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Key Words: food insecurity, American Indian, poverty

Measuring the Extent and Depth of Food Insecurity: An Application to American Indians in the United States

by

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Measuring the Extent and Depth of Food Insecurity: An Application to American Indians in the United States

Abstract: Within the extensive literature on food insecurity in the United States, little work has been done regarding (a) the depth and severity of food insecurity (as opposed to just the food insecurity rate) and (b) the food insecurity status of American Indians. This paper addresses both these topics using data from the 2001 to 2003 Core Food Security Module of the Current Population Survey. To measure food insecurity, three axiomatically-derived measures of food insecurity are used – the food insecurity rate, the food insecurity gap, and the squared food insecurity gap. As expected, given the worse economic conditions facing American Indians their food insecurity levels are generally higher than non-American Indians. However, the magnitude and significance of these differences differ depending on the choice of food insecurity measure. If, instead, only the food insecurity rate had been analyzed, the picture of food insecurity among American Indians viz. non-American Indians would be markedly different. Even after controlling for other factors in multivariate frameworks, these comparisons between American Indians and non-American Indians remain.

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The extent of food insecurity in the United States has become a well-publicized issue of concern to policymakers and program administrators. In 2003, for example, 11.2 percent of the population suffered from food insecurity (i.e., these households were uncertain of having, or unable to acquire, enough food for all their members because they had insufficient money or other resources) and 3.5 percent of the population suffered from food insecurity with hunger (i.e., at least some household members were hungry, at least some time during the year, because they could not afford enough food). In response to the burgeoning interest in food insecurity, in the past decade an extensive literature has been developed which examines the determinants and consequences of food insecurity in the United States (for recent work see, e.g., Bhattacharya et al., 2004; Bitler et al., 2005; Borjas, 2004; Dunifon and Kowaleski-Jones, 2003; Evenson et al., 2002; Furness et al., 2004; Garasky et al., 2005; Gundersen and Oliveira, 2001; Gundersen et al., 2003; Lararia et al., forthcoming; Ribar and Hamrick, 2003; Slack and Yoo, 2005; Stuff et al., 2004; Van Hook and Balistreri, forthcoming). Largely missing from this literature, however, are analyses of the depth of food insecurity in the United States and examinations of the food insecurity status of American Indians at a national level.

In virtually all cases, food insecurity (or, more broadly, food hardship) is measured with binary variables reflecting whether someone is food secure or food insecure. In some comparisons, three categories are also employed – food secure, food insecure, and food insecure with hunger. When these broad categories are used, however, a great deal of information is being suppressed. In particular, information is not being utilized when broad categories are created from the 18-item Core Food Security Module (CFSM) which is used in a wide variety of surveys including the Current Population Survey (CPS). Within the CFSM, a household with children responding affirmatively to three or more questions is deemed food insecure and a

household responding affirmatively to eight or more questions is deemed food insecure with hunger. As an example, consider two households, one responding affirmatively to 8 questions and one responding affirmatively to 18 questions. Both are treated as food insecure with hunger yet, arguably, the latter household has a higher level of food insecurity. In this paper, I use a series of measures which allow for the portrayal of both the extent and depth of food insecurity. Along with utilizing more of the information contained in the CFSM, the series of measures used in this paper allow one to ascertain the robustness of comparisons of food insecurity between groups.

Being able to portray the depth of food insecurity may be especially relevant for the second major topic being analyzed in this paper, the food insecurity status of American Indians. The economic status of Native Americans is substantially worse than the rest of the United States. This status is reflected in per-capita incomes which are 40 percent less than the entire population (Leichenko, 2003) and the large numbers of Native Americans with earnings in the lower end of the income distribution (Gergory, *et al*., 1997). These economic hardships are also reflected in the lower average incomes in counties with a high proportion of Native Americans (Leichenko, 2003, Table 2). Given the close connection between economic hardships and food insecurity (Nord, *et al*., 2004, Table 3), one may expect the food insecurity status of American Indians to also be substantially worse than the general population. While there have been numerous studies on individual Reservations examining the extent of food insecurity and other nutrition-deprivation problems (for a summary see American Indian Studies Programs, 2000; Tiehen, 2003a, 2003b; Vandeman, 2000, 2002) to date there have not been any analyses regarding the extent nor the depth of food insecurity among American Indians on a national basis.

I begin this paper with a discussion of the methodology employed to describe the extent and depth of food insecurity in the United States. I then turn to the data set used to apply this methodology – the Current Population Survey. Following this are the results from both bivariate and multivariate models and some concluding remarks.

The conclusions one reaches regarding the differences in food insecurity between American Indians and non-American Indians depend on the choice of food insecurity measure and the choice of population. While American Indians in households with and without children have higher rates of food insecurity when all households are examined, when the sample is restricted to the low-income population, measures of food insecurity which reflect the depth and severity of food insecurity show no statistically significant difference between American Indians and non-American Indians. The magnitude of the differences also depend on the choice of measure, especially for households without children. For the measures of food insecurity with hunger, there is no statistically significant difference between American Indian households with children and non-American Indian households with children across all the measures but American Indian households without children have higher levels of food insecurity with hunger, especially for the measures reflecting depth and severity. Even after controlling for other factors in multivariate frameworks, I find that these comparisons between American Indians and non-American Indians remain.

Methodology

In the United States, food insecurity is often measured through a series of questions regarding the food hardships facing a household. More affirmative responses to these questions are said to represent higher degrees of food insecurity. The affirmative responses can be designated as a

food insecurity index. Given the creation of a food insecurity index, the next step is to formulate an aggregate measure of food insecurity. One method is to create, as is done in the official statistics created by the USDA, categories of food insecurity such as food secure, food insecure without hunger, or food insecure with hunger (Nord et al., 2004). While this kind of partitioning may be helpful for some purposes, it neglects to take full advantage of the information contained in the 18 questions; the following discussion demonstrates how one can utilize more fully the richness of the 18 questions. The theoretical framework utilized here is based on similar constructions within the income poverty literature (e.g., Atkinson, 1987; Blackorby and Donaldson, 1980; Foster et al., 1984; Foster and Shorrocks, 1991; Kakwani, 1980; Pattanaik and Sengupta, 1995; Sen, 1976).[1]

Notation and Concepts

Let $N = \{1,\ldots,n\}$ denote the set of all households under consideration, n being the total number of households in the set. For all $i \in N$, let s_i denote the food indicator (FI) for household i where a higher value of s_i indicates a more unfavorable food situation for household i. I assume that, for every $i \in N$, s_i lies in the interval [0, z], where the value 0 denotes the complete absence of any unfavorable circumstance relating to food and z denotes the most unfavorable situation with respect to food.

