor one set over another since for those who will be concerned with the issue of equivalence scales will have the technical background to be able understand any clearly stated formula.

The parameter, "a", was included in our scale formula in order to characterize the OECD scale specification in relationship to other alternatives. However, it is questionable whether this parameter should be included if we give the following interpretation of the proposed scale formula. If all members of the family are assumed to have specific consumption needs which are independent of their living situation, it is the living situation which determines the economies of scale which households are possible to capture. These economies of scale represent potential savings in meeting these needs. For example, consider two adults living apart from each other, each with identical consumption needs. Now if they begin to live together, their individual consumption needs do not fall but they are able to eliminate duplicate expenditures and hence require less total expenditures to meet the same level of well-being they enjoyed prior to living together. In our formulation, this savings in percentage terms is equal to $1 - 2^{F-1}$. If F is equal to 1 (no economies of scale), the savings would zero. However, if F is equal to 0 (perfect economies of scale), the savings would be 50 percent, in other words, two could live as cheaply as one. If "a" is not equal to one, then living situation of the adults will be assumed to directly affect the consumption needs of the second adult which is inconsistent with the above interpretation of the scale formula. In the remaining portion of the paper, I will assume that all adults count the same, in other words, "a" will be set to one.

Values of "p" less than one are consistent with this interpretation since it is quite realistic for the consumption needs of individuals to differ on the basis of their age and in this case whether they are children (less than 19 years old). But there other characteristics other than the individual's living situation which could affect their consumption needs, for example, whether or not the individual was disabled. But in this paper, we will only focus upon age differences.

The equivalence scales will be sensitive to the choice of parameters, p and F. Of these two parameters, the scales will be more sensitive to the choice of the economies of scale factor. Comparing the elasticity of the scales with respect to changes in p and F, we see that

$$\eta_p = \frac{pK}{A+pK} \quad \text{and} \quad \eta_F = \log(S(A,K))$$

will both are positive indicating that larger values of either p or F will increase the values of the scales. However, a numeric comparison of these two elasticities indicated that at as long F exceeded a value of .40, the economies of scale elasticity will be larger for all families sizes and compositions. This analysis suggests that while care should be given to the selection of both p and F, we should be attentive to alternative values for F since they will have greater impact on our scales than possible variation in how children's needs are counted in relationship to adult needs.

But which values should be selected for p and F? One alternative would be pick values for p and F so as to approximate and hence smooth out the current scales. The simplest fitting technique would be to set p equal to 1.00 and then take two scales to estimate a value for F. Since perhaps the two most significant units are the single individual (the reference unit) and the family of four (two adults and two children), we employ their scales. Now the current scale for the single individual is 1.00 while for the family of four's scale is equal to 1.9493 (= $14,228/$7,299). Using these two points, the economies of scale factor, F, can be "fitted" by solving the following equation

$$F \times [\log(4) - \log(1)] = \log[1.9493] - \log[1.0]$$
$$F = .481$$

Rounding this estimate of F to the nearest tenth, we would arrive at an empirical justification for the Watts scale. But why is a value of 1.0 for p, the right assumption? Why use the comparison between the family of four and the single individual to fit the line? Why not use the family of two and the family of four or some other combination? To see how sensitive the choice of p and the units to "estimate" the economies of scale are, consider the information contained in Table 3.

Table 3

"Fitted" Values of F Under Alternative Assumptions for "p" and the Units Which are Compared

	Value for p :		
Family Sizes :	.50	.70	1.00
1 and 4	.608	.545	.481
1 and 3	.476	.439	.398
2 and 4	1.024	.782	.562
1 and 2	.364	.364	.364

As Table 3 indicates, a value for F is dependent upon which assumptions one makes in this two observation "estimation" procedure. To take into account more than two observations at a time and to allow the data to select which an appropriate value for p, we could select values for p and F which minimize the sum squared deviations of the equivalence scales implicit in the current thresholds, OS(A,K), from the value of the scale formula evaluated at p and F,

$$\Sigma_{A=1,2\ \ K=0,4}\ (OS(A,K) - (A+pK)^F)^2$$

The equivalence scale implicit in the current thresholds are listed in Table 4 for childless couples and one and two parent families with one to four children. To examine the importance of which observations are used to estimate the parameters, I reestimated the parameters using two subsets of these nine observations. The first subset eliminated the value for the childless couple and utilized just the scales for units with children (8 observations). The second subset of observations utilized just five observations, single parent families with one and two children and two parent families with one to three children. The fitted values for p and F are reported in Table 5.

Table 4

Implicit Equivalence Scales in Current Poverty Thresholds (Single Non-Aged Individual = 1.000)

Childless Couple (2 Adults) 1.287

	One Adult	Two Adults
With One Child	1.325	1.547
With Two Children	1.549	1.949
With Three Children	1.956	2.294
With Four Children	2.259	2.568

Table 5
Fitted Values for p and F Using the Current Thresholds

Sample :	p	F
All Nine Observations	.929	.510
Only Units with Children	.798	.547
Single Parent with One and Two Children Two Parents with One to Three Children	.698	.547

The smoothing of the scales using all nine scales yields a formula which closely resembles the Watts suggestion of the square root of family size (p = 1.0 and F = .50).[4] However, both parameters are sensitive to which observations are included in the smoothing. The omission of the scale for the childless couple has a substantial impact on both parameters. If we further restrict the sample to units where the vast majority children reside, only the estimate of the relative weight given to children is affected.

To gauge the impact of the smoothing on various household types, I have computed the difference between the actual scale and the scale implied by the smoothing process conditional upon the values of p and F. The absolute differences are reported in Table 6. If the reported difference is negative, then this implies that the actual scale is less than the predicted scale from the smoothing process. If the reported difference is positive, then the opposite holds.

[4] Constraining the value of p to 1.00, the minimizing value of F is .495 and has a minimal impact on the sum squared deviations.

