

Developing Poverty Thresholds Using Expenditure Data

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In its 1995 report, *Measuring Poverty: A New Approach*, the National Research Council of the National Academy of Sciences (NAS) Panel on Poverty and Family Assistance suggested developing a poverty measure that is understandable and broadly accepted by the public, statistically defensible and operationally feasible (see Citro and Michael (1995)). The Panel suggested ways to define the reference threshold using data from the Consumer Expenditure (CE) Survey, to update the threshold over time, to account for households with varying compositions, and to adjust for inter-area price differences. The Panel also suggested ways to revise the resource measure; however, we focus on their recommendations pertaining to the poverty thresholds.

A recent study by researchers at the Bureau of Labor Statistics and Bureau of the Census (Garner et al. (1997), referred to as BLS/Census study) replicated the Panel's work, estimated experimental thresholds using CE data and revised the resource measure. The study found that changes in the Panel's proposed thresholds and their experimental thresholds (based on various definitions of a minimum expenditure bundle) appear to be similar over the time period covered. The study also found that poverty rates based on these thresholds followed trends over time that are similar to trends in the current official poverty measure. The study also found, however, that the poverty rates based on these alternative thresholds and resource measures were always higher, both over time and across thresholds and subgroups, than were rates based on the official measure.

Since the initial BLS/Census study was conducted, two additional government and non-government groups¹ have identified areas requiring further research. Those areas related to the construction of poverty thresholds are:

- *Setting the initial poverty thresholds.* Should the initial poverty threshold remain unchanged?
- *The treatment of housing.* Should out-of-pocket housing expenditures be used or should such costs be estimated using a flow of services from home ownership, e.g., reported rental equivalence or imputed rent?
- *Updating the thresholds over time.* Should the thresholds be updated based on the change in median expenditures for a basic bundle of goods and services or by a price index?
- *Determining the geographical index.* How should the thresholds be adjusted for differences in prices across geographical areas?
- *Choosing an equivalence scale.* How should the thresholds be adjusted for differences in household sizes and types?

In this paper, we examine each of these five issues, focusing on the data and methodological issues related to the estimation of thresholds using CE data. We find that alternative definitions of the reference threshold do not significantly change the thresholds, with the treatment of homeownership having the largest effect. Thresholds based on imputed rents for owners result in lower thresholds than when the thresholds are based on out-of-pocket shelter costs, while higher thresholds result when shelter costs for owners are defined as reported rental equivalence. We find that updating the threshold using the change in median expenditures (the Panel's proposed method) rather than the change in the all-items Consumer Price Index (CPI-U) leads to a slightly larger increase in the thresholds between 1982 and 1995, but the change in

¹ These groups are the Office of Management and Budget Steering Group to Improve the Measurement of Income and Poverty and a team of

median expenditures has a higher variance than the change in the CPI-U. We also find that the geographic adjustment recommended by the Panel (a cost-of-living housing index based on a Housing and Urban Development (HUD) approach) yields similar results to those using BLS inter-area price indexes for 11 major expenditure categories. In addition, we find that the equivalence scale recommended by the Panel yields similar thresholds (using a two-adult, two-child reference household) to those resulting if other household types are chosen as the reference unit.

To assist in examining the effects of these methodological issues, we use thresholds derived in this study along with cash incomes from the Current Population Survey (CPS) to produce poverty rates for selected population groups in the U.S. in 1995. Replacing the Panel's cost-of-living housing index with one that accounts for more expenditure items has a minimal effect on the overall poverty rate, yet this replacement changes the poverty rates by region--rising in the Northeast and metropolitan areas and falling in the South and non-metropolitan areas. The percentage of poor children is not as sensitive to the equivalence scale used as are the percentage of elderly, married couples, and unrelated households.

In section I, we review the Panel's proposed formula for computing the thresholds and defining the reference unit and examine alternative methods for computing the thresholds. Section II examines the treatment of shelter expenditures in the thresholds. Section III deals with the Panel's recommendation to update the thresholds over time. Section IV compares the geographic adjustment made by the Panel to BLS experimental inter-area price indexes. Section V evaluates the adequacy of the proposed two-parameter equivalence scale used to produce the Panel's

researchers from the Brookings Institution and the Institute for Research on Poverty (see Burtless, Corbett and Primus (1997)).

thresholds. Section VI compares the thresholds to CPS income data to show the impact of changing the threshold definition on poverty rates and the distribution of the poverty population.

I. Determining the level of the threshold

The NAS Panel recommended that CE Survey data be used to calculate the thresholds for a particular year. Median expenditures for the reference household unit (adjusted to current dollars) are calculated using expenditures for food, clothing, shelter, and utilities (FCSU) for the three-year period previous to the current year. The resulting thresholds are based on a percentage of the median level of expenditures for FCSU and a small multiplier to account for other expenditures. The threshold for the reference unit is adjusted to reflect differences in costs associated with geographic location and household type. The Panel recommended the following formula for deriving the proposed poverty threshold for the reference unit:

$$T = \left[\frac{(M1 * P1 * median) + (M2 * P2 * median)}{2} \right]$$
$$= \left[\frac{(1.15 * .78) + (1.25 * .83)}{2} \right] * median$$

(where T = the reference family poverty threshold, $M1$, $M2$ = multipliers for a small additional amount, $P1$, $P2$ = some percentage level, $median$ = median expenditures for the basic bundle of food, clothing, shelter, and utilities).

The Panel recommended that the percentage of median expenditures should lie between 78 percent and 83 percent, corresponding to the 30th and 35th percentiles of the distribution of FCSU expenditures for a family composed of a married couple and two children. The Panel recommended a lower and upper value for the multiplier of 1.15 and 1.25, respectively. The threshold is computed by taking the average of these upper and lower values for both the

percentages and multipliers (as in the above equation), with the result being that the threshold equals $0.96725 \times$ median expenditures for the basic bundle.

The level of the basic threshold, before adjusting for differences in costs and in household composition, depends upon the definition of the basic bundle, the percentage values used to adjust the medians and the multipliers. In this paper, we use the multipliers and percentage values suggested by the Panel, which were also used in the BLS/Census study, to examine different methods for obtaining the median expenditures upon which the thresholds are based. The thresholds might change more dramatically if the percentages and multipliers were also calculated using the different methods.

To obtain the median expenditures on FCSU for the reference unit, the Panel pooled the prior three years of data. Because current year data may not be available in time to produce the thresholds, the Panel used data from prior years; however, the Panel did recommend that the most recent three years of data be used when available. For this study, we calculate the thresholds using data from the most recent three-year period. Specifically, the median FCSU for 1995 is calculated for the reference household using data from 1993 to 1995 updated to 1995 dollars with the CPI-U.

While the Panel recommended using a household with two adults (married or unmarried) and two children as the reference household, the Panel's calculations (and those of the BLS/Census study) were based on the expenditures of a consumer unit² composed of a married couple with two children.

Table 1 compares the method suggested by Panel (using the previous three-year period) to thresholds calculated using the most recent three years of data. Table 1 also presents the

² The terms family, household, and consumer unit are used interchangeably throughout this paper. See USDL1 for definition of consumer unit.

thresholds produced in the BLS/Census study and the official Census thresholds. Table 1 shows that using married couples with two children as the reference household and using the weighted median instead of the mean of the middle vingtile (as in the BLS/Census study) does not change the thresholds (see column (2) and (3)) There is also no clear pattern concerning whether using the most recent three years of data or the previous three years of data results in higher or lower thresholds (column (4) and (5)). Finally, the official thresholds produced by the Census Bureau are lower for 1989 through 1995 than are the two thresholds based on the Panel’s proposal. Since the resulting thresholds are quite similar, we assume that the most recent data are available and use the thresholds from column five for our analysis.³

Table 1: Comparing the Panel’s approach to Thresholds Produced Using Different Methods

Year	(1) Official Census thresholds	(2) BLS/Census Threshold 1	(3) Using current approach for Married couple with two children	(4) Using two- adult/two-child reference household and previous three- year median	(5) Using two- adult/two-child reference household and most recent three-year median
1989	\$12,576		12,908	na ⁴	\$12,790 ¹²
1990	\$13,255	\$13,771	13,755	\$13,481	13,398
1991	\$13,812	14,341	14,350	13,962	13,891
1992	\$14,228	14,796	14,806	14,309	14,349
1993	\$14,654	15,262	15,380	14,779	14,936
1994	\$15,029	15,634	15,718	15,318	15,211
1995	\$15,455	16,117	16,170	15,642	15,561

³ The availability of the last quarter of CE data could hold up the release of current year estimates. In this case, one could use quarter 4 of the previous year through quarter 3 of the current year to produce thresholds for the current year. For example, for 1995, using the most recent three years of data (1994 quarter 4 to 1995 quarter 3 reference periods) yields similar results—lowering the threshold by a small amount (around \$10 in 1995).

⁴ For most of the analysis in this paper, we use CE data for 1987-95. Thus computing thresholds using the Panel’s proposed method means that the earliest year computed is for 1990. That is, 1987-89 data are updated to 1990 dollars to compute the 1990 thresholds in column (4). Alternatively, the thresholds in column (5) are obtained by using the most recent three years of data, e.g., the 1988-90 data are updated to 1990 dollars for the 1990 threshold.

Chart 1 also compares the choice of reference household. This chart shows that the level of median expenditures for married couples with two children is slightly higher than those for a household with two adults and two children. The error bounds for median expenditures of the reference household show that the median expenditures are not significantly different from each other.⁵

Alternative methods

In constructing the Panel's poverty thresholds, and those used in the BLS/Census study, each quarter of data was treated independently. The Panel, however, recommended using only those consumer units who reported a complete year of expenditures.

