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FOOD INSECURITY AND INSUFFICIENCY AT LOW LEVELS OF FOOD EXPENDITURES

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In this study we investigate the external validity of the food insecurity and insufficiency measures—specifically, how these measures correlate with food expenditures—using the December 2003 Food Security Supplement of the Current Population Survey. We focus on a special segment of the population—households with low incomes and low food expenditures. If reports of food problems are based on a lack of food, reports should be nearly ubiquitous at the bottom of the expenditure distribution. We find, however, that this is not the case. We define and scale food expenditures several different ways and find that the reported incidence of food insecurity never rises above one-half anywhere along the corresponding expenditure distributions, leading to concerns about the external validity of the measure.

JEL Codes: I32, D12

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1. INTRODUCTION

Alongside measures of income and wealth, indicators derived from direct reports of well-being, including reports of material, financial, and food hardships, have become important components of our understanding of social welfare. The use of direct reports was pioneered by the work of Amartya Sen (1985, 1992) and became especially prominent in the release of the first Human Development Report (UNDP, 1990). Since then, there have been both increasing calls for the use of such measures, including by Stiglitz *et al*. (2009), and increasing research examining well-being measures in countries of varying income levels.[1]

In the United States, the most commonly used direct indicators of well-being are measures of food insecurity and food insufficiency. These measures have become widely-used tools for policymakers, advocacy groups, and researchers. Since 1995, Food Security Supplements have been regularly fielded as part of the

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[1]Examples include Alkire, 2002; Anderson, 2005; Burton and Phipps, 2007; Chakravarty and D'Ambrosio, 2006; Federman *et al*., 1996; Hamermesh, 2004; Kakwani, 1993; Mayer, 1993; Mayer and Jencks, 1989; McGillivray, 2005; Deutsch and Silber, 2005; Phipps, 2002; and Ramos and Silber, 2005.

Current Population Survey (CPS), and the U.S. Department of Agriculture (USDA) has used these to estimate the prevalence of food insecurity. By this measure, nearly one in eight Americans in 2003 was in a household identified as food insecure (Nord *et al*., 2004). Entering the recent recession, food insecurity was estimated to affect approximately one in six Americans (Nord *et al*., 2009). In addition to indicating the extent of food hardships, the measures are used to gauge progress toward national objectives and to evaluate the effectiveness of food assistance programs and other social supports (Wilde, 2004). They have also been used by researchers studying the antecedents and consequences of food hardships.[2] While their use has been most common in the U.S., in recent years these household-based measures of food insecurity have become used more frequently in both developed and developing countries.[3]

With their wider use these food hardship measures have also faced growing scrutiny, a scrutiny that is faced by other self-reports of well-being (e.g. Castles, 1998; Hamermesh, 2004; Siminski and Yerokhin, 2011). Of particular interest to social scientists is how best to interpret these measures. Formally, households are defined as being food secure if they "had access, at all times, to enough food for an active, healthy life for all household members" and food insecure if they lacked such access (see, e.g. Nord *et al*., 2009). Although this definition encompasses several elements, a key and policy-relevant feature is the quantity of food available to household members. Researchers and the public have generally interpreted the measures this way.[4]

Attention then turns to how closely the U.S. food hardship measures actually correspond to other objective measures of food adequacy and needs—that is, whether food insecurity and insufficiency have strong external validity. Here the record becomes surprisingly equivocal. While reported food hardships have the expected broad negative associations with household incomes and expenditures and positive associations with household size and other measures of need (Nord *et al*., 2009), the strength of these associations is modest (Hamilton *et al*., 1997). There are also many incongruous findings. One such finding is the surprisingly high proportion of reported food hardships among households with moderate and high levels of income (Nord and Brent, 2002). Another finding is that the average intakes for food insufficient households exceed 100 percent of the Recommended Daily Allowances for most nutrients (Rose and Oliveira, 1997). Along the same lines, Bhattacharya *et al*. (2004) found that children in poor, food insufficient households had nearly the same Healthy Eating Index values as children in more affluent, food sufficient households. These results beg for closer examination of the validity and possibly the interpretation of the hardship measures.

[2]Recent examples include Bhargava *et al*., 2008; DePolt *et al*., 2009; Gundersen, 2008; Gundersen and Kreider, 2008, 2009; Gundersen *et al*., 2009a, 2009b; Rose-Jacobs *et al*., 2008; Skalicky *et al*., 2006; Whitaker *et al*., 2006; Van Hook and Balistreri, 2006; and Yen *et al*., 2008.

[3]Examples of research using household-based measures in developed countries include Belsky *et al*., 2010 (UK), Egeland *et al*., 2010 (Canada), Kirkpatrick and Tarasuk, 2011 (Canada), Molcho *et al*., 2007 (Ireland), and Sellen *et al*., 2002 (UK). Examples in developing countries include Frongillo *et al*., 2003 (Bangladesh), Hadley *et al*., 2008 (Ethiopia), Kuku *et al*., 2011 (Zimbabwe), Maxwell *et al*., 1999 (Ghana), Melgar-Quinonez *et al*., 2006 (Bolivia, Burkina Faso, Philippines), Melgar-Quinonez *et al*., 2008 (Brazil), Perez-Escamilla *et al*., 2009 (Haiti), Racine *et al*., 2009 (Eastern Caribbean countries), and Studdert *et al*., 2001 (Indonesia).