Table 6

Difference between Actual and Predicted Scales for Different Household Types

	Fitted Specifications :			Watts
	p=.929 F=.510	p=.798 F=.547	p=.698 F=.547	p=1.00 F=.500
Childless Couples	-.137	-.174	-.174	-.127
Single Parent with :				
One Child	-.073	-.053	-.011	-.089
Two Children	-.159	-.136	-.064	-.183
Three Children	-.016	+.005	+.101	-.044
Four Children	+.053	+.069	+.186	+.023
Two Parents with :				
One Child	-.183	-.209	-.174	-.185
Two Children	-.042	-.065	-.003	-.051
Three Children	+.072	+.047	+.132	+.058
Four Children	+.135	+.106	+.212	+.199

The use of the smoothing formula, $(A + pK)^F$, creates several significant deviations from the scales implicit in the current thresholds. The most notable instances where the predicted scales are larger relative to the current scales are for childless couples and families of three (single parents with two children and two parent families with one child). This reinforces the discussion of the last section which questioned the consistency of the pattern of the scales. For family sizes greater than four, the effect of the smoothing will be to lower the scales. The combined effect of the smoothing procedure will tend to flatten out the scales compared to the current pattern for the equivalence scales.

While we have ironed out the "blips" in the current scales through this smoothing process, we have not provided any evidence that the current scales or the "smoothed" scales are appropriate or reasonable. To establish whether or not the current scales are reasonable, we will compare them with what evidence we have been able to establish about the economies of scale in consumption. One of the most relevant areas of research to this question is how parents allocate the household's total consumption toward their children. Due to the presence of collective consumption within the household such as housing, we can not directly observe how much is spent on children. Consequently, indirect methods must be created to determine the level of spending on children. The most common approach is to identify the amount of spending on the

children as the difference in total spending that is done by the family and the amount of spending that the adults would required to be equally well off but if the children were not present. For a family with A adults and K children, the amount of spending on the children expressed as a percentage of the household's total spending, ω(A,K), would be equal to

$$\omega(A,K) = \frac{S(A,K) - S(A,K=0)}{S(A,K)}$$

where S(A,K) are the equivalence scales for a household with A adults and K children. Using the scales implicit in the current thresholds (Table 4) and the above formula, we can compute the corresponding percentage of total household spending made on children and compare them to estimates of spending on children from the 1980 to 1986 Consumer Expenditure Survey which used the Rothbarth methodology of identifying equally well-off households. Due to sample size problems in this study, only estimates for single parent families with one and two children and for two parent families with three or less children were able to be provided.

Table 7
Percentage of Household Spending on Children

	Implicit in Current Thresholds	Watts p=1,F=.50	Betson (1990)
Single Parent:			
with One Child	24.5%	29.3%	30.7%
with Two Children	35.4%	42.3%	49.6%
Two Parents :			
with One Child	16.8%	18.4%	23.7%
with Two Children	34.0%	29.3%	35.4%
with Three Children	43.9%	36.8%	40.9%

The current thresholds assume less spending on children than what is estimated from survey data. Only in the case of two parents with three children, do the current thresholds assume more spending on children. In earlier comparisons, we found that the scales for families of three, single parents with two children and two parent families with one child, were lower than what would be expected from a comparison with other family types. Here we see that the largest deviations of spending on children from empirical estimates occur for these families which provides us some evidence to believe that the scales for these family types are too low in comparison to similar units without children.

The previous discussion lead us to conclude that the scales would become more "flat" after smoothing. In Table 7, I have included the share of spending on children implied by the Watts formula which was found to be a fair approximation to the current scales. The computed shares reported in the table indicate that they too are "flatted" by the smoothing process and are for all family types lower than what has been estimated.

But the estimated spending on children patterns serve as a basis of comparison for our current scales, could they not also be used to form a set of scales? Using the above relationship between the share of spending on children and the equivalence scales, we can derive the following relationship

$$\frac{S(A,K)}{S(A,K=0)} = \frac{1}{1 - \omega(A,K)}$$

which for single and two parent families would equal

$$\text{Single Parent (K=1,2) : } S(1,K) = \frac{1}{1 - \omega(1,K)}$$

$$\text{Two Parent (K=1,2,3) : } \frac{S(2,K)}{S(2,K=0)} = \frac{1}{1 - \omega(2,K)} \cdot$$

The five estimates of share of total spending on children provide "observations" of the right hand side of the above equations. From the observations on single parent families, we can directly infer the scales for single parents. It should be noted that due to small sample sizes the confidence bounds around these estimates are quite large compared to those of two parent families. The observations for two parent families can not be similarly used to infer the scales for these family types since the spending the children leads only to inferring the scale of the family to the scale for a childless couple. Without an independent estimate of the scale for two adult units, we can not directly identify the scales for two parent families.

To identify these scales, we could follow one of two paths. One path would be to make a "guess" of the scale for childless couples. For example, we could assume that the scale for a childless couple is the same as the scale for a single parent with one child which we have an estimate for from the spending patterns of single parents. The problem with this approach is that the created scales will greatly depend upon this assumption. Another path would be to specify a formula for all the scales and then to select the parameters which provide best fit the observations on child spending patterns. In this case, the choice of the formula identifies the scales. One obvious choice would be the formula I have already proposed :

$$S(A,K) = (A + pK)^F$$

which for single and two parent families would equal

$$\text{Single Parent (K=1,2) : } (1+pK)^F = \frac{1}{1 - \omega(1,K)}$$

$$\text{Two Parent (K=1,2,3) : } \frac{(2+pK)^F}{(2)^F} = \frac{1}{1 - \omega(2,K)} \ .$$

Using the five observations, the values for p and F, which would minimized the sum of the squared deviations of the right hand side from the left hand side of the above equations, are equal to .706 and .762 respectively.

Some may object to the above formula since by assumption a single parent family with one child will need less than a childless couple

$$S(1,1) = (1+p)^F < 2^F = S(2,0) \text{ if and only if } p < 1.$$

To allow for the possibility that first child in a single parent family is different from subsequent children, we will alter the formula for single parent families to include a third parameter, c, to denote the relative needs of first child.[5] Hence for single parents, the above equation can be rewritten as

$$\text{Single Parent (K=1,2) : } (1 + c + p(K-1))^F = \frac{1}{1 - \omega(1,K)} \ .$$

The values of c, p, and F, which minimize the sum squared deviations of this rewritten formula for single parent families and the original formula for two parents, are .651, .703, and .778. While the relative needs of subsequent children do not change, we find that the most consistent value for the relative needs of the first child is less than the second children. This is quite a counterintuitive finding. It is difficult to believe that the relative needs of the first child in a single parent family will be smaller than the second child. It is equally troubling for those who would be raising a concern about the original formula since they would have thought the value for c would be closer to 1.00 -- the first child in a single parent family is like an adult.