Let e ($1 > e \geq 0$) be the benchmark such that a household i is considered food insecure if and only if $s_i > e$.[2] We can now define the notions of a food insecurity index and a normalized food insecurity index for a household. For every household i, the food insecurity index (FII) for i is defined to be 0 if $s_i \leq e$ and it is defined to be $(s_i - e)$ if $s_i > e$. The FII of a household provides

[1] For more on the particular application to food insecurity used here, see Dutta et al., 2002.
[2] For simplicity, only food insecurity as a benchmark is used here. In the empirical portion of the paper, food insecurity with hunger is also used as a benchmark.

us with a measure of the extent to which the household is food insecure; it is clearly analogous to the notion of an individual's "shortfall" from the poverty line, used in the literature on poverty measurement. We get the normalized food insecurity index (NFII) for a household when we normalize the FII by dividing it by (z - e). Thus, the NFII for household i, denoted by d_i, is given by

$$d_i = \frac{s_i - e}{z - e} \text{ if } s_i > e;\ d_i = 0 \text{ otherwise} \qquad (1)$$

Let d denote the degree of food insecurity suffered by the group, N, of all households. I assume that d is a (real valued) function of $d_1,\ldots,d_n$. We shall call such a function a rule for aggregating household food insecurity levels. Thus, this aggregation rule is a function $D:[0,1]^n \rightarrow R^n$. Define d as $d=D(d_1,\ldots,d_n)$.

Form of the Aggregation Rule D

What form should one assume for the function D that aggregates the food insecurity levels, $d_1,\ldots,d_n$, of the households to arrive at the index, d, of food insecurity at a higher level of aggregation? The properties of similar rules for aggregating deprivation levels have been discussed extensively in the literature on income poverty. Some of the familiar properties that one may wish to impose on D are:

Normalization: For all $(d_1,\ldots,d_n) \in [0, 1]^n$, [if $d_i = 0$ for all $i \in N$, then $d = 0$] and [if $d_i = 1$ for all $i \in N$, then $d = 1$].

Anonymity: For all $(d_1,\ldots,d_n)$, $(d'_1,\ldots, d'_n) \in [0, 1]^n$, and, for all $i, j \in N$, if $[d_i = d'_j]$, $[d_j = d'_i]$ and [for all $t \in N - \{i,j\}$, $d_t = d'_t$], then $d = d'$.

Monotonicity: For all $(d_1,\ldots,d_n)$, $(d'_1,\ldots, d'_n) \in [0, 1]^n$, and, for all distinct i, j $\in$ N, if [$d_i \geq d'_i$ for all i $\in$N] and [$d_i \geq d'_i$ for some i $\in$N], then d > d', where d=D($d_1,\ldots,d_n$) and d'=D($d'_1,\ldots, d'_n$).

Transfer: For all $(d_1,\ldots,d_n)$, $(d'_1,\ldots, d'_n) \in [0, 1]^n$, and, for all distinct i, j $\in$ N, if [(for all p $\in$ N $-\{i, j\}$, $d_p = d'_p$) and ($d_i > d_j > 0$) and, for some $\delta > 0$, $d'_i = d_i + \delta$ and $d'_j = d_j - \delta > 0$) and (for all p, q $\in$ N, $d_p \geq d_q$ if and only if $d'_p \geq d'_q$)], then d' > d.

Normalization, which requires that d be 0 when the NFII is 0 for all households and d should be 1 when the NFII is 1 for all households, is an innocuous property. Its justification lies in the convenience it ensures. Anonymity requires that, other things remaining the same, if the NFII of two households are interchanged, then the food insecurity index for the society remains unaffected. Thus, anonymity demands that the households be treated by the aggregation rule in a symmetric fashion. In a framework based on the aggregation of individual deprivation levels, symmetric treatment of individuals is a compelling property. However, in our framework, where D aggregates the NFII's of households to arrive at the measure of overall food insecurity for N, the symmetric treatment of the households may be a less compelling property, given the possibility that the households may differ in their sizes. Monotonicity requires that, other things remaining the same, an increase in the NFII of a household leads to a rise in the value of the food insecurity index of the society as a whole. The transfer property is the counterpart of a similar property in the literature on poverty measurement (see, for example, Sen, 1976). Suppose, to start with, two households i and j suffer from food insecurity but the food insecurity of i is

greater than the food insecurity of j. Now suppose the NFII of i increases by δ, and, simultaneously, the NFII of j decreases by δ, while the NFII of every other household, the set of food-insecure households, and the ranking of the food-insecure households all remain unchanged. Then the transfer property stipulates that the food insecurity of the set, N, of all households must increase.

In this paper I use three different aggregation rules for the function D. Let n denote the number of households in a society. The different aggregation rules all can be expressed, by varying α through the following construction from Foster, Greer, and Thorbecke (1984).

$$d^{\alpha} = \frac{\sum_{i=1}^{n} (d_i)^{\alpha}}{n} \qquad (2)$$

When α = 0, d defines the food insecurity rate; when α = 1, d defines the food insecurity gap; and when α = 2, d defines the squared food insecurity gap. These are the three measures used in this paper. The head count measure (i.e., the most commonly used measure of food insecurity) satisfies the normalization and anonymity axioms but it does not satisfy either of the other two axioms; this is one of the reasons for dissatisfaction with the measure. The food insecurity gap satisfies the first three axioms but not the transfer axiom. The squared food insecurity gap measure satisfies all four axioms.

Data

For this paper I use data from the 2001, 2002, and 2003 December supplements from the CPS, a monthly survey of approximately 50,000 households. Along with being the official data source for official poverty and unemployment rates, in this supplement the CPS has the CFSM. The CFSM has been in at least one month in the CPS in every year since 1995. To avoid issues of

seasonality and changes in various other things (e.g., the screening questions), only the three most recently available December Supplements are used in this paper. Multiple years are used for this analysis due to the limited sample size of American Indians in any given year.[3] This is especially true when further breakdowns are examined in the manner described below.

The CFSM contains 18 questions that provide detailed information about the experiences of household members as it pertains to a household's inability to meet basic food needs due to financial constraints. (For households without children, 10 of these questions are answered.) The 18 questions used in the CFSM are found in Appendix Table 1. Each question is designed to capture some aspect of food insecurity and, for some questions, the frequency with which it manifests itself. Examples of questions include "I worried whether our food would run out before we got money to buy more," (the least severe question); "Did you or the other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food;" "Were you ever hungry but did not eat because you couldn't afford enough food;" and "Did a child in the household ever not eat for a full day because you couldn't afford enough food" (the most severe question). As described above, a household with children is categorized as (a) food secure if the respondent responds affirmatively to two or less of these questions; as (b) food insecure if the respondent responds affirmatively to three or more questions; and as (c) food insecure with hunger if the respondent responds affirmatively to eight or more questions. A household without children is categorized as (a) food secure if the respondent responds affirmatively to two or less of these questions; as (b) food insecure if the respondent responds

[3] In general, a household is observed in two successive years in the March CPS. In response, households observed for the second time in 2001 and 2002 are included in the sample and all households observed in 2003 are included in the sample.

affirmatively to three or more questions; and as (c) food insecure with hunger if the respondent responds affirmatively to six or more questions.

In order to convert the information from the CFSM into the relevant format for equation (1), one must first assign the relevant value to the number of affirmative responses for each household. I.e., one must first assign the relevant value to s_i, the food insecurity indicator. Consistent with the method used in the official calculations of the food insecurity measure, I use the Rasch scoring method which converts the affirmative and negative responses to the 18-item questionnaire into a single indicator. The underlying assumption of the Rasch method is that the probability that a household will answer a question affirmatively relative to answering it negatively depends on the degree of the food insecurity of the household and the extent of the severity of food insecurity captured by the question. In other words, the Rasch score assumes that the probability of a household answering a question positively or negatively follows a logistic distribution, the parameters of which depend on the households food insecurity level and the level of severity of the question. Using a maximum likelihood estimation based on the overall response pattern of households to all the questions, one can then derive each household's Rasch score.