We consider this recommendation by using two-adult/two-child consumer units who participated in the CE Interview Survey for the full four quarters.⁶ The quarterly expenditures for each of the four quarters are aggregated to obtain an annual measure of expenditures for each consumer unit. Since young renters are under-represented in the sample of consumer units who remain in the CE Survey for all interviews, we adjust the weights for consumer units by age of the reference person and housing tenure (homeowner or renter). The thresholds using four-quarter consumer units yield thresholds that are less than 2 percent different from the thresholds obtained by treating each quarter of data independently. (See columns one and two of Table 2.)

Another way to calculate the thresholds is to change the method used to convert the expenditures to current year dollars. For example, to calculate the 1992 thresholds, the Panel used 1989-91 data adjusted to 1992 dollars with the all-items CPI-U. Increases in the all-items

⁵ Chart 1 shows the 90% confidence intervals for the median, which is plus or minus about \$600 for 1995 (and an average coefficient of variation of about 2%). The size of the standard error coupled with the small difference in the medians indicates that using CPI components does not yield a significantly different value of the median than using the all-items CPI. The same is true when using four-quarter consumer units.

⁶ Since 1980, these consumer units represent about 75-80 percent of all consumer units interviewed.

CPI-U represent the combined effect of changes in all prices but the prices of the components of FCSU may not rise at the same rate.

To examine whether differences in price changes among commodities affect the threshold calculations, we convert expenditures in each component of the basic bundle (i.e., food, apparel, shelter and utilities) into current dollars by the respective component CPI-U. The median expenditure is calculated using the sum of the component price adjusted expenditures. Our results reveal that the thresholds adjusted by component-specific CPI-U indexes are less than 1 percent lower than the all-items CPI-U adjusted threshold in all years except 1993, when it is slightly higher. (See column three of Table 2.) Table 2 shows that there is not much difference in the change in the threshold levels between 1989 and 1995.

Table 2: Basic threshold and alternative thresholds for the reference two-adult/two-child household

Year	(1) Basic Threshold using FCSU	(2) Using FCSU and Only four-quarter consumer units	(3) Using FCSU Adjusted by component CPI-U
1989	\$12,790	\$13,015	\$12,768
1990	\$13,398	\$13,609	\$13,361
1991	\$13,891	\$14,133	\$13,832
1992	\$14,349	\$14,413	\$14,269
1993	\$14,936	\$14,938	\$14,960
1994	\$15,211	\$15,402	\$15,101
1995	\$15,561	\$15,762	\$15,536
Percent change 1989-95	21.7%	21.1%	21.7%

II. The treatment of shelter expenditures for homeowners

To estimate shelter costs for homeowners, the Panel used the actual out-of-pocket expenditures as reported in the CE Survey.⁷ The BLS/Census research team also used out-of-

⁷ For homeowners, shelter expenditures include those for mortgage interest, property taxes, maintenance, repairs, and homeowner's insurance. Mortgage principal payments are not included.

pocket expenditures in their work but tested the use of a rental equivalence value collected in the CE Survey.⁸ Another way to estimate shelter costs for homeowners is to use hedonic regression-pricing models that relate observed market prices for housing to the implicit expenditures for specific characteristics of the housing unit. An hedonic model is used in this study to produce imputed rents for homeowners using rents paid by renters. We only produce thresholds for 1995 because we are still in the development stage for the hedonic specification; once the model has been refined, thresholds for the other years will be produced.

Estimated imputed rent is used in combination with expenditures that homeowner's report for housing maintenance, repairs, and insurance to obtain the final thresholds. This is in contrast to what the Panel recommended: "...a preferable definition [for the shelter variable for homeowners] would include actual outlays for mortgage payments, taxes, insurance, and maintenance and repairs, together with an imputed amount for the estimated rental value of the home net of such outlays."⁹ We decided only to include the imputed contract rent plus homeowner expenditures for housing maintenance, repairs, and insurance in order that owner and renter shelter costs would be comparable.¹⁰

Owner's imputed rent is based on a semilog regression of renter's contract rent on selected housing and location characteristic variables. Gillingham (1975) and others have found that a semilog regression fits the hedonic price-characteristics relationship fairly well. The rent variable, expenditure for contract rent¹¹ includes cash rent paid plus rent received as pay.¹² To be

⁸ Homeowners are asked, "If someone were to rent your home today, how much do you think it would rent for monthly, unfurnished and without utilities?"

⁹ Citro and Michael, 1995, p. 148.

¹⁰ It is likely that adding in *all* homeowner expenditures for these commodities results in an overestimate of maintenance, repairs, and insurance that are comparable to the expenditures paid by renters. In the future an adjustment will be made to allocate only part of homeowner expenditures for these commodities as in done in the computation of the CPI-U for owner shelter costs. For example, owner's shelter insurance will be adjusted to account for personal property replacement but will not include the insurance for the replacement of the housing structure itself.

¹¹ In the rent values reported, utilities may already be included in the rental price. In future analyses, a dummy variable will be added to the regression model to control for this. Interaction terms for whether the rent includes utilities with the number of rooms in the housing unit will also be added.

¹² Contract rent is created using data from the CE MTAB files. Cash rent is represented by UCC code 210110 and rent as pay as UCC code 800710.

included in the rental equation, renters are identified as renters in the CE database and as having reported a positive contract rent expenditure. Owners are identified as those consumer units owning their dwelling and having a positive expenditure for out-of-pocket shelter expenditures (as defined for the basic threshold definition), or a positive expenditure for rental equivalence. The requirement of some positive owner expenditure is added to ensure that the owner sample is actually composed of owners.

Following the procedure used to compute the 1995 thresholds in Table 1, we pool quarterly data from quarter one 1993 through quarter four 1995 for use in the regression estimation. Each quarterly interview is treated independently, resulting in data for 61,169 consumer units during this period. For this study, 21,810 consumer units are classified as renters and 38,293 as owners. The remaining units are either people living in college housing or renters who did not report a positive rental expenditure value.

The housing unit characteristics selected for the sample are in part based on the set used by Moulton (1995) and Kokoski et al. (1994) in their research on inter-area indexes of the cost of shelter using hedonic quality adjustment. To provide proxies for housing quality, they used 1980 U.S. Census group or enumeration district level variables, e.g., the percentage of housing units in an area which are mobile homes and the percentage of housing units with indoor plumbing. In future models we plan to include location data from the 1990 U.S. Census. Such data would allow us to add neighborhood characteristics to the CE file. This information would provide our best proxy for housing quality with data that are currently available. A list of the independent variables in the rental regression is presented in Appendix 2A. The hedonic regression is modeled using the following equation:

natural logarithm of rent paid by renters

= f [age of the dwelling, age of the dwelling squared, type of dwelling,¹³ age of housing unit*housing type, number of bedrooms, number of bedrooms squared, number of rooms other than bed rooms and baths, whether CU has more than one complete bathroom, whether the government pays part of the housing costs, whether the unit is public housing, type of heating,¹⁴ other amenities,¹⁵ geographic sampling areas (PSUs)]

Imputed rents for owners are estimated using the characteristics of owner housing and the coefficients that are obtained from the estimation of the above equation. The adjusted R-square value is 0.38 for the three-year sample.

Presented in Table 3 are the medians of quarterly shelter expenditures for consumer units with two adults and two children for both owners and renters. Owner expenditures are presented separately for consumer units with mortgages and those without mortgages. Table 3 shows that rents for renters are lower than imputed rents for owners with mortgages but are greater than imputed rents for owners without mortgages. For the four quarters in 1995, median imputed rents for the reference unit are between 58 and 70 percent higher for owners with mortgages than for owners without mortgages. The highest shelter costs are shown for homeowners with mortgages when costs are based on rental equivalence; the next highest values are for out-of-pocket shelter expenditures for homeowners with mortgages. Shelter costs are lowest for owners without mortgages when shelter is defined as out-of-pocket expenditures.

Table 3. Medians of Shelter Costs for Renters and Owners in Current Quarter and Year dollars, Quarterly Values for Two Adults with Two Children Consumer Units

Collection Period	Renters total rent	Owners							
		With a mortgage				Without a mortgage			
		imputed rent	Shelter with imputed Rent	Shelter as out-of-pocket	Shelter as rental equivalence	imputed rent	shelter with imputed rent	shelter as out-of-pocket	shelter as rental equivalence
95Q1	1350	1477	1658	2016	2250	933	985	220	1200
95Q2	1275	1519	1609	1885	2400	891	971	225	1473

¹³ Dummies for detached, row house, end unit townhouse, duplex, numplex, garden apartment, high rise apartment, flat, mobile home.

¹⁴ Dummies for type of heating is gas, electric, oil, or other.

¹⁵ Dummies for has swimming pool, tennis court, barn or stable, guest house, porch, terrace, patio, apartment, off-street parking, window air conditioning, or central air conditioning.

95Q3	1400	1448	1616	1952	2400	904	1086	417	1650
95Q4	1425	1531	1720	2047	2400	941	1093	325	1500

To examine how shelter costs vary by total expenditures, we rank the two adults with two children reference households by their total expenditures into 20 equal groups or vingtiles. The ranking was done separately for renters and owners (see Chart 2).¹⁶ Chart 2 shows that shelter costs are higher and increase more rapidly for consumer units in the upper vingtiles when these costs are defined as rental equivalence or as out-of-pocket expenditures for mortgage holders as compared to other definitions of shelter and for owners without mortgages.