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5 This assumption, like assuming that secondary adults in an unit need less than the first adult, is inconsistent with our interpretation of scale formula. However, by allowing the first child in a single parent family is a one way to allow for the economies of scale to differ between single and two parent families but retaining the assumption that F is the same between the two family types.

Setting c to 1.00 and selecting p and F to minimize the sum squared deviations, we find a value for p of 1.066 and F of .584. Thus counting the first child in a single parent family as an adult suggests that if we are going to be consistent with the empirical literature, we should count all children as adults. Setting both c and p to 1.00, the minimizing value of F is .601. In this formulation like the Watts formulation, all families of the same size regardless of its composition of adults and children would have same scale. But to be consistent with the empirical literature on the cost of raising children, the economies of scale factor, F, would be .60 instead of .50 as in the Watts proposal.

The scales we have produced have relied upon the estimates of the spending on children and hence can only provide information on the scale for that household type relative to the scale for a household with the same number of adults without children. As we have seen, this means that one of the most important scales, the scale for the childless couple, was determined either by the assumption of the scale itself or by the functional form assumed that all the scales would follow. While we have explored this latter strategy, it is now time to examine its implications. While we have explored various specifications for the scale formula, in all cases the scale for a childless couple was assumed to be 2^F where F is the economies of scale factor. We have seen that the appropriate or a reasonable value for F depended upon how we counted children in relationship to adults and what data we would want to be consistent, the current poverty scales or the scales implicit from spending patterns on children. A summary of findings are reported in the following table.

Table 8
Summary of Values for p and F

Data and Assumptions Used in Estimation of :	p	F	$\frac{S(2,0)}{S(1,0)}$	$\frac{S(1,0)}{S(2,0)}$
Current Poverty Scales (All family types)	.93	.51	1.42	.70
Current Poverty Scales (Single Parents with 1 and 2 children and Two Parents with 1 to 3 children)	.70	.55	1.46	.68
Spending Patterns on Children	.70	.76	1.69	.59
Spending Patterns on Children (All Children count as Adults)	1.00	.60	1.52	.66

The current scale for childless couples is 1.28 (= S(2,0)/S(1,0)) or equivalently stated the single individual's needs is 78 percent of that of a childless couple. Using just this scale, the corresponding value for F would be .36. Compared to the scales for childless couples which were inferred either from smoothing the current scales or what we inferred from spending patterns on children, we would infer a significantly larger economies of scales than what is assumed in the current scales. This means that as we move from a single individual to a couple, the current scales assume much smaller increases in the family needs than we find from other sources even from the smoothing of the current scales. On the other hand, when one of the adults leaves or dies, the current scales imply the amount of reduction in needs will be smaller than implied by any of the scales we have produced here.

Ideally, we would like some evidence on the scale for childless couples. Unfortunately, the methods used to allocate consumption to children in families are inappropriate for the allocation of consumption between adults in households. However, we can compare the results of three alternative approaches : expert judgment; utility based approach; and subjective scales. The first approach relies upon individual or panels of experts who provide their judgment of what is considered to be reasonable scales. While the scales created out of this process may be based upon some empirical evidence they are more likely to reflect the subjective views of the experts. The current poverty lines are an example of such a process. The second approach is similar in spirit to the methods employed in the cost of children literature since the allocation of consumption within the household is accomplished by comparing equally well off households of different compositions. But the proxies used in allocating expenditures to children are felt to be inappropriate for comparing two adult families with single adult families and hence specific utility function must be assumed. It should be emphasized that the choice of functional form for the utility function can be highly restrictive and hence bias the estimates of the "cost" of additional adults as well as children in the family. The third approach is very similar to the expert judgment approach except instead of asking "experts" about their judgment about the appropriate scales, this approach asks the "person on the street" through survey techniques. A survey of the scales for childless couples are presented in Table 9.

Table 9

Percentage Increase in Needs for Adding One Adult to a Single Individual

Expert Judgment :	
Official Poverty Lines	
Non-Elderly Head	29%
Elderly Head	26%
BLS Family Budget	
Non-Elderly Head	40%
Elderly Head	83%
OECD	70%
Canada Low Income Cut Offs	36%
Utility Based :	
Van der Gaag and Smolensky (1982)	
Non-Elderly Head	28%
Elderly Head	41%
Merz et al (1993)	
Non-Elderly Head	69%
Elderly Head	64%
Subjective :	
Danziger et al (1984)	
Non-Elderly Head	25%
Elderly Head	23%
DeVos and Garner (1989)	
Non-Elderly Head	37%
Elderly Head	63%

As Table 9 demonstrates, there exists wide variation in the estimates of how much more does a childless couple need compared to a single individual. To compare the various approaches, we will focus upon simple averages of the various estimates. The Subjective Approach provides the lowest estimates of the increase in needs, 37 percent. At the other end of the spectrum are the estimates from the Utility Based Approach which had an average of 51 percent increase in needs. Perhaps not too unsurprising, the Expert

Judgment Approach provided the middle ground estimates of an average 49 percent increase if all the scales were considered and an average of 45 percent if only the scales from the U.S. were considered.

While some individual estimates of the childless couple scale are consistent with the one implicit in the current thresholds, the overall average of the estimates suggest that the current scale is too small. On the hand, the estimate of the childless couple scale from our previous analysis of the spending patterns on children, 1.69, is at the high end of possible values. If we assume that all children count as adults (p = 1.00), the value of F which best fits the spending patterns on children is .60 implying a scale for a childless couple of 1.52 which is much closer to the averages from other approaches.

The Watts proposal of using an economies of scale factor of .50 implies a scale for a childless couple of 1.41 which is also clearly in the range of possible values for this scale. Combined with the observation we made earlier that the Watts proposal provides a good summary of the current scales, it is not surprising that this proposal has gained a lot of attention. What those individuals have failed to consider in their endorsement is that the current scales and hence also the Watts proposal, underestimate the needs of children especially in two parent families.