For households with children, the value of e is 2.56 (i.e., 2 affirmative responses) when the food insecurity measure is being used (6.02 when the food insecurity measure with hunger is being used) and the value of z is 13.03 (i.e., 18 questions). For households without children, the value of e is 3.10 when the food insecurity measure is being used (6.16 when the food insecurity measure with hunger is being used) and the value of z is 11.05 (i.e., 10 questions). The values for other numbers of affirmative responses are found in Appendix Table 1.

Figure1 gives the frequency for each of the values of s for the two samples in this paper – households with children and households without children. Consistent with the work being done below, these are counts for the three years combined. As seen, there are a large number of households suffering from serious levels of food insecurity. As an example, 193 households with children and 261 households without children responded affirmatively to 10 questions. Under the current measure, if one were looking at food insecurity or at food insecurity with hunger, these households with children responding affirmatively to questions are treated the same as the 296 households with children responding affirmatively to 8 questions, i.e., they are both food insecure with hunger. For households without children, they would be treated the same as the 713 households responding affirmatively to 6 questions. Or, if food insecurity was being analyzed, these households responding to 10 questions would be treated the same as households responding affirmatively to 3 questions – 983 in the case of households with children and 1,614 for households without children.

[Figure 1 about here]

In terms of defining who is American Indian, on the 2001 and 2002 CPS, there were four questions used to establish race. In households where the respondent answered "American Indian, Aleut, or Eskimo", the household is defined as American Indian. In the 2003 CPS, persons were allowed to report multiple races. The possible combinations which lead to a designation of American Indian for this paper are "American Indian or Alaskan", "white and American Indian," "black and American Indian,", "American Indian and Asian", "white, black, and American Indian," "white, American Indian, and Asian," and "white, black, American Indian, and Asian." This change resulted in a decrease in the percentage of persons who reported that they were only American Indian but, overall, an increase in the percentage of persons who

reported that they were at least part American Indian. Insofar as it is unlikely that there was an increase in the percentage of the population that is American Indian, the increase is presumably due to persons who may have identified, say, as "black" before but now identify as "black-American Indian." In this paper, I define anyone in 2003 who reported that they were at least part American Indian as "American Indian." I also consider how the results may differ if an alternative definition of American Indian is used for 2003.

Results

Comparisons of Food Insecurity and Food Insecurity with Hunger

The top panel of Table 1 has the results for the extent of food insecurity under each of the three measures among American Indians and non-American Indians for the years 2001 to 2003 for households with children. These are further broken down for all income levels and for households with incomes below 185 percent of the poverty line.[4] The latter is denoted as the "low-income sample." Across all three measures for the all-income sample, food insecurity is higher among American Indians than among non-American Indians and these differences are statistically significant.[5] For example, under the food insecurity gap measure, the respective figures are 0.066 and 0.040. For the low-income sample, the difference between American Indians and non-American Indians is significant for the food insecurity rate measure (0.417 versus 0.345) but not for the other two measures.

[Table 1 about here]

In the bottom panel of Table 1, the results for the sample of households without children are displayed. For both the sample of all incomes and the low-income sample, American Indians

[4] This is the income cutoff for the Supplemental Nutrition Program for Women, Infants, and Children (WIC) and for reduced price meals through the National School Lunch Program and National School Breakfast Program.
[5] Unless otherwise noted, statistically significant differences are at the 95 percent confidence level.

have higher food insecurity rates than non-American Indians. For example, for the food insecurity gap the respective figures for American Indians and non-American Indians for the all income sample are 0.078 and 0.030 and, for the low-income sample, 0.134 and 0.077.

Along with considering the orderings across the three measures one may also wonder whether the magnitude of the differences is similar across the measures. One way to consider this is by taking the ratio of the food insecurity measures for American Indians to non-American Indians. The results for households are in Figure 2. As done in Table 1, these are further broken down by income status.

[Figure 2 about here]

For the sample of households with children, the ratios are quite similar across all three measures. For the sample of households without children, however, the ratios differ markedly as more weight is placed on the food insecurity of those with higher food insecurity levels (i.e., as the value of α increases.) For the all-income sample of households without children, the ratio is 2.07 when $\alpha=0$ and it is 2.94 when $\alpha=2$.

In Table 2, the results for food insecurity with hunger are displayed in a manner similar to Table 1. In contrast to the food insecurity results, there is no statistical distinction between food insecurity with hunger between American Indians and non-American Indians among households with children. This holds for both the all-income sample and the low-income sample. Moreover, for the low-income sample, the food insecurity gap and the squared food insecurity gap is the same for American Indians and non-American Indians – 0.023 and 0.008. Turning to households without children, however, one does see differences. In both the all-income and the low-income sample, American Indians have higher food insecurity with hunger than non-American Indians across all three measures. For example, for the squared food

insecurity gap, the figures are 0.031 and 0.009 for the all-income sample and 0.049 and 0.025 for the low-income sample.

[Table 2 about here]

To again give some sense of the magnitude of the differences between American Indians and non-American Indians, the results for the food insecurity with hunger results are displayed in Figure 3. As in Figure 2, the ratio between American Indians and non-American Indians for households without children in the all-income sample is increasing in α - the ratio is 2.83 when α=0, 3.14 when α=1, and 3.44 when α=2. For the low-income sample, however, the increase is much smaller - the respective figures are 1.86, 1.87, and 1.96.

[Figure 3 about here]

Multivariate Analyses

The differences between food insecurity among American Indians and non-American Indians may be due to many factors. For example, as seen in Appendix Table 2, over nearly every characteristic one may associate with higher rates of food insecurity, American Indians are worse off. For example, lower income households have higher probabilities of food insecurity; the average income-to-poverty ratio of American Indians in households with children is 2.31 while for non-American Indians, the ratio is 3.06.

To consider the influence of being in a household headed by an American Indian, net of other factors, I therefore estimate the following tobit model. One needs to use a tobit model in estimations like this because the food security measure is a censored measure since we do not fully observe the food security status of the vast majority of food secure households. While we do observe the food insecurity status of some food secure households, those responding

affirmatively to one or two questions, there is no way to distinguish the food insecurity status of households responding negatively to all 18 questions. The following model is established:

$d_{ij}^{\alpha} = d_{ij}^{\alpha}*$ if $d_{ij}^{\alpha}*>0$; $d_{ij}^{\alpha} = 0$ otherwise (2)

$d_{ij}^{\alpha}* = \alpha_j AMERICANINDIAN_i + \delta j NONMETRO_i + \boldsymbol{\beta} j \mathbf{X} i + \gamma_j \mathbf{Y}_i + \zeta_j \mathbf{Z}_i + e_{ji}$

where j denotes whether the food insecurity or the food insecurity with hunger distinction is being used; AMERICANINDIAN=1 if a household is headed by an American Indian, 0 otherwise; NONMETRO=1 if a household lives in a nonmetro area, 0 otherwise; **X** is a vector of variables reflecting non-economic characteristics of the household; **Y** is a vector reflecting economic characteristics of the household; **Z** is a vector of year fixed effects; and e is an error term.