Shelter costs based on imputed rents are also highly correlated with out-of-pocket shelter expenditures, with a correlation coefficient of 0.65. The correlation is not as strong with rental equivalence, with correlation coefficients of 0.41 and 0.49 for all owners and for owner reference households respectively (see Appendix Table 2B).

Since the rental equivalency based thresholds are higher than the other two thresholds, we examined rental equivalence data from the CPI Housing Survey to determine whether responses to rental equivalence questions are similar across survey instruments (see Appendix Table 2C).¹⁷ We find that owner reported rental equivalence in the CPI Housing data file is almost the same as the CPI-U consumer units in the CE survey, around \$2100 per quarter, for the last three quarters of 1995.

Homeowners' shelter costs (imputed rents plus homeowners' expenditures for maintenance, repairs and insurance¹⁸) based on the imputed rents model are compared to shelter costs based on out-of-pocket expenditures and shelter cost based on rental equivalence. We then

¹⁶ Since the vingtiles are not the same for renters and owners, in the future, income ranges will be used for this part of the analysis.

¹⁷ Special thanks to Steve Henderson of the CPI Housing Branch for running the data on the CPU Housing Survey.

¹⁸ Including all homeowner expenditures for these commodities may result in an overstatement of maintenance, repairs and insurance expenditures that are comparable to the expenditures paid by renters.

compare the thresholds that result from using these three different methods of measuring shelter costs. Using imputed rent in the shelter definition (along with other homeowner costs) yields a threshold of \$15,403 for 1995, which is quite similar to the basic threshold using out-of-pocket shelter costs (\$15,561), yet lower than the threshold using only the rental equivalence value collected in the CE Survey (\$17,011).

In discussing the treatment of homeownership on the resource side, Betson (1995) states that assigning an imputed rental value to homeowners may understate a homeowner's needs if the homeowner has a mortgage and overstate the homeowner's needs if the homeowner does not have a mortgage. Our results, on the threshold side, suggest that this may indeed be the case. A basic question that still needs to be addressed is whether the poverty threshold should allow for ownership of housing or just for a flow of services for comparable housing.

III. Updating the thresholds

The NAS Panel recommended that the poverty thresholds, once determined, should be updated over time using the change in median expenditures for the basic bundle of goods (composed of FCSU) of the reference households (see Citro and Michael (1995)). According to Primus (1997), this is the most controversial of the Panel's recommendations. The Panel intended to use an adjustment factor that increases more than inflation and that would be a more "relative" updating mechanism. The Panel expected that the median FCSU expenditures by the reference household would increase by more than the inflation rate but by less than the change in per capita Personal Consumption Expenditures (PCE).¹⁹

¹⁹ U.S. Department of Commerce, *Statistical Abstract of the United States, 1996*, Table No. 685.

Chart 3 compares changes in median FCSU expenditures for the reference two-adult/two-child household, the all item CPI-U²⁰, and the PCE. PCE increase faster than median FCSU expenditures, which increase faster than the CPI-U. These results seem to confirm the Panel's expectations regarding the use of the median FCSU as an updating mechanism. These results, however, may not hold for each year, because the change in the median is volatile. For example, using the inflation rate to adjust the 1990 threshold to 1995 yields a higher threshold than using the Panel's proposed method.

Chart 4 compares the annual changes between the percent changes in the median expenditures on FCSU for the two-adult/two-child reference unit and the inflation rate (using the CPI-U-X1). The changes in FCSU median expenditures track the inflation rate fairly closely; however, there are a few outliers (e.g., 1985, 1993, and 1994). The standard errors are also calculated for the change in the median expenditures for each year beginning with 1990 and ending with 1995.²¹

After the Panel published their report, concern was raised that the Panel's proposed updating method would be highly volatile and would have a large variance, especially when compared to the variance of the change in the CPI-U.²² As Chart 4 shows, the standard errors for the changes in the median are fairly large (e.g., 2.3 percent in 1995) compared to the standard error for inflation (0.15 percent). The 90 percent confidence interval for the change in the median expenditures for 1995 is from 0.6 to 4.0 percent.

To reduce the variance in the rates of change, the rates of change for various household types can be calculated and the average of these rates used. Another way to reduce the variance

²⁰ U.S. Bureau of Labor Statistics, *CPI Detailed Report*, January 1996. We also use the CPI-U-X1 for 1982. The new CPI-U definition, based on rental equivalency, was introduced in 1983.

would be to calculate the change in the median equivalent expenditures (i.e., household expenditures adjusted by an equivalence scale). Assuming that the changes for the different household types are not correlated, we find that the standard error falls by almost 50 percent for both alternative methods. (See Table 4.) These standard errors, however, are still larger than the standard errors of the inflation rate. These latter two methods also decrease the percentage change in the median for the 1990-95 years. This is because the median expenditures increase the most for the reference household.

Table 4. Various Methods to Update the Threshold

Year	Change in median FCSU expenditures for reference household	Inflation rate	Average change in median for nine household types	Change in median equivalent FCSU for all households (using P=0.70 and F=0.65)
1990	4.8	5.4	4.8	4.7
1991	3.7	4.2	3.9	3.7
1992	3.3	3.0	1.9	1.9
1993	4.1	3.0	2.3	2.5
1994	1.8	2.6	2.3	2.4
1995	2.3	2.8	2.3	2.3
Average standard error	0.95	0.15	0.51	0.53
Percent change from 1990-95	21.7	22.9	18.9	18.7

IV. Geographic indexes: Adjusting for inter-area price differences

The Panel noted that it is widely agreed that it is desirable to adjust poverty thresholds for differences in prices across geographic area, but that there are no generally accepted inter-area cost-of-living indexes that correspond to the CPI. Various approaches have been proposed to estimate inter-area price differences.

²¹ These errors are produced using the replicate weights found in the CE Survey data file and half-samples for each of the three-year periods in our study. See interview microdata documentation (USD2) for an explanation of how to use the replicate weights to produce variances.

²² Memorandum from Katharine Abraham to Eric Hanushuk, June 1995.

The Panel developed an inter-area price index for shelter using a modified version of a method developed by HUD for administering rental housing subsidies. Using a combination of data from the American Housing Survey, the 1990 decennial census, and a random-digit dialing survey, HUD developed a set of fair market rents that vary by geographic location. The Panel used a modified approach (using only the decennial census) and computed index values for each of the 341 metropolitan areas (setting the U.S. average equal to 1.0). The index values were based on the cost of rent²³ at the 45th percentile of the distribution for each area. The data were then grouped into six population size categories within each of the nine census regions. The non-metropolitan and small metropolitan areas were aggregated by region, and new index values recomputed, which produced a final set of 41 index values.

The index values were further adjusted for the estimated fraction of the poverty budget accounted for by housing (including utilities), which was set at 44 percent. This effectively created a fixed-weighted inter-area price index with two components, housing and all other goods and services; the price of other goods and services was assumed not to vary.

For this paper, adjustments in expenditures for inter-area price differences are based on research performed at BLS by Kokoski, Cardiff, and Moulton (1994).²⁴ These researchers used an hedonic methodology and monthly CPI-U price data for July 1988 through June 1989 to produce experimental inter-area price indexes; indexes were computed for the 44 CPI publication geographic areas. These experimental inter-area price indexes were created at the lowest commodity level for which CPI price data are available and then were aggregated to form index factors for 11 major expenditure categories. This was accomplished by weighting lower level

²³ These are rents for two-bedroom apartments that had complete plumbing facilities, kitchen facilities, and electricity and into which the occupant had moved within the last five years.

indexes using expenditure shares from CE Survey data. The resulting 11 expenditure categories comprise about 85 percent of total consumer spending.

Following Weber (1997), a residual category vector is calculated for the remaining 15 percent of expenditures by taking the average of the 11 existing factors for each area. The indexes were then updated to 1995 using the ratios between the 1995 and 1989 component-specific CPI-U for each of the 44 geographic areas. Inter-area price indexes for each area are obtained by taking the weighted average of the 12 commodity-specific indexes using the area-specific expenditure shares as weights.²⁵

To obtain the price indexes for each of the 41 region/size areas used in the Panel's report, we use the 12 region/size averages from the procedure in Kokoski et al. (1994) for each of the three smaller areas in each of the nine census regions. For example, the indexes for the small, medium and large size metro areas in the Western region are used for areas with fewer than 250,000 persons, 250,000-500,000 persons and 500,000-1,000,000 persons, respectively, in both the Mountain and Pacific divisions. Indexes for the larger areas (with 1,000,000-2,500,000 persons and over 2,500,000 persons) are obtained by taking the weighted average of the metropolitan areas located in each region that are represented in the inter-area indices.

To compare the method used by the Panel and the one used in this study, both sets of indexes are normalized so that the weighted average (using the population distribution for the 41 region/size areas as weights) is 1.000. Although the BLS inter-area price indexes include more expenditure categories than the Panel's Housing index, both methods produce similar indexes and the correlation coefficient is 0.78. Appendix 3A shows the inter-area consumer price indexes

²⁴ The BLS inter-area price research is still in progress and the current indexes are of experimental status. They do not reflect official BLS published data.

²⁵ Appendix 3B provides a detailed description of the method used to update these indexes to 1995.

used by the Panel with the BLS inter-area price indexes by region and population size.