The NAS Panel's recommendations of values of .70 for p and .75 for F were based upon their concern of being consistent with our knowledge about how parents spend on their children. But employing these values implies that the threshold for a single individual would 40 percent of the threshold of a family of two adults and two children. Currently, the thresholds of a non-elderly single individual is 51 percent of the family of four and the threshold for an elderly individual is 47 percent. Focusing upon this comparison, the Panel was concerned that it might not be justified in reducing the threshold for single individuals as much as would have been implied by its analysis given the precision in the estimates of the spending patterns on children. To signal this uncertainty, the Panel chose to provide a lower bound value for F of .65 while keeping the value of p at .70. This ad hoc adjustment in the value for F increased the threshold of the single individual to be 45 percent of the family of four and a scale for the childless couple of 1.57. Unfortunately, in trying to solve one problem, the Panel created another. By maintaining a value of .70 for p, the implicit spending on children was reduced when F was reduced to .65. Again the most significant departures from the estimates of spending on children was in the two parent families. To be consistent with the cost of children literature when using a value of .65 for F, children's needs must be assumed to be 85 percent of that of adult's needs.

But if we wish to constrain the scale for childless couples to be a specific value and at the same time provide the "best" values for the other parameters of the scale formula, (c, p, and F), we can reformulate our fitting procedure by minimizing the squared deviations of the fitted scales for a family type from the

scales implied by the value for S(2,0) and the spending patterns from the cost of children literature. In particular, the deviations for single and two parent families would be equal to

$$\text{Single Parent (K=1,2)} : \quad \frac{1}{1 - \omega(1,K)} \; - \; (1+c + p(K-1))^F$$

$$\text{Two Parent (K=1,2,3)} : \quad \frac{1}{1 - \omega(2,K)} \; S(2,0) \; - \; (2+pK)^F \, .$$

If the scale for the childless couples is fixed at the value implicit in the Watts formula, 1.414, the values for c, p, and F which minimize the sum squared deviations are equal to .815, .519, and .689. If a slightly larger value of 1.50 is used for S(2,0)[6] then the minimizing values for c, p, and F are .671, .446, and .777.

In this section of the paper, I have attempted to outline what could constitute a reasonable set of equivalence scales. To aid us in comparing alternative scales, I proposed that all possible scales be expressed in a common form, $(A + pK)^F$, where A and K are the number of adults and children respectively, and p is the relative proportion of children's needs to adult's needs, and F is the economies of scale factor in household consumption. We latter considered a modification to the above formula for single parent families which counted the needs of the first child in these families as c instead of p. The single criterion that was used in the selection of the three parameters, c, p, and F, was whether or not the scales were consistent with our existing knowledge about the economies of consumption within the household. Since most our knowledge about household consumption is from studies about children, it is not too surprising that this literature could not provide all the necessary information upon which to base a set of scales. The gaps in our knowledge had to be filled by assumption or by our intuition.

To summarize the findings of this section's discussion, we begin with the Watts proposal of adopting the square root of the family size as the equivalence scale. As we saw, this formula provides a reasonable smoothing of the current scales but the implied spending on children was lower than what has been estimated in the literature. But the inclusion of this proposal in our analysis is warranted given the wide attention it has received. However, all the remaining scales I will analyze have been constructed to be consistent with the cost of children literature. The differences in the scales will be due to different assumptions used to the scales for childless couples and single parent families.

In its report, the NAS Panel suggested that the needs of children be counted as p percent of that of an adult and that all scales be derived from the explicit formula $(A+pK)^F$ where the parameters p and F where

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6 This value is consistent with the Social Security adjustment for benefits.

chosen to be consistent with spending patterns on children. This set of parameters provided what might be called an "upper" bound based upon the value for the economies of scale factor, F, which was "high" relative to the value used in the Watts proposal. The higher value for the economies of scale factor imply that the scales will increase faster with the size of the family and hence the relative difference between the needs of the single individual and all other family sizes will be larger. Since the Panel had also proposed to set the level of the threshold using the family of four as the reference unit (this topic will be discussed in the next section), they were concerned about the relationship between the single individual and the family of four implied by their estimate. Given the uncertainty in the data used to estimate p and F, the Panel recommended that a "reasonable" lower bound for F would be .65. While the Panel did not recalibrate the value of p to be consistent with this lower value of F and estimates of spending on children, I have and will use .85 for p in the analysis to follow.

While the Panel explicitly addressed the relative position of single individuals and childless couples in their ad hoc modification of the economies of scale factor, F, they did not similarly address the relative needs of single parents. In the Panel's formulation, single parent families are assumed to need less than families of the same size but with more adults. The current thresholds assume that for families of four or less, the single parent families need more. While intuition may lead us to conclude that the Panel's recommendation was reasonable, we have no independent evidence that it indeed is the case. One proposal would in the absence of such evidence, we should count children as adults just as in the Watts proposal but utilize an economies of scale factor which generate spending patterns on children more consistent with our estimates.

The final set of scales we will consider allow for the first child in a single parent family to count differently than other children, c, and for the independent setting of the scale for a childless couple, S(2,0). Two values for the childless couple were selected (1.414 and 1.50), the remaining three parameters, c, p, and F, were chosen so as to replicate observed spending patterns on children. Of all the scales considered in this paper, this option allows for the greater flexibility in the scales.

While the values for all the parameters were originally chosen with the various criteria in mind, for the purpose of the analysis and presentation, the values have been "rounded." The exact parameter values that we will consider are summarized in Table 10.

Table 10

Alternative Scale Formula Specifications

	c	p	F
Watts	1.00	1.00	.50
NAS Panel :			
Upper Bound	.70	.70	.75
Lower Bound	.85	.85	.65
"Children Count As Adults"	1.00	1.00	.60
Fix Scale for Childless Couple			
S(2,0) = 1.41	.80	.50	.70
S(2,0) = 1.50	.70	.45	.75

C. The Choice of Reference Unit

The NAS Panel proposed setting poverty thresholds by first selecting a level of need for the reference family unit and then to use a set of equivalence scales to create thresholds for other family types. This procedure requires that three choices be made: the choice of reference family, the choice of a level of needs for that family type, and the choice of equivalence scales. Clearly, uncertainty surrounding the appropriate values for the reference thresholds and scales will be reflected in the variation of the poverty thresholds. What is not clear is how the choice of reference unit will interact with these uncertainties. The question that this section attempts to answer, is the choice of reference family unit an arbitrary choice or can the choice of reference family serve to reduce the amount of variation in possible thresholds?