The results for the food insecurity measure are in the top panel and the results for the food insecurity with hunger measure are in the bottom panel of Table 4. These are further broken down by whether or not children are in the household. The effect of being an American Indian on the probability of being food insecure is positive and significant for all three measures for the all-income and the low-income sample of households with children.[6] In other words, even net of other factors, American Indians are more likely to be food insecure. A similar result holds for the sample of households without children. A key difference in the results is the relative size of the coefficients across the different values of α. One way to portray the magnitude of the effects is to divide the coefficient on the American Indian variable by the average value for each of the values of α. For the all-income sample in households with children, as one moves from α=0 to α=2, this ratio increases from 1.25 to 1.40. In contrast, as

[6] The coefficients on the other variable and year fixed effects are suppressed in Table 4. These variables are of the expected sign, magnitude, and statistical significance.

one moves from $\alpha=0$ to $\alpha=2$ in households without children, this ratio increases from 4.94 to 7.82.

For the food insecurity with hunger measure in households with children, all else equal, American Indians are no more likely to be food insecure with hunger in comparison to non-American Indians. And, for the low-income sample, while insignificant, the effect of being American Indian is negative. In contrast, in households without children the effect of being American Indian is positive and statistically significant. As with the food insecurity measures, the magnitude is increasing in α.

Alternative Specifications

I now consider two further specifications of the multivariate model. The first specification changes the definition of who is American Indian in 2003. As noted above, in 2001 and 2002 (and previous years), persons were allowed to place themselves in one and only one racial category in the CPS but in 2003 persons were allowed to select multiple categories. To see how this expansion affects the results, I keep the American Indian/non-American Indian distinction the same in 2001 and 2002 but for 2003 I now only limit the group of persons defined as American Indian to those who declared themselves only American Indian on the CPS. For 2003, this reduces the number of households headed by an American Indian by 53 percent and increases the number of households headed by a non-American Indian by 0.5 percent. As seen in Table 4, the estimation of equation (2) is essentially the same as in Table 3. While the coefficients on the American Indian variable are, in general, slightly smaller, the choice of how one defines American Indian in this context does not seem to matter to a large extent.

The second specification addresses, to some extent, the distinction between American Indians who live in nonmetro and those who live in metro areas.[7] As seen in Appendix Table 1, American Indians are much more likely to live in nonmetro areas than non-American Indians. For households with children, 29.2 percent of American Indians live in nonmetro areas versus 17.9 percent of non-American Indians and for households without children, the figures are 30.2 percent and 19.6 percent. The differences are even larger for households with incomes less than 185 percent of the poverty line. A central reason for the larger percentage of American Indians living in nonmetro areas is that most Reservations are in nonmetro areas. This may imply that the impact of living in a nonmetro area differs from non-American Indians.

To see whether the living in a nonmetro area has a differential influence upon the probability of food insecurity for American Indians, equation (2) is estimated with an interaction term between AMERICANINDIAN and NONMETRO. The results are found in Table 5. A comparison between the results in Table 3 and Table 5 indicates two possible effects of being an American Indian in a nonmetro area. First, for lower-income households without children, the effect of being an American Indian is now insignificant but the combined effect of being an American Indian and an American Indian in a nonmetro area is significant. Second, for lower-income households with children, the effect of being an American Indian is still insignificant (as it was in Table 3) but the interaction term is negative and statistically significant. These findings demonstrate that living in a nonmetro area may be protective for low-income American Indian households with children but not for low-income American Indian households without children. In the concluding remarks I return to this point.

[7] A metro area is defined as a county with a population of 50,000 or more, a county with an urbanized area, or a county with economic ties to a metro area (Jolliffe 2003; Office of Management and Budget 2000). Nonmetro areas are then defined as areas not meeting any of these criteria.

Conclusion

This paper has described a method of measuring food insecurity which allows researchers and policymakers to move beyond just looking at simple breakdowns of food secure versus food insecure and food secure and food insecure without hunger versus food insecure with hunger. In other words, through the use of the measures in this paper, the richness of the 18 questions in the CFSM can be more fully utilized, enabling pictures of the extent, depth and severity of food insecurity and analyses of robustness of conclusions regarding food insecurity.

I have applied this theoretical framework to a consideration of the food insecurity of American Indians. As expected, in general, American Indians have higher levels of food insecurity than non-American Indians but this conclusion depends on the choice of measure and choice of sample. Moreover, the magnitude of the differences depends on the choice of measure. These differences carry over to multivariate considerations of differences between American Indians and non-American Indians. So, along with a slew of negative consequences arising from limited economic opportunities for American Indians - including high rates of obesity, high prevalences of diabetes, high rates of tooth decay, and low rates of breastfeeding – one can now conclude with a high degree of robustness, that American Indians also face higher levels of food insecurity, even after controlling for other factors. These higher levels of food insecurity and food insecurity with hunger are especially prominent for households without children.

I conclude with some suggestions for future research. First, this paper has made a comparison between American Indians and non-American Indians but there are many other groups with higher than average food insecurity rates (e.g., single parents with children) which are in need of greater study with a richer theoretical framework. Second, this analysis has used the CPS but a wide array of other data sets have the CFSM and the theoretical framework of this

paper could be fruitfully utilized there. In particular, there are numerous data sets with information on American Indians, some of which have the CFSM. (For more on this, see Feingold et al., 2004.) Third, in this paper I have created food insecurity measures based on the income poverty measures of Foster, Greer, and Thorbecke (1984). More generally, there are numerous other income poverty measures that may be justifiable as food insecurity measures.

In terms of topics specific to American Indians, one issue not explored in this paper is the effect of living on-or-off a Reservation on the probability of food insecurity. The results in Table 5 regarding the effects of being an American Indian in a nonmetro area provides some preliminary evidence that proximity to a Reservation or residence on a Reservation may matter. To investigate this further, the CPS cannot be used since residence is not disaggregated to the Reservation-level due to confidentiality reasons. Other data sets, in conjunction with CPS, may allow for answers to this issue.

References

American Indian Studies Programs. 2000. *Bibliography of Resources Related to Food Assistance and Health of North American Indians and Alaska Natives*. University of Arizona, American Indian Studies Programs.

Atkinson, A. 1987. "On the Measurement of Poverty." *Econometrica* 55(4): 749-764.

Bhattacharya, J., J. Currie, and S. Haider. 2004. "Poverty, Food Insecurity, and Nutritional Outcomes in Children and Adults." *Journal of Health Economics* 23(4): 839-862.

Bitler, M., C. Gundersen, and G. Marquis. 2005. "Are WIC Non-Recipients at Less Nutritional Risk than Recipients? An Application of the Food Security Measure." *Review of Agricultural Economics* 27(3): 433–438.

Blackorby D. and D. Donaldson. 1980. "Ethical Indices for the Measurement of Poverty." *Econometrica,* 48(4): 1053-1060.

Borjas, G. 2004. "Food Insecurity and Public Assistance." *Journal of Public Economics* 88: 1421-1443.

Dunifon, R., and L. Kowaleski-Jones. 2003. "The Influences of Participation in the National School Lunch Program and Food Insecurity on Child Well-Being." *Social Service Review* 77(1): 72-92.