Table 5: Comparison of 1995 thresholds for two-adult/two-child household using the BLS and Panel geographic adjustments

Geographic area	Thresholds	
	BLS inter-area	NAS housing index
National average: Reference threshold	15561	15561
Washington, DC	18378	17273
Greater Los Angeles	18984	18782
San Diego	17973	18782
Mid Atlantic: Medium size metro area	16355	15748
New England: Medium size metro area	16355	17724
East South Central: Non-metro area	12791	12776
West South Central: Non-metro area	12791	13242

Table 5 illustrates the main differences between the BLS inter-area approach and the Panel’s housing index approach. Because the BLS approach is based on the CPI publication geographic areas, some larger metropolitan areas within the same region (e.g., Greater Los Angeles and San Diego) have different thresholds, while the housing index assigns the same threshold. In addition, because there are only four regions in the BLS approach, different regions of similar size (e.g., medium sized cities in the Mid-Atlantic and New England regions) obtain similar thresholds, while obtaining different thresholds under the Panel’s approach. Finally, both adjustments cause the thresholds in non-metropolitan areas to be less than the national average.

V. The two-parameter equivalence scale

An equivalence scale is used to adjust the thresholds for differences in household size and composition. The Panel reported that standard methods for using expenditure data to estimate various types of equivalence scales yield many different scales depending on the assumptions made about the measure of well-being, the estimation method, the types of households and data used in the analysis.

The Panel and others have suggested that some issues remain, which must be addressed in determining “reasonable” equivalence scales. These issues include the smoothness of the scales, differences in the cost of children, differences between one and two adult households, and differences between single parent and two-parent households.

The Panel recommended that the thresholds for household types other than the reference type be determined using an equivalence scale that would adjust for the number of adults and children in the household. This two-parameter scale is given by $(A + PK)^F$, where A represents the number of adults and K represents the number of children. The Panel recommended that the scale economy factor, F , be set at either 0.65 or 0.75 and that the parameter P be set at 0.7. The Panel chose two scale economy factors for F —0.75 because it is close to the Betson-Michael value²⁶ and 0.65 because it yields equivalence scales that are close to equivalence scales implicit in the current poverty thresholds. The Panel’s choice of an equivalence scale appears to be consistent with the Betson-Michael findings *and* the data, at least for smaller families. The Panel stated that they prefer “a more direct approach that recognizes the arbitrariness by setting an equivalence scale formula directly and transparently...(Citro and Michael (1995), page 166)” It also satisfies two criteria: it recognizes the differences between children and adults and it adjusts for economies of scale associated with larger family sizes.

To examine whether household-type specific thresholds would be different from those recommended by the Panel, we consider the expenditures on FCSU for various household types and calculate the median for each household type and their respective threshold using the 0.96725

²⁶ Betson and Michael, 1993, chose the equivalence scale parameters by minimizing the sum of the squared deviations of the observed proportional costs of children from the fitted proportional costs of children. The fitted estimates for the recommended equivalence scale are: $(A + 0.70K)^{0.762}$

factor. This would then provide a benchmark of using a different reference household to compute the thresholds.

Table 6 shows the thresholds for the two-adult/two-child household for 1989-1995. In 1995, the threshold for the reference household is \$15,561, while it is \$7,237 for single adults. Dividing the median value for singles by the median value for a two-adult/two-child household produces a ratio of 0.47. Similarly, the ratio for two adults without children is 0.71 and the ratio for one adult with one child is 0.63.

Table 6. Thresholds using Median FCSU for Various Family Types as the Reference households

Household Type	1989	1990	1991	1992	1993	1994	1995	Percent change 1989-95
Single adults	\$6,191	\$6,488	\$6,694	\$6,790	\$6,907	\$7,049	\$7,237	16.9
Two adults	\$9,224	\$9,647	\$10,064	\$10,235	\$10,474	\$10,748	\$11,012	19.4
Other adults without children	\$11,561	\$12,116	\$12,417	\$12,715	\$13,090	\$13,631	\$13,929	20.5
One adult, one child	\$8,184	\$8,340	\$8,589	\$8,842	\$9,186	\$9,685	\$9,732	18.9
One adult, two or more children	\$8,415	\$8,744	\$9,115	\$9,390	\$9,654	\$9,976	\$10,182	21.0
Two adults, one child	\$11,352	\$12,018	\$12,715	\$12,857	\$13,043	\$13,126	\$13,321	17.3
Two adults, two children	\$12,790	\$13,400	\$13,891	\$14,350	\$14,936	\$15,211	\$15,561	21.7
Two adults, three or more children	\$12,971	\$13,469	\$14,104	\$14,512	\$15,199	\$15,555	\$16,065	23.9
Other with children	\$13,455	\$14,373	\$14,961	\$15,258	\$15,298	\$15,529	\$15,751	17.1

While the relationship between the thresholds is fairly constant over this period, using different household types as the base could affect the updating mechanism over time. As Table 6 shows, the household with two-adults and three or more children experienced the largest increase in the median bundle (23.9 percent), while single adults only experienced a 16.9 percent increase.

The two-parameter scale with parameters of $F=0.65$ and $P=0.7$ implies that the scales for a single person, two adults and one adult/one child are 0.45, 0.71 and 0.64, respectively (see Table 7). For several of the household types, this two-parameter scale is a rough approximation

of the ratios between the medians. The similarity, however, does not hold for larger households, e.g., couples with three children or single parents with two children.

Table 7: Ratio of Thresholds Using Two Adults with Two Children as the Reference Household

Household Type	1995	Average using 1989-95
Single adults	0.465	0.473
Two adults	0.708	0.713
Two adults, one child	0.856	0.884
Two adults, two children	1.000	1.000
Two adults, three or more children	1.032	1.017
One adult, one child	0.625	0.625
One adult, two or more children	0.654	0.654

Table 8 presents the scales for the major family types using the scales implicit in the poverty thresholds, three parameterizations of the two-parameter scale (columns 2-4), and a scale recommended by Betson (1996) (column 5). The scale recommended by Betson allows for the first child in a single-adult family to increase the scale more than the first child in a two-adult family. In addition, Betson's scale restricts the relationship between two adults and one adult families to imply that the scale for the two-adult family is 41 percent more than the scale for the single adult family.²⁷ Finally, column 6 presents a scale based on the ratio of the median (in Table 7). This scale is found by minimizing the squared differences between the two-parameter scales and the implied scales using five household types: singles, two adults, two adults with one child, two adults with two children, and one adult with one child.²⁸ Using the natural logarithms of the scales and weighting the data by the percent of households in each household type yields an estimate of $F=0.61$ and $P=0.72$.

²⁷ Betson's scale is given by 1.41 for two-adult households, $(A + c + P*(K-1))^F$ for single parent households (c is the parameter for the first child in a single-parent household) and $(A + PK)^F$ for other households, where $P=.5$, $F=.7$ and $c=.8$.

²⁸ These five household types account for 77.9% of consumer units and 61.5% of the population of persons.

Table 8: Scales Implied by Two-Parameter Equivalence Scale, $(A+PK)^F$, Using Various Parameters and Other Scales

Household Type	1 Implicit in Current Poverty Thresholds ²⁹	2 $F=0.50$ $P=1.00$	3 Panel-1 $F=0.65$ $P=0.70$	4 Panel-2 $F=0.75$ $P=0.70$	5 Betson Scale	(6) Estimated using the average scales from Table 7 $F=0.61; P=0.72$
Single adults	0.513	0.500	0.451	0.399	0.453	0.471
Two adults	0.660	0.707	0.707	0.672	0.655	0.719
Two adults, one child	0.794	0.866	0.861	0.841	0.880	0.867
Two adults, two children	1.000	1.000	1.000	1.000	1.000	1.000
Two adults, three children	1.177	1.118	1.129	1.151	1.114	1.123
One adult, one child	0.680	0.707	0.637	0.595	0.699	0.656
One adult, two children	0.794	0.866	0.797	0.770	0.830	0.812

We consider Betson’s scale since it has been argued that poverty thresholds for a single parent with two children (a three, person family) should be higher than for a household with two adults and one child (also a three-person family).

VI. Impact of the proposed thresholds on poverty rates and the composition of the poor

Once a threshold is chosen, we need to examine the impact on both poverty rates and the composition of the poor population. Although the Panel recommended many changes to the resource side of poverty measurement, we use the current resource measure (before-tax cash income) to compare the effects of the different thresholds.³⁰ This differs from the BLS/Census study, which examined poverty rates using both experimental thresholds and an alternative resource measure.

Table 9 summarizes the results of how changing various equivalence scale parameters and adjusting the 1995 reference thresholds (\$15,561) for inter-area price differences affects the

²⁹ Using the non-elderly thresholds for one and two person households.

poverty rate. The use of either the BLS experimental inter-area index or the Panel's housing index yields a lower poverty rate than when no geographic adjustment is made. The use of either of the two recommended economies of scale factors (F) also lowers the poverty rates. The poverty rate is lowest when $F = 0.75$ and the BLS geographic index is used. This result, that the Panel's equivalence scale lowers the poverty rate, is also shown in the Panel's report and in Betson (1996).