While in principle any family type could be chosen as the reference family, we will consider only two possible candidates, the single individual and the family of four composed of two adults and two children. The single individual is a likely candidate given our previous discussion of equivalence scales was based upon using this "lowest common denominator" to judge the reasonableness of the scales. However, the NAS Panel recommended that the family of four to be used as the reference family. They based this recommendation upon the observation that the choice of a family unit more central to the distribution of family types would reduce the sensitivity of the thresholds to the choice of the equivalence scales. To elaborate on that point, we begin by making two simplify assumptions. First, we let us assume that we know with certainty the reference threshold if we use either the single individual or the family of four as the reference family. We will further assume that all children can be counted as adults and hence all scales can be written as N^F where N is number of family members. The economies of scale factor, F, is not known with certainty and will be treated as a random variable. While the above formula for the scales is expressed relative to the single individual, they can also be express relative to any other family type. In this case where the family of four is used as the reference family, the scales are equal to $(N/4)^F$.

Given this notation, the poverty thresholds for any family size, T(N) when using either the single individual or the family of four can be written as

Reference Family is the Single Individual : $T(N) = T_1 \times N^F$

Reference Family is the Family of Four : $T(N) = T_4 \times (N/4)^F$.

where T_1 and T_4 are the thresholds when we utilize the single individual and family of four as the reference unit. The variation in the thresholds for any family size is directly related to our uncertainty or variation in

F, the economies of scale factor. Logically, the economies of scale of household consumption will be bounded by zero and one. If we assume complete ignorance about the economies of scale of consumption in households, we can characterize F as an uniform random variable from the unit interval [0,1]. Alternatively, we could have more information about F. In particular, we could believe based upon our analysis of the spending patterns on children that a good guess about F is .60. To reflect our uncertainty, we assume that F is normally distributed with a mean of .60 and a standard deviation of .10. To isolate the interaction of the choice of reference family has with the uncertainty about the scale, we measure the extent of variation in the thresholds by family size in terms of the coefficient of variation in the thresholds or the standard deviation of the threshold divided by the mean threshold for any family size. Since the threshold is a nonlinear function of the random variable, F, I have computed the coefficient of variation by family size by constructing a sample of 10,000 scales by drawing from the two assumed distributions of F. The results of these calculations are presented in the following table.

Table 11

Variation in Thresholds by Family Size Due to Uncertainty in Equivalence Scales and Choice of Reference Family

		Ignorance of F		Mean of F = .60	
Family Size	Percentage of Population	Reference Family : 1	4	Reference Family : 1	4
1	14.5%	.000	.394	.000	.140
2	23.2%	.199	.199	.070	.070
3	19.5%	.313	.083	.111	.029
4	22.8%	.394	.000	.140	.000
5	11.9%	.454	.064	.164	.022
6	4.9%	.503	.117	.183	.041
7	3.2%	.544	.161	.199	.056
Overall Average*		.289	.138	.235	.049

* The overall averages across family sizes were constructed using the relative probability that the family size is represented in the U.S. population.

Table 11 indicates that the use of the single individual as the reference family will increase the relative variation in poverty thresholds for all family sizes greater than two persons. For two individuals, the choice of reference does not affect the relative variation in scales and only in the case of the family of one does the choice of the single individual reduce the variation in the threshold. This result is independent the amount of uncertainty we have about F. Given this pattern it is not surprising that when the coefficients of variation by family size are weighted by their relative representation in the population (by persons), the average relative variation in thresholds is roughly halved when we use the family of four as the reference unit as opposed to using the single individual.[7]

Having provided a rationale for selecting the family of four composed of two adults and two children as the reference family, Table 12 presents the current scales and the six alternative scales expressed in terms of the family of four. By comparing each alternative scale with the current scale, we can investigate the impact of changing equivalence scales on poverty rates if the threshold for reference family of four remains unchanged.

The adoption of the alternative scales have a significant impact on the poverty thresholds of single individuals. Thresholds for the non-elderly single individuals will be lower under all six alternatives. With the exception of the Watts scale, a similar conclusion can be drawn for elderly single individuals even though the distinction between the elderly and non-elderly has been eliminated. From the discussion in the previous section, we can provide an explanation for this result. The movement from the family of four to the single individual can be best thought of as having two components: the change from the family of four to a childless couple and from the childless couple to the single individual. The first component involves eliminating the two children from consideration of the family's needs. We have equated the reduction in the household's needs to the amount of the household's budget which was spent on the children. The current scales imply that 34 percent of the budget is for the children which is very close to what the cost of children literature has estimated what two parents spend on their children. Thus we would expect that all the constructed scales which closely match spending patterns on children to be very close to the current scales and indeed this what we see in Table 12. The only exception is the Watts proposal which as we noted in the previous section implicitly assumes smaller levels of spending on children than either the current scales or what is found in the literature.

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7 A good approximation to the coefficient of variation of the threshold for a given family size is provided by

$$SD(F) \times | Log[N/R] |$$

where SD(F) is the standard deviation of F and R is the number of individuals in the reference family. This expression is standard deviation of the log of the threshold.

Table 12

Comparison of Alternative Scales Expressed Relative to the Family of Four - Two Adult and Two Children

	Percentage of All Persons	Current Scales	ALTERNATIVE SCALES: Watts Proposal c=1.00 p=1.00 F=.50	NRC Panel :Count Children Upper c=.70 p=.70 F=.75	NRC Panel :Count Children Lower c=.85 p=.85 F=.65	NRC Panel :Count Children as Adults c=1.00 p=1.00 F=.60	Fix S(2,0) Scale S(2,0)=1.41 c=.80 p=.50 F=.70	Fix S(2,0) Scale S(2,0)=1.50 c=.70 p=.45 F=.75
Single Individual								
Non-Elderly	10.5%	.513						
Elderly	4.0%	.473						
All	14.5%		.500	.399	.427	.435	.463	.450
Childless Couple								
Non-Elderly	13.8%	.660						
Elderly	6.4%	.596						
All	20.2%		.707	.672	.670	.660	.655	.675
One Adult with :								
One Child	3.0%	.680	.707	.595	.637	.660	.699	.670
Two Children	3.0%	.795	.866	.770	.815	.841	.830	.799
Three Children	1.5%	1.003	1.000	.933	.973	1.000	.953	.921
Two Adults with :								
One Child	9.7%	.794	.866	.841	.844	.841	.800	.881
Two Children	14.9%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Three Children	7.2%	1.177	1.118	1.151	1.144	1.143	1.114	1.114
Four Children	2.3%	1.318	1.225	1.295	1.279	1.275	1.223	1.225