Dutta, I., C. Gundersen, and P. Pattanaik. 2002. *Measures of Food Insecurity at the Household Level*. Working Paper, Department of Economics, University of California, Riverside, No. 02-03.

Evenson, K., B. Lararia, V. Lamar Welsch, and A. Perry. 2002. "Statewide Prevalences of Concern About Enough Food." *Public Health Reports* 117: 358-365.

Feingold, K., N. Pindus, L. Wherry, S. Nelson, T. Triplett, and R. Capps. (2005). *Background report on the use and impact of food assistance programs on Indian reservations.* U.S. Department of Agriculture, Economic Research Service, Contractor and Cooperator Report 4.

Foster, J. and A. Shorrocks. 1991. "Subgroup Consistent Poverty Indices." *Econometrica,* 59(3): 687-709.

Foster, J., J. Greer, and E. Thorbecke. 1984. "A Class of Decomposable Poverty Measures." *Econometrica* 52(3): 761–766.

Furness, B., P. Simon, C. Wold, and J. Asarian-Anderson. 2004. "Prevalence and Predictors of Food Insecurity Among Low-Income Households in Los Angeles County." *Public Health Nutrition* 7(6): 791-794.

Garasky, S., L. Morton, and K. Greder. 2005. "The Food Environment and Food Insecurity: Perceptions of Rural, Suburban, and Urban Food Pantry Clients in Iowa." *Family and Economics Nutrition Review*, 16(2): 41-48.

Gregory, R., A. Abello, and J. Johnson. 1997. "The Individual Economic Well-Being of Native American Men and Women During the 1980s: A Decade of Moving Backwards." *Population Research and Policy Review*, 16: 115-145.

Gundersen, C., and V. Oliveira. 2001. "The Food Stamp Program and Food Insufficiency." *American Journal of Agricultural Economics* 83(4): 875-87.

Gundersen, C., L. Weinreb, C. Wehler, and D. Hosmer. 2003. "Homelessness and Food Insecurity." *Journal of Housing Economics* 12(3): 250-272.

Jolliffe, D. 2003. "On the Relative Well-Being of the Nonmetropolitan Poor: An Examination of Alternative Definitions of Poverty During the 1990s." *Southern Economic Journal* 70: 295-311.

Kakwani, N. 1980. "On a Class of Poverty Measures." *Econometrica*, 48(2): 437-446.

Laraia, B., A. Siega-Riz, C. Gundersen, and N. Dole. "Psychosocial Factors and Socioeconomic Indicators are Associated with Household Food Insecurity Among Pregnant Women." *Journal of Nutrition*. Forthcoming.

Leichenko, R. 2003. "Does Place Still Matter? Accounting for Income Variation Across American Indian Tribal Areas." *Economic Geography 79* (4), 365-386.

Nord, M., M. Andrews, and S. Carlson. 2004. *Household Food Security in the United States, 2003*. Washington, DC: U.S. Department of Agriculture, Economic Research Service, Food Assistance and Nutrition Research Report 42.

Office of Management and Budget. 2000. "Standards for Defining Metropolitan and Micropolitan Statistical Areas." *Federal Register, 65*, 82228-82238.

Pattanaik, P. K. and M. Sengupta. 1995. "An Alternative Axiomatization of Sen's Poverty Measure." *Review of Income and Wealth* 41(1): 73-80.

Ribar, D., and K. Hamrick. 2003. *Dynamics of Poverty and Food Sufficiency*. Washington, DC: U.S. Department of Agriculture, Economic Research Service, Food Assistance and Nutrition Research Report 33.

Sen, A. 1976. "Poverty: An Ordinal Approach to Measurement." *Econometrica*, 44(2): 219–231.

Slack, K. and J. Yoo. 2005. "Food Hardship and Child Behavior Problems Among Low-Income Children." *Social Service Review*, 79(3): 511-536.

Stuff, J., P. Casey, K. Szeto, J. Gossett, J. Robbins, P. Simpson, C. Connell, and M. Bogle. 2004.

"Household Food Insecurity is Associated with Adult Health Status." *Journal of Nutrition*, 134; 2330-2335.

Tiehen, L. (Editor). 2003a. *Food Assistance and Nutrition Research Small Grants Program: Executive Summaries of 2002 Research Grants*. U.S. Department of Agriculture, Economic Research Service, Food Assistance and Nutrition Research Report No. 38.

Tiehen, L. (Editor). 2003b. *Food Assistance and Nutrition Research Small Grants Program: Executive Summaries of 2001 Research Grants*. U.S. Department of Agriculture, Economic Research Service, Food Assistance and Nutrition Research Report No. 37.

Vandeman, A. (Editor). 2002. *Food Assistance and Nutrition Research Small Grants Program: Executive Summaries of 2000 Research Grants*. U.S. Department of Agriculture, Economic Research Service, Food Assistance and Nutrition Research Report No. 20.

Vandeman, A. (Editor). 2000. *Food Assistance and Nutrition Research Small Grants Program: Executive Summaries of 1998 Research Grants*. U.S. Department of Agriculture, Economic Research Service, Food Assistance and Nutrition Research Report No. 10.

Van Hook, J. and K. Balistreri. Forthcoming. "Ineligible Parents, Eligible Children: Food Stamps Receipt, Allotments, and Food Insecurity Among Children of Immigrants." *Social Science Research*, in press.

Table 1: Measures of Food Insecurity for American Indians and Non-American Indians, 2001-2003, by Income and Household Composition

	All Households		Households with Incomes Below 185 Percent of the Poverty Line	
	American Indians	Non-American Indians	American Indians	Non-American Indians
	(1)	(2)	(3)	(4)
Food Insecurity Measure	Households with Children			
Food Insecurity Rate (α=0)	0.261**	0.156	0.417**	0.345
	(0.023)	(0.004)	(0.037)	(0.006)
Food Insecurity Gap (α=1)	0.066**	0.040	0.108	0.093
	(0.007)	(0.001)	(0.012)	(0.002)
Squared Food Insecurity Gap (α=2)	0.024**	0.015	0.039	0.035
	(0.003)	(0.000)	(0.009)	(0.001)
	Households without Children			
Food Insecurity Rate (α=0)	0.157**	0.076	0.277**	0.185
	(0.016)	(0.002)	(0.031)	(0.004)
Food Insecurity Gap (α=1)	0.078**	0.030	0.134**	0.077
	(0.010)	(0.001)	(0.019)	(0.002)
Squared Food Insecurity Gap (α=2)	0.050**	0.017	0.084**	0.046
	(0.008)	(0.000)	(0.015)	(0.001)

Notes: Standard errors are in parentheses. Superscripts of * or ** are used in columns (1) and (3) if the p-value of the difference between columns (1) and (2) and columns (3) and (4) are less than 0.1 or 0.05, respectively.