Table 9: 1995 Poverty Rates for All Persons Using Different Thresholds, Geographic Adjustments and Equivalence Scales³¹

Threshold level for reference household	Type of equivalence scale	Method of geographic adjustment	Poverty rate
\$15,455 (official)	Census thresholds	None	13.8
15,455 (official)	Census thresholds	Panel	13.7
15,455 (official)	Census thresholds	BLS	13.7
15,561 (based on median FCSU)	$P=.7; F=.65$	None	13.7
15,561 (based on median FCSU)	$P=.7; F=.65$	Panel	13.5
15,561 (based on median FCSU)	$P=.7; F=.65$	BLS	13.4
15,561 (based on median FCSU)	$P=.7; F=.75$	None	13.0
15,561 (based on median FCSU)	$P=.7; F=.75$	Panel	12.9
15,561 (based on median FCSU)	$P=.7; F=.75$	BLS	12.8
15,403 (based on median FCSU with imputed rent)	$P=.7; F=.65$	BLS	13.3
17,011 (based on median FCSU with rental equivalence)	$P=.7; F=.65$	BLS	15.2

Table 9 also shows that increasing the threshold leads to higher poverty rates. The effect of changing the threshold definition, whether by changing the measurement of shelter costs (e.g., using imputed rent or rental equivalence) or by changing the adjustments for different household types and sizes, is to increase or decrease the poverty rate. For example, each change in the

³⁰ We used person-weighted data from the 1996 CPS March Supplement for families and unrelated individuals. In order to make the geographic indices comparable, the indices were adjusted so that the weighted mean over the sample was equal to 1.0.

³¹ While the confidence interval for the thresholds would imply larger changes in the poverty rates, the confidence interval for the CPS poverty rate is about 0.3%

threshold of one percentage point (e.g., \$156 for the reference household) causes the poverty rate to increase by 0.18 percentage points (e.g., from 13.4 percent to 13.58 percent). Similarly the poverty rate for children increases by 0.22 and the poverty rate for elderly increases by 0.27.

Chart 5 shows that the relationship between the poverty rate and the percent of the reference threshold is fairly linear for all persons and children, however, it is non-linear for the elderly. The Census reports that the poverty rate increases for all people and children by similar amounts, which is what we find.³² However, our changes for the elderly are more dramatic.

To examine the effect of the geographic adjustments, we calculate poverty rates for four geographic regions and for metropolitan and non-metropolitan areas. (See table 10.) Table 10 shows that both geographic inter-area price adjustment methods lower the poverty rate in the non-metropolitan areas while raising the poverty rate in the metropolitan areas.

Table 10: 1995 Poverty rates by region and metropolitan area, using no geographic adjustment, the Panel and BLS inter-area adjustment (using the scale with $F=0.65$; $P=0.7$)

	Northeast	Midwest	South	West	Metropolitan areas	Non-metro areas
No geographic adjustment	12.5	10.8	15.9	14.6	13.3	15.3
Panel-Housing Index	13.8	9.9	14.2	15.8	13.9	12.2
BLS Inter-area Index	15.0	9.9	13.4	15.8	13.9	11.7

The BLS inter-area adjustment has a larger effect than the Panel’s housing index in the Northeast, mainly because of the large indexes in the Mid-Atlantic division. The Panel report shows that the geographic price adjustment increases poverty in the Northeast and West. While these indexes do not affect the overall poverty rates, they could have a large impact on state and

³² U. S. Bureau of the Census, “Poverty in the U.S.-1995,” Bulletin P-60, No. 194, Table C.

local area poverty rate estimates.

Next, we consider various parameterizations of the two-parameter scale and examine the effects on the poverty rates. Similar to Johnson (1996), we find that using almost any parameter, P , reflecting a child's needs to be less than an adult's to adjust the poverty threshold, lowers the poverty rate for children (See Table 11.) In addition, we find that increasing the elasticity (F) causes the poverty rate for all persons to fall. Johnson (1996) shows that this is mainly due to the relative decrease in the threshold for one and two-adult families, which falls as the elasticity parameter increases. Betson (1995b) also notes that the poverty rate of children is not as sensitive to alternative specifications of the equivalence scale as is the poverty rate of the elderly.

Table 11: Scale Sensitivity: 1995 Poverty Rates for Persons Using Various Parameters for the Two-Parameter scale (using the reference threshold of \$15,561 and the BLS inter-area price index).

	$P=.7$			$P=.85$			$P=1.0$		
	All			All			All		
Elasticity, F	Persons	Children	Elderly	Persons	Children	Elderly	Persons	Children	Elderly
0.50	14.4%	19.6%	15.3%	14.1%	19.7%	13.8%	13.8%	19.9%	12.3%
0.65	13.4	19.7	10.8	13.1	20.0	9.2	12.8	20.2	7.9
0.7	13.1	19.8	9.4	12.8	20.1	7.9	12.5	20.2	6.9
0.75	12.8	19.9	8.3	12.5	20.1	7.0	12.3	20.3	6.1
1	12.1	20.2	5.0	11.9	20.7	4.3	11.7	20.9	3.9

Finally, we examine the effect of the choice of equivalence scales on the composition of the poor. (See Table 12.) We use the scales implicit in the poverty thresholds, two parameterizations of the two-parameter scale and scales recommended by Ruggles (1990) and Betson (1996).

Using the BLS inter-area price indexes and the \$15,561 threshold for the reference household, Table 12 compares the composition of poor persons among demographic groups when the equivalence scale changes. For example, the percent of poor who are children varies slightly (but stays at about 40 percent) depending on the equivalence scale. The same is true for the

proportion of persons in female-headed households. The percent of the poor who are elderly varies with a change in the equivalence scale used. The elderly-share of the poor increases (relative to the proportion using the Census thresholds) for each of the alternative equivalence scale specifications except for Panel-2, $(A + 0.7K)^{0.75}$, for which the elderly-share of the poor falls. The Panel-2 scale also causes the percent of the poor living in married-couple households and the black-share of the poor to increase. The choice of the scale has little impact on the distribution by region.

Table 12: Composition of the Poor for Certain Demographic Groups by Equivalence Scale Using BLS Inter-Area Price Adjustment

	Composition of the Population	Implicit in Official Thresholds	Panel-1 $F=.65;$ $P=.7$	Panel-2 $F=.75; P=.7$	Ruggles $F=.5; P=1$	Betson Scale
Children	26.7	39.8	39.0	41.2	38.5	39.0
Elderly	12.0	8.9	9.7	7.7	10.7	9.4
People in female headed households	15.4	40.1	40.5	41.5	40.3	40.5
People in married couple households	66.3	34.0	35.4	37.4	32.9	34.6
Unrelated individuals	15.0	22.6	20.5	17.3	23.1	21.0
Blacks	11.0	22.8	22.9	23.8	22.4	23.1
Northeast	19.5	21.5	21.8	21.9	21.8	21.8
Midwest	23.4	17.3	17.3	16.9	17.5	17.3
South	34.9	34.9	34.9	34.9	34.8	34.9
West	22.2	26.2	26.1	26.3	25.8	26.1
Non-metropolitan area	22.5	19.6	19.6	19.4	19.8	19.3

VII. Conclusions

In this paper, we addressed many of the recommendations of the National Academy of Sciences (NAS) Panel on Poverty and Family Assistance in an attempt to develop an improved poverty measure. Selecting the initial threshold, i.e., choosing among specific data related methods, is an empirical question. If variations in the methods yield only small differences, then

the simpler method should be used. Although it is appealing conceptually to use consumer units who participate in the CE survey for four quarters and to use CPI-component indexes, the resulting alternative definitions of a median bundle produce similar thresholds and are therefore not necessary.

We found that thresholds that used out-of-pocket expenditures for shelter in defining the FCSU bundle lie between the estimates that use a flow of service approach to measure homeowners' shelter expenditures. The treatment of homeowner shelter costs requires more research, especially if the flow of housing services for homeowners is to be included in the resource measure.

We also found that the adjustments for geographic differences in prices and household size affect the composition of the poor and not the overall poverty rate. The geographic adjustment using the BLS indexes produces results similar to the Panel's geographic adjustment that relies only on housing. In addition, the ratio of median expenditures on the basic bundle for some of the household types was found to be similar to the Panel's recommendation for the equivalence scale (using $F=0.65$). Although these two scales are similar, small changes in the parameters in the two-parameter scale affect the poverty rates of singles and the elderly.

Finally, updating the threshold by using the change in the median basic bundle produces a relative threshold and one that is more volatile than using the inflation rate. Over the 1990-95 period, using changes in the median expenditures for the reference household leads to smaller changes in the thresholds than when the inflation rates are used (although historically adjusting by the inflation rate would have caused a larger change). Perhaps the least controversial way to update the threshold would be to update the threshold definition every five or ten years with the

change in the median value and to update the threshold level with the inflation rate in the intervening years.