The second component, the move from a childless couple to the single individual, is governed by the amount of economies of scales due to the addition of the second adult in the family. As we have noted, the current scales assume that there is a considerable economies from the addition of the second adult, far more than what is perhaps believable. All the alternative scales assume smaller economies of scale which mean that the proportional difference between childless couples and single individuals will be larger. Since the alternative scales based upon spending patterns on children are roughly the same as the current scales for childless couples, these alternative scales will produced lower poverty thresholds based upon their assumption of smaller economies of scale for the second adult. The Watts proposal which also assume smaller economies of scale for the second adult creates single thresholds which are larger than the current threshold for single elderly individual but smaller than non-elderly individuals because the childless couple scale is significantly higher than any other scale. If the Watts proposal had built into reasonable spending assumptions on children, then using the identical economies of scales for the second adult, the scale for a single individual would had been on the order of .467 also lower than either of the current two scales for single individuals.

As we have noted the alternative scales for childless couples are larger than the current scale for non-elderly couples. The only exception is the slightly smaller scale created when the childless couple scale are fixed at 1.414 times that of the single individual. However, for elderly couples, the elimination of any distinction on the basis of the reference person's age creates thresholds for the elderly which are significantly larger than the current thresholds.

The relationship of scales of single parents to other families of the same had been a concern raised in the previous section. There are some that argue that given there is no evidence on this relationship, we should equate the scales and thresholds for these groups to families of equal size. The simple way to accomplish this relationship is to equate the needs of children to adults as in the Watts and "Count Children as Adults" proposal. But counting the first child in a single parent family and fixing the scale for childless couples will also create the "desired" relationship. In fact, when we fix the childless scale at 1.414, the single parents with two or less children have scales which larger than two adults present, the same pattern present in the current scales.

The relationship of the proposed scales for single parents to the current scales is a mixed picture. The Panel's upper bound proposal creates scales and hence thresholds which are significantly lower than the current scales especially for single parents with one child. Even counting children as adults does not guarantee that the scales for single parents will rise compared to the current scales. When the more reasonable economies of scale factor of .60 is used, scales single parents with one child would see their

thresholds decline compared to the current thresholds. Single parents with two children would see the poverty threshold rise in all the proposed scales except the Panel's upper bound proposal.

While economies of scale in consumption are an important determinate of how the scales will change with family size, it is not the only factor. Some have commented that the Panel's recommendations of using a relatively large economies of scale factor will favor the larger families sizes relative to the smaller. While we have seen that scales for single individuals would fall, Table 12 shows that the scales for two parents with three and four children would also fall under all the alternative proposals. The Watts proposal with an economies of scale factor of .50 does not even produce the lowest scales for these family types. Fixing the scale of the childless couples at 1.414 times the single individual's scale and also counting children's needs less than an adult uses a higher value for F but produces lower scales than the Watts.

D. Empirical Consequences of Alternative Scales

While the previous section documented how alternative specifications for the equivalence scales would compare to each other and to the current scales, this section investigates the extent to which the alternative scale specifications will affect the overall count and composition of the poverty population. We begin by examining the "pure" incremental effect of the alternative scales by recalculating the poverty population by holding the threshold of the family of four constant at $14,228 and setting the thresholds for all other family types using the alternative scales. The measure of resources used in determining whether the household is poor or not will be the current definition, Census money income. The only change that will be reflected in these simulations will be the change of all thresholds relative the threshold for the family of four. The results of these calculations are presented in Table 13.

Based upon our earlier discussion, we would expect that each demographic group will be differentially affected by the alterations of the scales in the poverty thresholds. Some groups can be expected to increase their representation in the poverty population while others will decline. There is no reason to believe that these shifts in the poverty population will balance out and the resulting total poverty count will be same as using the current thresholds. In 1992, the Census Bureau counted 14.5 percent of the population (36.9 million persons) to be poor. My calculations indicate that the adoption of alternative scales will have an impact on the overall count ranging from lowering the total poverty rate by .7 percentage points (1.8 million persons) to raising the rate by .4 percentage points (1.0 million persons). Of the six sets of scales examined, three (the Watts proposal and the two set of scales which fixed the scales of childless couples) lead to an increase in the number of poor. The other three scales (both NAS Panel scales and the "Count Children as Adults" where the economies of scale was set to .60) lead to overall reductions in the poverty population.

Our earlier discussion indicated that single individuals and couples, especially the elderly, would face the greatest change in their poverty thresholds. With sole exception of the Watts proposal, the thresholds for elderly single individuals would fall while all of the alternative scales would create higher thresholds for elderly couples. The recalculation of the poverty populations presented in Table 13 indicate that the poverty rate of the elderly population is sensitive to these changes. In the case of the Watts scale which would lead to increases in thresholds for both elderly single individuals and couples, the poverty rates of these groups rise significantly. The poverty rate of elderly single individuals rise by 2.7 percentage points (a 11 percent rise in the poverty rate) while the poverty rate of elderly couples are predicted to rise by 3.2 percentage points which corresponds to a 49 percent increase in their incidence of poverty. At the other extreme, the upper bound values for the equivalence scales suggested by the NAS Panel would lower the

Table 13

Pure Impact of Alternative Scales on the Poverty Rates of Demographic Groups

		Percentage Point Change from Current Poverty Rates					
		Watts Proposal	NAS Panel :Count Children			Fix S(2,0) Scale	
			Upper	Lower	as Adults	S(2,0)=1.41	S(2,0)=1.50
	Current Poverty Rates	c=1.00 p=1.00 F=.50	c=.70 p=.70 F=.75	c=.85 p=.85 F=.65	c=1.00 p=1.00 F=.60	c=.80 p=.50 F=.70	c=.70 p=.45 F=.75
Total Population	14.5	.4	-.7	-.4	-.5	.1	.1
Elderly Single Individuals :	24.9	2.7	-9.4	-5.5	-4.5	-1.1	-2.3
Elderly Couples :	6.5	3.2	2.1	2.0	1.7	1.6	2.2
All Elderly :	12.9	2.6	-1.8	-.7	-.6	.7	.9
Non-Elderly Single Individuals :	20.6	-.4	-4.7	-3.2	-3.0	-2.1	-2.5
Non-Elderly Couples :	5.4	1.0	.3	.3	.1	-.1	.4
Children :	21.9	-.2	-.5	-.3	-.3	-.2	-.4
Persons in Female Headed Families :	38.5	1.1	-.7	.1	.2	.7	.3
Persons in Family Size of :							
1	21.8	.5	-6.0	-3.9	-3.4	-1.8	-2.4
2	9.9	1.7	.3	.6	.5	.6	.8
3	12.0	1.7	.8	1.1	1.0	2.1	1.9
4	11.1	-.1	.0	-.1	-.1	.2	.4
5	16.6	-1.3	-.4	-.6	-.8	-.7	-.6
6	22.2	-2.2	-.4	-1.0	-1.4	-1.5	-.9
7+	35.1	-5.4	-.4	-2.5	-3.6	-2.2	-1.3