Table 2: Measures of Food Insecurity with Hunger for American Indians and Non-American Indians, 2001-2003, by Income and Household Composition

	All Households		Households with Incomes Below 185 Percen of the Poverty Line	
	American Indians	Non-American Indians	American Indians	Non-American Indian
	(1)	(2)	(3)	(4)
Food Insecurity Measure	Households with Children			
Food Insecurity Rate (α=0)	0.055	0.038	0.092	0.090
	(0.011)	(0.001)	(0.020)	(0.003)
Food Insecurity Gap (α=1)	0.015	0.009	0.023	0.023
	(0.003)	(0.000)	(0.005)	(0.001)
Squared Food Insecurity Gap (α=2)	0.005	0.003	0.008	0.008
	(0.002)	(0.000)	(0.002)	(0.001)
	Households without Children			
Food Insecurity Rate (α=0)	0.085**	0.030	0.151**	0.081
	(0.013)	(0.001)	(0.027)	(0.003)
Food Insecurity Gap (α=1)	0.044**	0.014	0.073**	0.039
	(0.008)	(0.000)	(0.016)	(0.001)
Squared Food Insecurity Gap (α=2)	0.031**	0.009	0.049*	0.025
	(0.006)	(0.000)	(0.012)	(0.001)

Notes: Standard errors are in parentheses. Superscripts of * or ** are used in columns (1) and (3) if the p-value of the difference between columns (1) and (2) and columns (3) and (4) are less than 0.1 or 0.05, respectively.

Table 3: Effect of Being an American Indian on Food Insecurity and on Food Insecurity with Hunger, 2001-2003

	Food Insecurity Rate (α=0)	Food Insecurity Gap (α=1)	Squared Food Insecurity Gap (α=2)	Food Insecurity Rate (α=0)	Food Insecurity Gap (α=1)	Squared Food Insecurity Gap (α=2)
	All Households			Households with Incomes Below 185 Percent of the Poverty Line		
	(1)	(2)	(3)	(4)	(5)	(6)
	Food Insecurity					
	Households with Children					
American Indian	0.232**	0.058**	0.025**	0.203**	0.050**	0.022**
	(0.076)	(0.022)	(0.011)	(0.075)	(0.024)	(0.012)
	Households without Children					
American Indian	0.385**	0.191**	0.133**	0.294**	0.157**	0.112**
	(0.094)	(0.042)	(0.028)	(0.102)	(0.048)	(0.034)
	Food Insecurity with Hunger					
	Households with Children					
American Indian	0.059	0.016	0.005	-0.018	-0.004	-0.004
	(0.175)	(0.047)	(0.022)	(0.181)	(0.051)	(0.025)
	Households without Children					
American Indian	0.594**	0.304**	0.223**	0.475**	0.247**	0.183**
	(0.141)	(0.070)	(0.050)	(0.153)	(0.079)	(0.059)

Notes: Standard errors are in parentheses. The other coefficients in this model are suppressed. A listing of the variables can be found in Appendix Table 1. Year fixed effects are also included. Superscripts of * or ** are used if the p-value of the difference from zero for the coefficients in are less than 0.1 or 0.05, respectively.

Table 4: Effect of Being an American Indian on Food Insecurity and on Food Insecurity with Hunger, Alternative Specification of American Indian in 2003, 2001-2003

	Food Insecurity Rate (α=0)	Food Insecurity Gap (α=1)	Squared Food Insecurity Gap (α=2)	Food Insecurity Rate (α=0)	Food Insecurity Gap (α=1)	Squared Food Insecurity Gap (α=2)
	All Households			Households with Incomes Below 185 Percent of the Poverty Line		
	(1)	(2)	(3)	(4)	(5)	(6)
	Food Insecurity					
	Households with Children					
American Indian	0.198**	0.050*	0.021*	0.168**	0.047*	0.021
	(0.088)	(0.026)	(0.012)	(0.085)	(0.028)	(0.014)
	Households without Children					
American Indian	0.320**	0.155**	0.104**	0.258**	0.145**	0.105**
	(0.121)	(0.054)	(0.036)	(0.127)	(0.060)	(0.042)
	Food Insecurity with Hunger					
	Households with Children					
American Indian	0.018	0.004	0.001	0.040	0.012	0.004
	(0.203)	(0.055)	(0.025)	(0.201)	(0.057)	(0.028)
	Households without Children					
American Indian	0.441**	0.220**	0.159**	0.435**	0.232**	0.174**
	(0.185)	(0.092)	(0.066)	(0.192)	(0.099)	(0.074)

Notes: Standard errors are in parentheses. The other coefficients in this model are suppressed. A listing of the variables can be found in Appendix Table 1. Year fixed effects are also included. Superscripts of * or ** are used if the p-value of the difference from zero for the coefficients in are less than 0.1 or 0.05, respectively.

Table 5: Effect of Being an American Indian on Food Insecurity and on Food Insecurity with Hunger, 2001-2003

	α=0	α=1	α=2	α=0	α=1	α=2
	All Households			Households with Incomes Below 185 Percent of the Poverty Line		
	(1)	(2)	(3)	(4)	(5)	(6)
	Food Insecurity					
	Households with Children					
American Indian	0.272**	0.070**	0.032**	0.317**	0.088**	0.041**
	(0.107)	(0.032)	(0.015)	(0.110)	(0.035)	(0.018)
In Nonmetro Area	-0.131**	-0.045**	-0.022**	-0.114**	-0.043**	-0.022**
	(0.030)	(0.009)	(0.004)	(0.032)	(0.010)	(0.005)
American Indian*In	-0.080	-0.024	-0.014	-0.212	-0.071	-0.036
Nonmetro Area	(0.151)	(0.045)	(0.021)	(0.150)	(0.048)	(0.025)
	Households without Children					
American Indian	0.298**	0.158**	0.113**	0.118	0.088	0.069
	(0.132)	(0.058)	(0.039)	(0.157)	(0.074)	(0.052)
In Nonmetro Area	-0.079**	-0.042**	-0.030**	-0.038	-0.027	-0.021*
	(0.033)	(0.014)	(0.010)	(0.036)	(0.017)	(0.012)
American Indian*In	0.179	0.069	0.041	0.307	0.121	0.075
Nonmetro Area	(0.189)	(0.083)	(0.056)	(0.206)	(0.097)	(0.069)
	Food Insecurity with Hunger					
	Households with Children					
American Indian	0.219	0.063	0.025	0.303	0.086	0.035
	(0.237)	(0.064)	(0.030)	(0.242)	(0.068)	(0.033)
In Nonmetro Area	-0.293**	-0.079**	-0.036**	-0.270**	-0.077**	-0.037**
	(0.072)	(0.019)	(0.009)	(0.076)	(0.021)	(0.010)
American Indian*In	-0.340	-0.102	-0.041	-0.690*	-0.195*	-0.084*
Nonmetro Area	(0.352)	(0.095)	(0.044)	(0.368)	(0.104)	(0.051)
	Households without Children					
American Indian	0.522**	0.271**	0.203**	0.440**	0.231**	0.171**
	(0.196)	(0.097)	(0.070)	(0.227)	(0.117)	(0.087)
In Nonmetro Area	-0.165**	-0.088**	-0.065**	-0.102**	-0.060**	-0.046**
	(0.054)	(0.027)	(0.020)	(0.058)	(0.030)	(0.023)
American Indian*In	0.150	0.068	0.042	0.065	0.030	0.023
Nonmetro Area	(0.280)	(0.139)	(0.100)	(0.307)	(0.159)	(0.118)

Notes: Standard errors are in parentheses. The other coefficients in this model are suppressed. A listing of the variables can be found in Appendix Table 1. Year fixed effects are also included. Superscripts of * or ** are used if the p-value of the difference from zero for the coefficients in are less than 0.1 or 0.05, respectively.