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Chart 1
Median Expenditures on FCSU
for two alternative reference household types

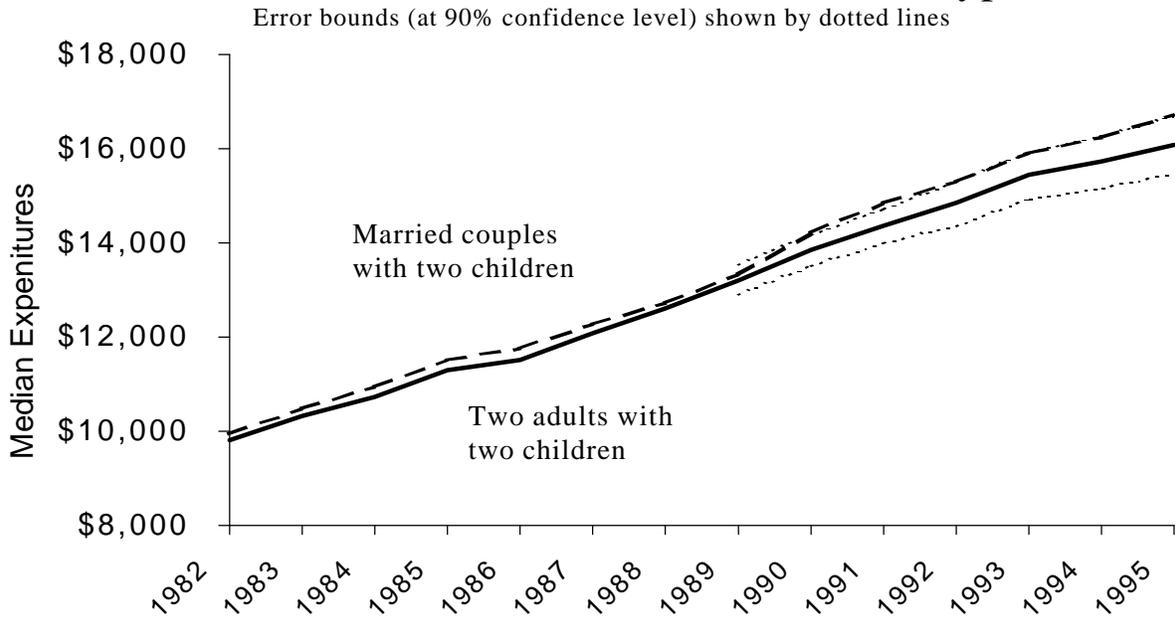


Chart 2
1995 Median Annualized Shelter Costs for Owners
for Reference Family: by Vingtile

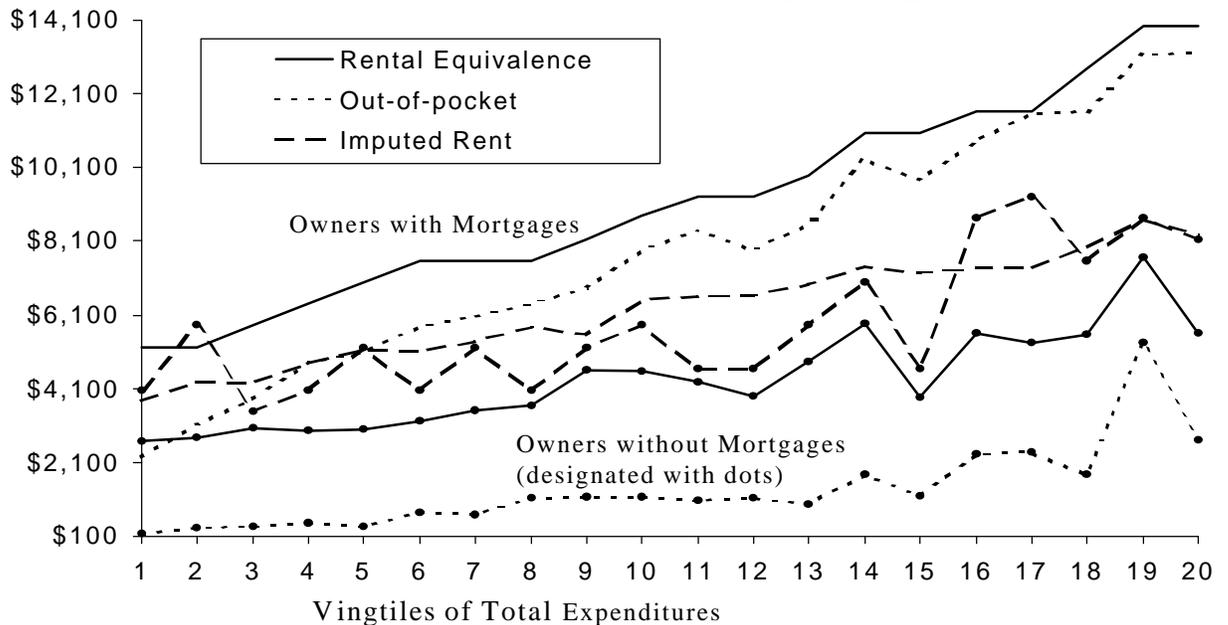


Chart 3
 Updating the Thresholds:
 The Intuition Behind the Panel's Proposal

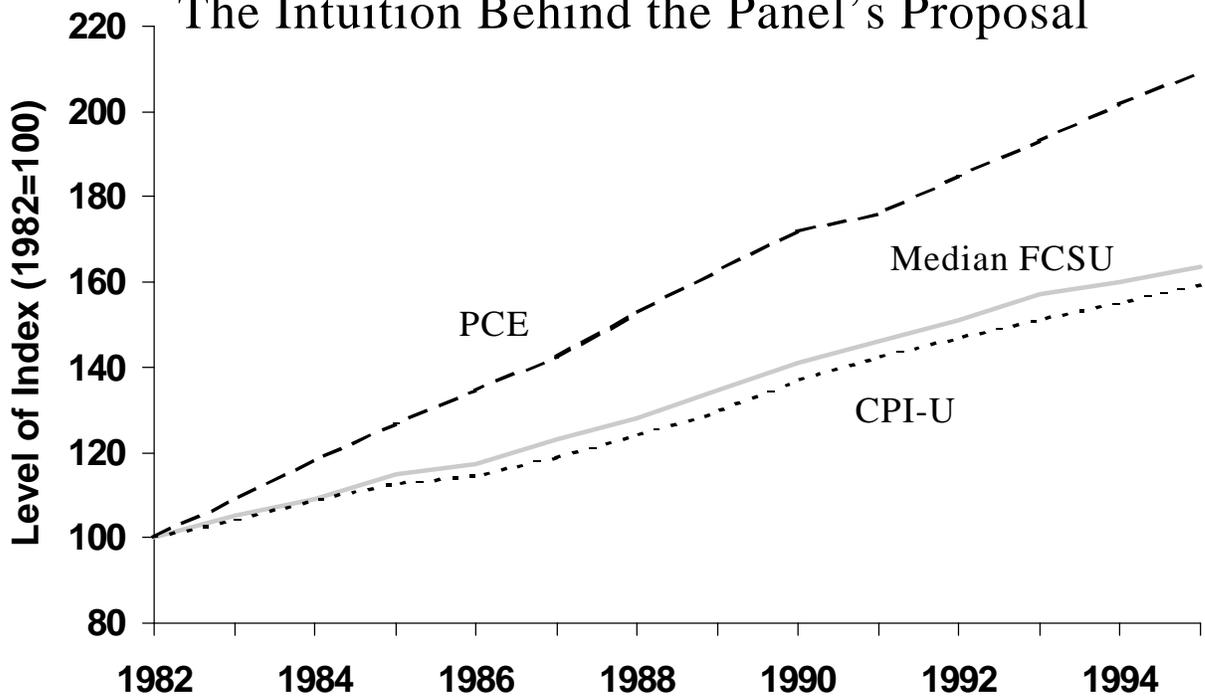


Chart 4
 Percent Changes in Median FCSU and inflation rate:
 1983-95

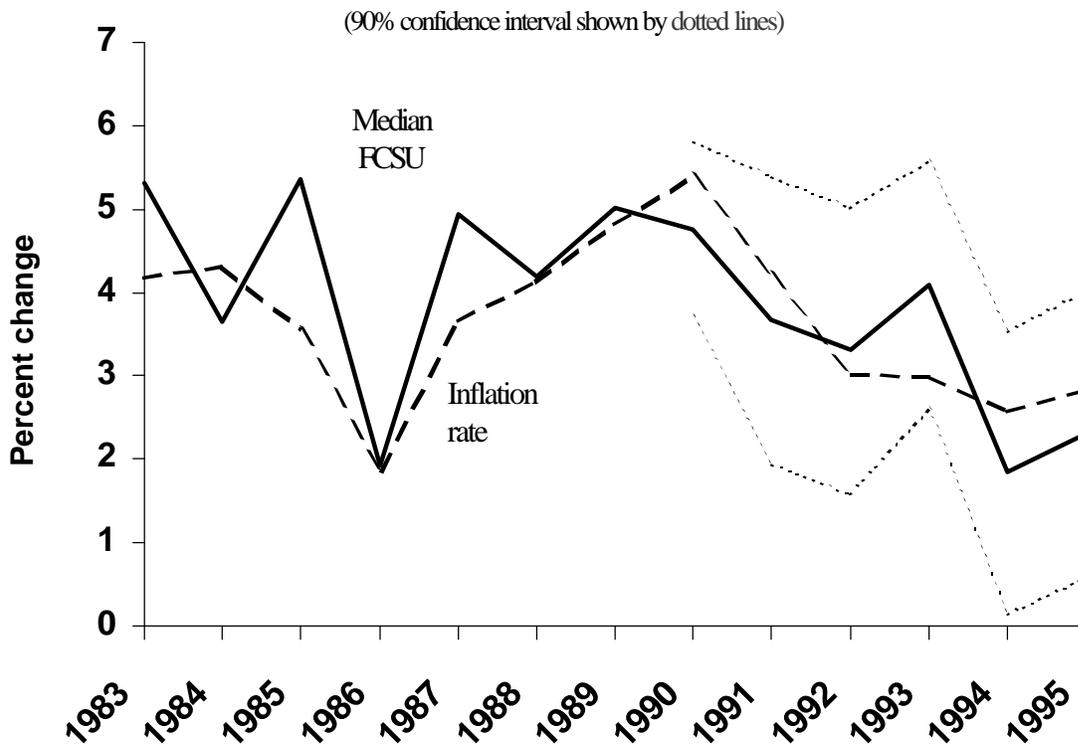
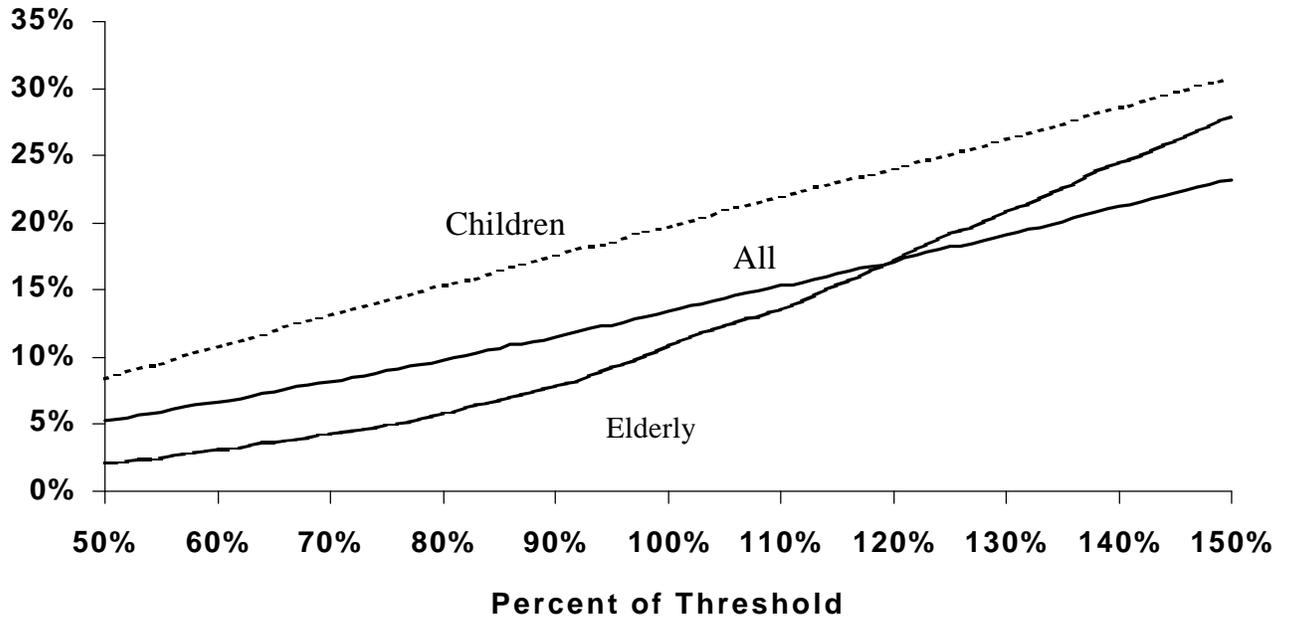