poverty rate for elderly singles by 9.4 percentage points or 38 percent reduction in the group's current poverty rate. As noted above, all the scales with the exception of the Watts scales would create lower thresholds for elderly single individuals. The lower bound values suggested by the Panel and the scales created by counting children as adults would also reduce poverty rates of elderly single individuals, however, the impact would be about one half that created by the Panel's upper bound scales. The strategy of fixing the scale for couples created thresholds which had the smallest impact on the reduction in poverty incidence among this group.

All of the six alternative scales created thresholds for elderly couples which are higher than current thresholds and consequently the poverty rates for this group rose when the poverty population were redrawn. The impact on the poverty rate of the elderly couples ranged from an increase of 1.6 to 3.2 percentage points or equivalently a 25 to 49 percent increase in incidence of poverty among the elderly couples.

While the total number of elderly rose significantly with the use of the Watts scales, the net impact on the number of poor elderly with the other five scales was mixed due to the falling number of elderly living alone combined with the rising number of elderly who lived with others. The Watts scales created a 20 percent increase in the number of elderly poor, while at the other extreme, the upper bound NAS Panel scales created a 14 percent reduction. The remaining four scales created either smaller increases or decreases in the elderly poor population.

Comparing the impact of the alternative scales between the elderly and non elderly populations, we see that the elderly population is much more sensitive to changes in their thresholds than is the non elderly. For example, the upper bound NAS Panel recommendation would create a threshold for all single individuals of $5,677 if the threshold for a family of four was held constant at its 1992 value of $14,228. In 1992, the threshold for a single individual under 65 was $7,299 and for an individual 65 and older, the poverty threshold was $6,729. Although the younger single individuals faced a larger reduction in their threshold, the reduction in the number of non elderly single individuals was significantly smaller than the reduction of the number of elderly singles. In the case of the non elderly singles, a 22 percent reduction in the threshold created a 23 percent reduction in their poverty count. For elderly singles, a 16 percent reduction in their threshold created a 38 percent reduction in poverty. Elderly couples appeared to be equally sensitive to changes in their thresholds. Using the upper bound NAS scales, thresholds for elderly couples increased by 13 percent but their poverty count rises by 32 percent.

While the selection of scales have been shown to have a significant impact on the poverty rate of the elderly population, the alternative scales are not predicted to have such a large impact upon other subgroups

of the population. For example, the number of children in poverty are reduced by all of the scales examined in this paper but the largest reduction is only 2.2 percent. The number of poor living in families headed by a single female families is relatively unaffected (the largest change is only 3 percent) by the scales. Only in the case of the upper bound NAS recommendations, does the number of poor living in female headed families fall but again by rather small percent, 1.8.

The poverty rates of one classification of the population which would be easily affected by alternative scales would be the classification by family size. We have already examined the impact of the scales on single individuals (family sizes of one) and couples but it is also very instructive to examine the differential impact on other family sizes. If we ignore the single individuals in our comparison, the upper bound NAS Panel creates almost a neutral impact on poverty rates by family size. Only for family size of three, does the incidence of poverty change by more than five percent when using these scales. The same can not be said for other scales. At the other extreme, the Watts proposal has the largest impact on poverty rates by family size. Compared to the current thresholds, the Watts scales significantly increases poverty rates for families of two and three while reducing poverty rates for families of five and more. While this pattern of changes in poverty rates is shared by all scales, the Watts scales represent an extreme.

Reformulating the equivalence scales in the poverty thresholds was only one of several recommendations made by the NAS Panel. The Panel also recommended that the poverty thresholds reflect variation in the geographic cost-of-living as well as numerous changes to the definition of family resources. To explore how the six alternative scales would interact with the Panel's other recommendations, I have recalculated the poverty population using the six alternative scales with the remainder of the Panel's recommendations. To facilitate a comparison of the poverty composition under the six alternative scales, I have adjusted the poverty threshold for the family of four so that the total poverty count under each alternative was identical to the current count of 14.5 percent of the population.[8] The impact on the poverty rate of various subgroups are reported in Table 14.

If we compare the impact of alternative scaling of the poverty thresholds when all the Panel's recommendations are implemented, we see that a pattern of differential impacts on poverty rates similar to what was found when only the scales were changed. The only difference is the magnitude of the impact on the various subgroups. Again the main story is that the alternative scales will have a differential impact on how we view the incidence of poverty among single individuals especially the elderly. But the rest of the story is similar. There would be fewer children especially fewer children living in families headed by

[8] The thresholds had to be reduced from the 1992 threshold of $14,228 to a level ranging from $12,383 for the Watts scales to $12,930 for the upper bound value of the NAS Panel. The threshold for the family of four which were employed in each alternative are reported in Table 14.