Figure 1: Number of Affirmative Responses to Food Insecurity Questions, 2001-2003

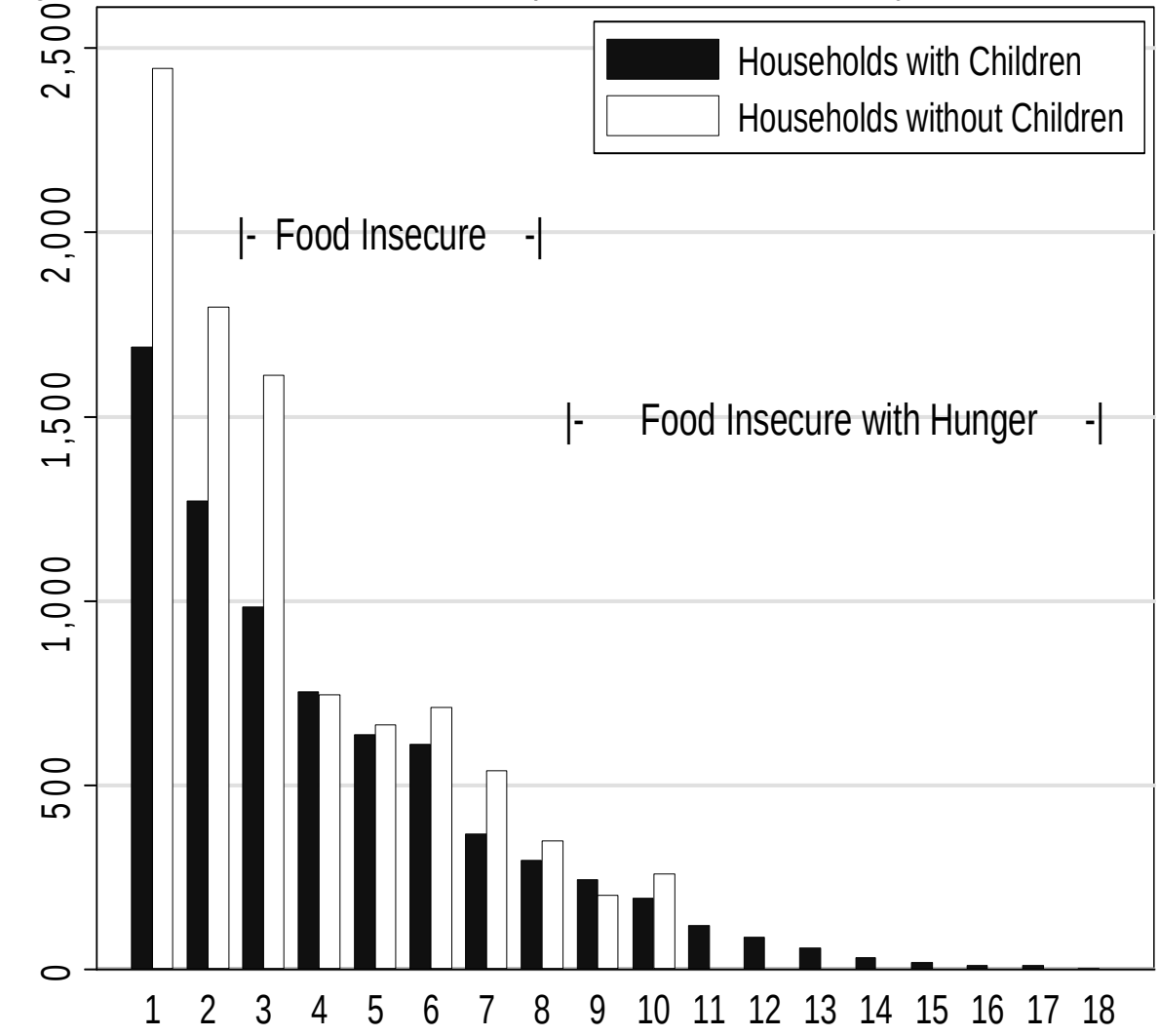
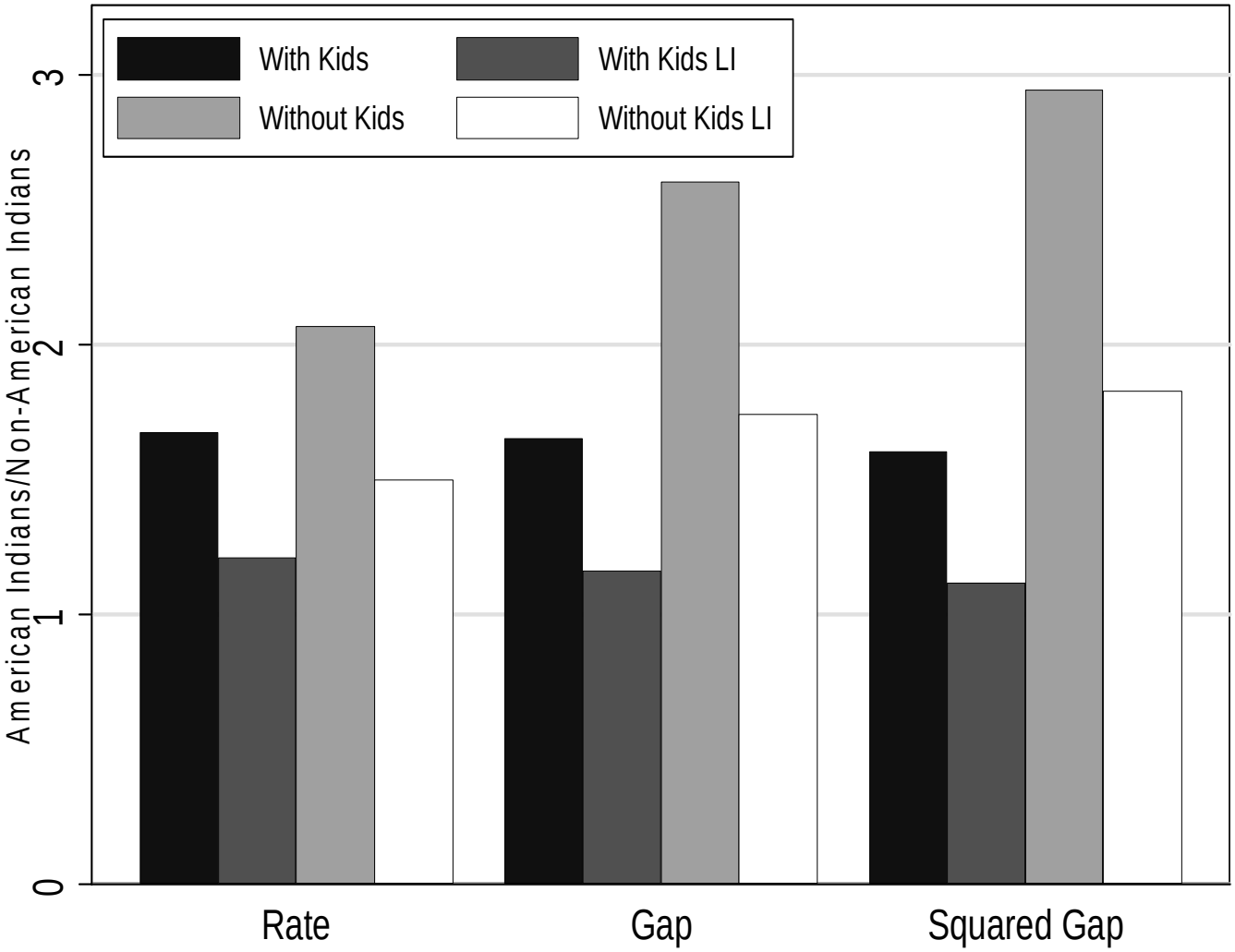
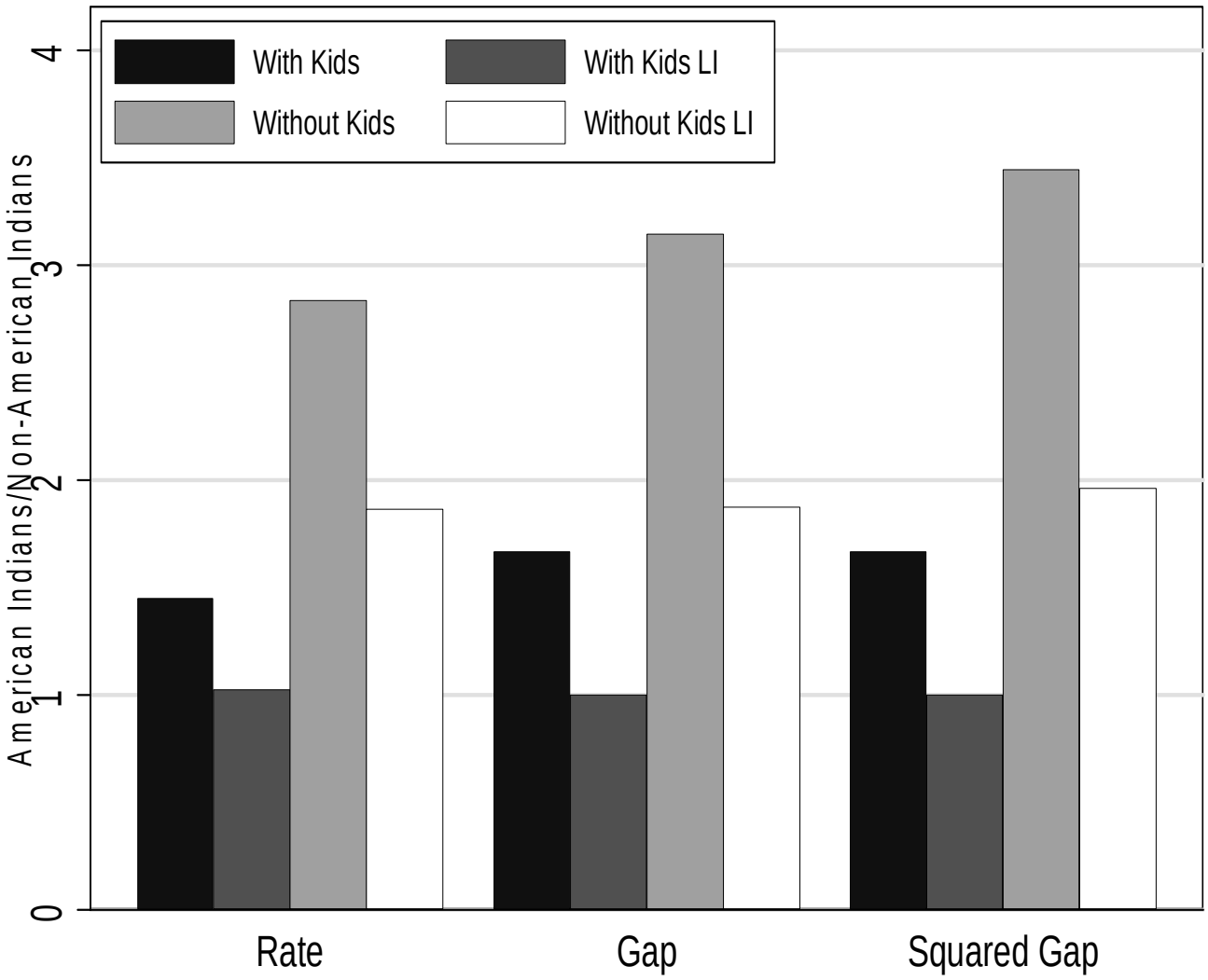