Chart 5
Poverty Rates by Percentage of Threshold Level



Appendix 1: Consumer Expenditure Survey

The Consumer Expenditure (CE) Interview Survey data is the source of data used to compute poverty thresholds in this paper. The CE Survey has been a continuing quarterly survey since 1980. About 5,000 consumer units participate in the Interview portion of the CE Survey each quarter. Data are collected from consumer units³³ five times over a 13-month period. The first interview, based on a one-month recall, is used to ‘bound’ the interview or to reduce the likelihood that expenditures will be reported in the next interview. Data reported in the first interview are not released nor are they used in for any estimation. Expenditure data are collected in the second through fifth interviews for the previous three months. For example, a consumer unit that is visited in March reports expenditures for February, January, and December. The sample is a rotating panel in which 20 percent of the sample are interviewed for the first time each quarter while 20 percent are interviewed for the last time. The Interview survey covers about 95 percent of total expenditures.³⁴

³³ A consumer unit comprises members of a household who are related or share at least two out of three major expenditures--housing, food, and other living expenses. A person living alone is a single consumer unit.

³⁴ U.S. Department of Labor, 1995. As part of the evaluation of CE data, BLS compares its estimates of aggregate consumer expenditures and income with independent sources of data. Comparisons are made with the Personal Consumption Expenditures component of the National Income and Product Account, the National Health Accounts, the Current Population Survey, and other data resources. When differences in definitions and populations are accounted for, the CE data compare reasonably well with both the levels and changes over time of the other data sources

Appendix 2A. Independent Variables in Hedonic Regressions

<i>AGE</i>	Age of unit in years up to a maximum of 93 years for CUs interviewed in 1993, 94 for those in 1994, and 95 for those in 1995. Age is the midpoint of the range of years provided for year built. If age is unknown, age is imputed as the average age for other housing units in the PSU.
<i>AGESQ</i>	<i>AGE</i> squared.
<i>DETACHED</i>	Dummy variable equal to 1 if the unit's structure type is single family detached.
<i>ROWHOUSE</i>	Dummy variable equal to 1 if the unit's structure type is a row or townhouse inner unit.
<i>ENDROW</i>	Dummy variable equal to 1 if the unit's structure type is an end row or end townhouse.
<i>DUPLEX</i>	Dummy variable equal to 1 if the unit's structure type is a duplex (detached two-unit structure).
<i>NUMPLEX</i>	Dummy variable equal to 1 if the unit's structure type is a 3-plex or 4-plex (3 or 4 unit structure).
<i>GARDEN</i>	Dummy variable equal to 1 if the unit's structure type is garden (multi-unit structure).
<i>HIRISE</i>	Dummy variable equal to 1 if the unit's structure type is high-rise (multi-unit structure which has 4 or more floors).
<i>APTFLAT</i>	Dummy variable equal to 1 if the unit's structure type is apartment or flat (a unit not described above).
<i>MOBILEHO</i>	Dummy variable equal to 1 if the unit's structure type is mobile home or trailer.
<i>(OTHOU is reference)</i>	Other
<i>AG_DET</i>	<i>AGE</i> x <i>DETACHED</i>
<i>AG_ROW</i>	<i>AGE</i> x <i>ROWHOUSE</i>
<i>AG_END</i>	<i>AGE</i> x <i>ENDROW</i>
<i>AG_DUP</i>	<i>AGE</i> x <i>DUPLEX</i> .
<i>AG_NUM</i>	<i>AGE</i> x <i>NUMPLEX</i>
<i>AG_GAR</i>	<i>AGE</i> x <i>GARDEN</i>
<i>AG_HIR</i>	<i>AGE</i> x <i>HIRISE</i>
<i>AG_APTF</i>	<i>AGE</i> x <i>APTFLAT</i>
<i>AG_MOBI</i>	<i>AGE</i> x <i>MOBILEHO</i>
<i>(AG_OTH is reference)</i>	
<i>BEDS</i>	Number of reported bedrooms. If number of bed rooms is unknown, the number of bedrooms is imputed as the average number of bedrooms for other housing units in the PSU.
<i>BEDS_SQ</i>	<i>BEDS</i> squared.
<i>ROOMS</i>	Number of rooms other than bedrooms and baths. This is computed as the difference between the number of rooms in the CU living quarters, including finished living areas (but excluding all baths) and the number of bedrooms. If number of rooms including finished living areas (but excluding all baths) is unknown or is equal to zero (meaning that there had to be at least one room which is not a bath in the unit), number of rooms is imputed as the average number of rooms for other housing units in the PSU.
<i>E_BR</i>	Dummy variable equal to 1 if the unit has more than one complete bathroom.

Appendix 2A (continued). Independent Variables in Hedonic Regressions

<i>GOVTYES</i>	Dummy variable equal to 1 if government is paying part of housing cost.
<i>PUBHYES</i>	Dummy variable equal to 1 if public housing.
<i>HGAS</i>	Dummy variable equal to 1 if the main source of heating is gas (underground pipes).
<i>HELEC</i>	Dummy variable equal to 1 if the main source of heating is electricity.
<i>HOIL</i>	Dummy variable equal to 1 if the main source of heating is oil.
<i>SWIM</i>	Dummy variable equal to 1 if the unit has a swimming pool.
<i>TENNIS</i>	Dummy variable equal to 1 if the unit has a tennis court.
<i>BARNYES</i>	Dummy variable equal to 1 if the unit has a barn or stable.
<i>GREEN</i> ³⁵	Dummy variable equal to 1 if the unit has a greenhouse.
<i>GUEST</i>	Dummy variable equal to 1 if the unit has a guesthouse or separate servant's quarters.
<i>PORCH</i>	Dummy variable equal to 1 if the unit has an enclosed porch.
<i>TERR</i>	Dummy variable equal to 1 if the unit has a terrace.
<i>PATIOYES</i>	Dummy variable equal to 1 if the unit has a patio or balcony.
<i>APTYES</i>	Dummy variable equal to 1 if the unit has an apartment.
<i>OFFPARK</i>	Dummy variable equal to 1 if the unit has an off street parking.
<i>WINAC</i>	Dummy variable equal to 1 if the unit has a window air conditioner.
<i>CENTAC</i>	Dummy variable equal to 1 if the unit has central air conditioning.
<i>PSU1101 through PSU5634</i> (reference is <i>PSU5436</i>) ³⁶	Dummy variable equal to 1 for each of the PSUs included in the model.

³⁵ In some cases, there were no renters with greenhouses. When this occurred, GREEN was not included in the regression model.

³⁶ In a few cases, there were no observations in the reference PSU so another PSU was used.