Table 14

Impact of Alternative Scales and other NAS Recommendations on the Poverty Rates of Demographic Groups

		Percentage Point Change from Current Poverty Rates					
		Watts Proposal	NAS Panel :Count Children Upper	Lower	as Adults	Fix S(2,0) Scale S(2,0)=1.41	S(2,0)=1.50
Poverty Line :		$12,383 c=1.00 p=1.00 F=.50	$12,930 c=.70 p=.70 F=.75	$12,805 c=.85 p=.85 F=.65	$12,780 c=1.00 p=1.00 F=.60	$12,520 c=.80 p=.50 F=.70	$12,576 c=.70 p=.45 F=.75
	Current Poverty Rate						
All Elderly	12.9	5.8	3.3	3.7	3.6	4.1	4.3
Elderly Single Individuals	24.9	.5	-7.4	-5.3	-4.7	-2.6	-3.7
Elderly Couples	6.5	10.0	9.9	9.5	9.0	8.3	9.1
Non-Elderly Single Individuals	20.6	.1	-4.3	-3.0	-2.6	-1.6	-2.3
Non-Elderly Couples	5.4	1.9	1.7	1.6	1.4	1.0	1.5
Children	21.9	-2.6	-1.4	-1.5	-1.3	-2.4	-2.6
Female Headed Families	38.5	-4.5	-5.0	-4.2	-3.8	-5.0	-5.7
Other Families with Children	10.1	-.7	1.1	.5	.4	.2	.5
Family Size :							
1	21.8	.2	-5.1	-3.6	-3.2	-1.9	-2.7
2	9.9	3.4	2.5	2.6	2.6	2.4	2.6
3	12.0	.8	.5	.7	.8	1.4	1.3
4	11.1	-.4	.8	.4	.4	.3	.3
5	16.6	-2.9	-.3	-.9	-1.0	-2.2	-2.0
6	22.2	-4.8	-1.3	-2.2	-2.4	-3.7	-3.0
7+	35.1	-9.4	-.6	-3.6	-4.8	-5.3	-4.5

Table 14 -- Continued

Impact of Alternative Scales and other NAS Recommendatons on the Poverty Rates of Demographic Groups

		Percentage Point Change from Current Poverty Rates					
		Watts Proposal	NAS Panel :Count Children Upper	Lower	as Adults	Fix S(2,0) Scale S(2,0)=1.41	S(2,0)=1.50
	Poverty Line :	$12,383 c=1.00 p=1.00 F=.50	$12,930 c=.70 p=.70 F=.75	$12,805 c=.85 p=.85 F=.65	$12,780 c=1.00 p=1.00 F=.60	$12,520 c=.80 p=.50 F=.70	$12,576 c=.70 p=.45 F=.75
	Current Poverty Rate						
Weeks Worked :							
0 weeks	38.2	-1.7	-3.3	-2.9	-2.9	-2.7	-2.8
48-52 weeks	4.9	.9	1.4	1.3	1.2	1.2	1.2
Received Cash Welfare	59.4	-16.7	-16.4	-15.7	-15.5	-16.5	-17.5
No Health Care Insurance	32.0	2.7	3.8	3.2	3.0	3.8	4.1
White	11.6	.7	.6	.6	.6	.6	.7
Black	33.2	-4.4	-4.2	-4.0	-3.8	-4.2	-4.6
Hispanic	29.4	.4	3.1	2.1	1.6	2.3	2.6

single females. Poverty rates for families of two and three would rise while poverty rates for families of five or more would decline. The only differences between scales is with regard to the magnitude of the number of persons either drawn into poverty or removed from the rank of the poor. This observation on the relative unimportance of alternative scales can be extended to classifications based on economic variables and demographic variables not directly taken into account in either the current scales nor the alternatives. For example, if we examine poverty rates among those individuals who received cash welfare, alternative scaling does not appear to have any impact on the story other than to change the number of persons reclassified as poor.

Conclusions

The purpose of this paper has been threefold. First, we sought to question the current poverty thresholds not in terms of their absolute level but with respect to their relative relation to each other. In particular, we explored the equivalence scales implicit in the current poverty thresholds. Based upon the evidence provided, we arrived at the conclusion, that the current thresholds contain a set of scales which are erratic and in some instances indefensible.

To correct these shortcomings, we then turned to the problematic question of defining what would constitute a reasonable set of scales. Could a reasonable set of scales be constructed from a smoothing of the current thresholds? If so, then the Watts proposal of using the square root of family size would provide a rough approximation to the current scales. But the problems with the current set of scales were not just confined to a lack of "smoothness" but they were also shown to understate the relative spending on children relative to adults which have been estimated from the cost of children literature. Smoothing of the current scales would not rectify this problem and in fact tended to widen the gap between the implicit spending on children in the proposed scales and the estimates on child spending found in the literature. If we adopt the minimum criterion that the scales should be consistent with our estimates of spending on children then the case in favor of the Watts scales is greatly diminished.

However, to base the scales on our empirical estimates of spending on children did not uniquely define a set of scales. Other assumptions and normative judgments had to be adopted. To highlight how alternative assumptions about the relative needs of children and the needs of childless couples relative to the needs of single adults could play an important factor in determining a set of equivalence scales, I derived five alternative sets of scales which were all consistent with our empirical knowledge about spending on children. The lesson that I hope was underscored is that it is impossible to identify a set of scales based solely upon the observed behavior of households, additional assumptions have to be made which can not be verified. These assumptions can either take the form of assuming a specific formula can describe the entire set of scales to clearly normative propositions that child should count the same as adults when it comes to formulating what a household needs.

If the chosen set of scales depended upon arbitrary assumptions, one would hope that the assumptions would not seriously affect either the scales or the picture of who is poor. But unfortunately that is not the case. Our picture of the number of elderly and the number of poor living alone is greatly affected by the scales which are employed. While the profession has spent significant resources to examine the question of economies of scale of additional children to a family, the scale relating one and two adults has not been investigated. As this paper has demonstrated, it is this scale which has created many of the problems in the

current thresholds and is crucial in deciding which set of scales is indeed reasonable for poverty measurement. Clearly a research program which shed some light upon this issue is needed.

One approach which would be feasible as well as potentially fruitful, is the use of survey questions to estimate subjective equivalence scales for childless couples and single parent families with one child. I would suggest augmenting an existing survey with the maximum of two questions which would be asked of a subsample of the survey. For individuals living alone, I would ask the following two questions :

> "How much more would you have to spend on food, clothing, and shelter, if you instead of living alone, you lived with another adult?"
>
> "How much more would you have to spend on food, clothing, and shelter, if you instead of living alone, you had a child?"

For childless couples, I would augment the survey with the following question :

> "How much less would you have to spend on food, clothing, and shelter, if you instead of living with your spouse, you lived alone?"

For the single parents with one child, I would ask :

> "How much less would you have to spend on food, clothing, and shelter, if you instead of living with your child, you lived alone?"

While the exact wording of the questions would need further thought, the answers to these questions as well as other socio-demographic information from the survey would allow us to estimate directly what individuals thought were reasonable economies of scales in consumption and the extent to which "loss aversion" is important to the construction of equivalence scales.