Figure 2: Differences in Food Insecurity for American Indians and non-American Indians



Note: LI denotes households with incomes less than 185 percent of the poverty line.

Figure 3: Differences in Food Insecurity with Hunger for American Indians and non-American Indians



Note: LI denotes households with incomes less than 185 percent of the poverty line.

Appendix Table 1: Questions on the Core Food Security Module and Value of Food Indicator , Ordered by the Model Number of Affirmative Responses

Food Security Question Associated with the Modal Number of Affirmative Responses	Households with children		Households without children	
	Number of affirmative responses	Food Indicator (FI)	Number of affirmative responses	Food Indicator (FI)
Worried food would run out	1	1.30	1	1.72
Food bought did not last	2	2.56	2	3.10
Respondent not eat balanced meals	3	3.41	3	4.23
Child fed few, low-cost foods	4	4.14		
Adult cut/skip meals	5	4.81	4	5.24
Child not fed balanced meals	6	5.43		
Respondent eat less than should	7	6.02	5	6.16
Adult skip meals, 3 or months	8	6.61	6	7.07
Child not eating enough	9	7.18		
Respondent hungry but did not eat	10	7.74	7	8.00
Respondent lost weight	11	8.28	8	8.98
Child meal size cut	12	8.79		
Adult not eat for whole day	13	9.31	9	10.15
Child hungry	14	9.84		
Adult not eat for whole day, 3 or months	15	10.42	10	11.05
Child skipped meal	16	11.13		
Child skipped meal, 3 or months	17	12.16		
Child not eat for whole day	18	13.03		

Appendix Table 2: Measures of Food Insecurity for American Indians and Non-American Indians, 2001-2003, by Income and Household Composition

	All Households		Households with Incomes Below 185 Percent of the Poverty Line	
	American Indians	Non-American Indians	American Indians	Non-American Indians
	Households with Children			
Income/Poverty	2.310	3.064	1.087	1.126
	(0.094)	(0.014)	(0.037)	(0.007)
Less than High School Degree	0.223	0.127	0.344	0.270
Married	0.681	0.729	0.636	0.544
Homeowner	0.524	0.687	0.356	0.421
In Nonmetro Area	0.292	0.179	0.347	0.146
	Households without Children			
Income/Poverty	3.020	3.840	1.067	1.183
	(0.106)	(0.138)	(0.034)	(0.005)
Less than High School Degree	0.204	0.153	0.384	0.333
Married	0.361	0.433	0.275	0.269
Homeowner	0.560	0.680	0.466	0.515
In Nonmetro Area	0.302	0.196	0.443	0.262

Notes: Standard errors are in parentheses.