Table 2B: Correlation Between Shelter Costs Based on Imputed Rent and Other Shelter Cost Variables: Owners Only in 93Q1-95Q4

(weighted data)

Variable	Shelter with Imputed Rent	
	All Owners	Two Adults with Two Children
imputed rent	0.60	0.70
out-of-pocket shelter expenditures	0.65	0.65
mortgage interests	0.28	0.37
property taxes	0.17	0.34
maintenance, repairs, and insurance	0.84	0.75
rental equivalence	0.41	0.49

Appendix Table 2C. Median Quarterly Rental Equivalence from the CE Compared to Rental Equivalence Values in the CPI Housing Data File: CPU-U Consumer Units Only

(CE data are from quarterly reports, CPI Housing Survey data are from monthly reports)

Data File and Rental Equivalence Definition	Collection Period		
	95Q2	95Q3	95Q4
CPI Housing Data File (unweighted)			
Adjusted Field Representative Estimate of Rental Equivalence	\$2,123.08	\$2,133.93	\$2,163.58
Field Representative Estimate of Rental Equivalence	2150.00	2325.00	2100.00
Owner Reported Rental Equivalence	2050.00	2150.00	2100.00
CE Data File (weighted)			
All Owners			
Shelter with Imputed Rent	1518.84	1544.12	1554.25
Shelter as Out-of-Pocket Expenditures	1049.00	1105.00	1086.00
Owner Reported Rental Equivalence	2100.00	2100.00	2100.00
Owners with Mortgage			
Shelter with Imputed Rent	1608.75	1615.55	1720.30
Shelter as Out-of-Pocket Expenditures	1885.00	1952.00	2046.50
Owner Reported Rental Equivalence	2400.00	2400.00	2400.00
Owners without Mortgage			
Shelter with Imputed Rent	970.55	1086.33	1092.65
Shelter as Out-of-Pocket Expenditures	225.00	417.25	325.00
Owner Reported Rental Equivalence	1473.00	1650.00	1500.00

Rental Equivalence Question in CPI Housing Survey: "If this (house/apartment) were a rental unit, how much do you think it would rent for monthly, including maintenance but without utilities and furniture?"

Appendix 3A: Interarea cost-of-living adjustments: Cost-of-Housing Index Values and Kokoski, Cardiff and Moulton inter-area Price indices updated by Weber (Relative to 1.00 for the United States as a Whole) by Region (Census Division) and Size of Metropolitan Area and Metropolitan Area (where available). (See Appendix 3B for method used to update data to 1995.)

Region and Population Size	Housing Index Value	KCM Index Value Updated to 1995
New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont)		
Non-metropolitan areas and Metropolitan areas under 250,000	1.119	1.027
Metropolitan areas 250,000-500,000	1.119	0.985
Metropolitan areas 500,000-1,000,000	1.139	1.051
Metropolitan areas 1,000,000-2,500,000	1.132	1.266
Metropolitan areas 2,500,000 or more	1.200	1.266
Boston		1.266
Middle Atlantic (New Jersey, New York, Pennsylvania)		
Non-metropolitan areas and Metropolitan areas under 250,000	0.901	1.027
Metropolitan areas 250,000-500,000	0.989	0.985
Metropolitan areas 500,000-1,000,000	1.012	1.051
Metropolitan areas 1,000,000-2,500,000	0.967	1.029
Buffalo		1.056
Pittsburgh		1.013
Metropolitan areas 2,500,000 or more	1.178	1.289
New York City		1.379
New York City - New Jersey Suburbs		1.287
New York City - Connecticut Suburbs		1.393
Philadelphia		1.114
East North Central (Illinois, Indiana, Michigan, Ohio, Wisconsin)		
Non-metropolitan areas and Metropolitan areas under 250,000	0.889	0.890
Metropolitan areas 250,000-500,000	0.951	0.960
Metropolitan areas 500,000-1,000,000	0.979	0.969
Metropolitan areas 1,000,000-2,500,000	0.987	1.011
Cincinnati		0.996
Milwaukee		1.027
Metropolitan areas 2,500,000 or more	1.051	1.061
Chicago		1.137
Cleveland		0.965
Detroit		0.995
West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota)		
Non-metropolitan areas and Metropolitan areas under 250,000	0.854	0.890
Metropolitan areas 250,000-500,000	0.954	0.960
Metropolitan areas 500,000-1,000,000	0.973	0.969
Metropolitan areas 1,000,000-2,500,000	1.020	0.982
Kansas City		0.955
Minneapolis		1.028
St. Louis		0.953
Metropolitan areas 2,500,000 or more (use areas 1-2.5 million)	1.020	0.982

Region and Population Size	Housing Index Value	KCM Index Value Updated to 1995
South Atlantic (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia)		
Non-metropolitan areas and Metropolitan areas under 250,000	0.892	0.822
Metropolitan areas 250,000-500,000	0.953	0.927
Metropolitan areas 500,000-1,000,000	0.999	0.943
Metropolitan areas 1,000,000-2,500,000	1.035	0.946
Tampa		0.946
Metropolitan areas 2,500,000 or more	1.110	1.101
Atlanta		1.059
Baltimore		1.076
Miami		1.033
Washington, DC		1.181
East South Central (Alabama, Kentucky, Mississippi, Tennessee)		
Non-metropolitan areas and Metropolitan areas under 250,000	0.821	0.822
Metropolitan areas 250,000-500,000	0.928	0.927
Metropolitan areas 500,000-1,000,000	0.940	0.943
Metropolitan areas 1,000,000-2,500,000 (use West South Central figures)	0.954	1.085
Metropolitan areas 2,500,000 or more	NA	NA
West South Central (Arkansas, Louisiana, Oklahoma, Texas)		
Non-metropolitan areas and Metropolitan areas under 250,000	0.851	0.822
Metropolitan Areas 250,000-500,000	0.904	0.927
Metropolitan areas 500,000-1,000,000	0.935	0.943
Metropolitan areas 1,000,000-2,500,000	0.954	1.085
New Orleans		1.085
Metropolitan areas 2,500,000 or more	0.997	1.015
Dallas		1.005
Houston		1.026
Mountain (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming)		
Non-metropolitan areas and Metropolitan areas under 250,000	0.881	0.950
Metropolitan areas 250,000-500,000	0.968	0.987
Metropolitan areas 500,000-1,000,000	1.031	0.965
Metropolitan areas 1,000,000-2,500,000	0.995	1.070
Denver		1.070
Metropolitan areas 2,500,000 or more	NA	NA
Pacific (Alaska, California, Hawaii, Oregon, Washington)		
Non-metropolitan areas and Metropolitan areas under 250,000	0.961	0.950
Metropolitan areas 250,000-500,000	1.010	0.987
Anchorage		1.230
Metropolitan areas 500,000-1,000,000	1.020	0.965
Honolulu		1.329
Metropolitan areas 1,000,000-2,500,000	1.095	0.980
Portland		0.980
Metropolitan areas 2,500,000 or more	1.207	1.234
Greater Los Angeles		1.220
Los Angeles County		1.230
San Diego		1.155
San Francisco		1.299
Seattle		1.194

NOTE: Housing cost indexes calculated from 1990 census data on gross rent for two-bedroom apartments with specified characteristics; index values drawn from the 45th percentile of the gross rent distributions. Index value calculated using 44 percent of housing cost index and 56 percent of unitary index (see table 5.3 in NAS report). **N.A.**, Not applicable: no such areas in the region.

For KCM index, averages for metro areas of 1 - 2.5 million persons and 2.5 million persons or more are determined by using the weighted average for PSUs in the respective area with the census 1990 population as weights. Indices for metro areas of 0.5 - 1 million persons, 0.25 to 0.5 million persons, and less than .25 million persons are the indexes for the Region size B, C and D, respectively. Indexes are normalized such that the weighted average over the 45 region/size areas is 1.000 (using the population weights in the March 1996 CPS).

Appendix 3B: Updating the Kokoski, Cardiff, Moulton (KCM) Inter-Area Geographic Consumer Price Index to 1994 and 1995

A brief description of the method used to update and modify the KCM index to approximate inter-area price indexes for 1994 and 1995 follows.³⁷ The initial step in the approximation of the inter-area indexes for 1994 is to update the KCM price indexes and the residual proxy vector to the desired time period. This is done by inflating the KCM price factors using the ratios of the 1994/1989 CPI-U for each KCM expenditure category and for each of the 44 geographic areas. Next the average of the areas' 1994 (inflated KCM) price factors are taken for each expenditure category. Dividing each individual area factor by the average area factor for each expenditure category then creates a new series of (1994) price factors. The resulting matrix is used to deflate the 1994 CE Survey expenditure data, by geographic area, for the 11 categories that were originally estimated by the KCM index and for the residual vector. The construction of a similar matrix for 1995 follows the same method.

In addition to individual expenditure category indexes, an all item index is required in order to adjust total expenditures and annual incomes in accordance with the price structure of each geographic area. The all items index approximates an inter-area COL index, in that it is weighted by the shares of expenditures that are unique to each area. Expenditure shares (individual category expenditures as a share of total expenditures) are estimated at the CPI area publication level using data from the 1994 and 1995 CE Surveys. The observations used for the shares estimates are restricted to those CUs that reside in the Primary Sampling Units (PSUs) included in the study. Multiplying the shares of total expenditures times the 12 vectors (the original 11 KCM categories and the residual vector), and again times the 1995 CPI/1989 CPI for

³⁷ The indices were updated by Weber, 1997.

each area and expenditure category, results in elements of total spending for 1995 that are based on updated 1988-89 inter-area price differences and spending habits unique to each area. These elements are summed across the 12 spending categories by area and the mean of the sum of the elements over all areas is calculated. A proxy for inter-area cost of living differences in 1995 is obtained by dividing the sum of each area's elements by the mean of the elements for all areas.