[4]Wilde (2004) provides a thorough discussion of the uses and misuses of the food security measure.

In this article, we carefully investigate properties of the one-question food insufficiency measure and the 18-item food insecurity measure from the Food Security Supplement (FSS). We use the information from the FSS on the December 2003 CPS. Specifically, we compare these directly-reported hardship measures to alternative measures of food expenditures each scaled by different measures of food needs, concentrating on households at the low ends of the income and expenditure distributions. Our focus is motivated by a logical and straightforward interpretation of the food hardship measures in which people report problems when their consumption falls below some critical threshold. This interpretation yields the standard prediction that food expenditures and food hardships should be negatively associated. More than that, however, the interpretation also implies that reports of problems should be nearly ubiquitous among people with extremely low expenditure levels. When we compare reports of food hardships from the CPS with reports of food expenditures scaled by objective measures of needs, we find evidence for the first prediction but not the second. In particular, there is no point along an objectively-scaled expenditure distribution where much more than half of the survey respondents report experiencing being food insufficient or food insecure. This finding obtains even when we restrict the analysis to households with very low incomes.

When we re-run the analysis using measures of food expenditures that are scaled by a subjective measure of needs, we do find the hypothesized pattern of near-universal reporting of food problems at the low end of the expenditure distribution. These latter findings taken together with other evidence, lead us to conclude that the measures are internally valid (people are answering similar questions in similar ways). However, the modest levels of reporting at the low ends of the objectively-defined distributions indicate the measures may have weak external validity.

2. The Food Insufficiency and Insecurity Measures

We analyze the external validity of two widely-used food hardship indicators in the U.S.: the food insufficiency measure and the food insecurity scale. The two measures are closely related, with each addressing households' food problems. However, the measures differ in their history and development, the specific hardships they address, and, ultimately, their construction. Below, we discuss the measures, starting with the earlier and simpler food insufficiency measure and then moving on to the food insecurity measure.

The USDA developed the single-item food insufficiency question to gather information about whether Americans, and especially low-income Americans, obtain enough to eat. The question has appeared in numerous surveys since 1977. The question is prefaced by prompting people to think about food consumption and affordability in the previous 12 months. They are then asked:

Which of these statements best describes the food eaten in your household:

1. Enough of the kinds of food we want to eat.
2. Enough but not always the *kinds* of food we want to eat.
3. Sometimes not enough to eat.
4. Often not enough to eat.

The second through fourth statements reflect increasingly severe conditions associated first with the adequacy and variety of the household's diet and then with its levels of consumption. In the December 2003 FSS, 78.7 percent of households reported having enough of the kinds of food they wanted to eat; 17.8 percent reported having enough but not the kinds of food they wanted to eat; 2.8 percent reported sometimes not having enough to eat; and 0.7 percent reported often not having enough to eat.

Two advantages of the food insufficiency measure are its simplicity and clarity. Because it is based on a single item, it can be included in a survey at little cost. Also, the problems covered by the item are immediately apparent, which assists in its interpretation. At the same time, the measure has the disadvantage of being noisier than a well-constructed multiple-item scale. In addition, the definitions of particular conditions, such as "not always," "kinds of food," "sometimes," and "not enough," are left to the respondent's interpretation. Also, the measure does not address some problems that researchers and policymakers might want to monitor, such as whether people experience anxiety over their food situation or the degree of a household's hunger.

In the early 1980s, concerns regarding food hardships in the U.S. led to the creation of a Presidential Task Force on Food Assistance, a comprehensive report by the Life Sciences Research Office (LSRO) of the Federation of American Societies for Experimental Biology, and eventually, the enactment of the National Nutrition Monitoring and Related Research Act of 1990. From this legislation, the USDA and the Department of Health and Human Services (DHHS) were jointly directed to develop a "food insecurity" measure (Hamilton *et al*., 1997).

An inter-agency group from the USDA and DHHS began working in the early 1990s on a measure that could distinguish among a sequence of conditions defined in the LSRO report:

1. Food security: "access by all people at all times to enough food for an active, healthy life."
2. Food insecurity: "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways."
3. Hunger: "the uneasy or painful sensation caused by a lack of food," which is "a potential, although not necessary, consequence of food insecurity."

Subsequent analysis, research, testing, and refinement led to the creation of the 58-item FSS to the CPS, which was first fully fielded in 1995 (Hamilton *et al*., 1997).

The FSS is a household instrument. Because food insecurity is very likely to be absent among some groups, the FSS initially screens households on whether they have had incomes below 185 percent of the poverty line in the past 12 months, whether they experienced food insufficiency (as defined above), and whether they ran out of food or money (and experienced some other problems). Households that pass *any* of these screens are then asked about other food hardships. It is important to be aware of the screens in any analysis of the full FSS sample because they create artificial correlations between income and food insufficiency on the one hand and food insecurity on the other.

The 12-month food security scale, which we examine below, is constructed from 18 of the items that are asked in the FSS (10 items if the household does not include children). The items, which differ in their severity, all ask about hardships that the household experienced in the preceding 12 months. The first and least severe of the items asks whether the respondent "worried whether our food would run out before we got money to buy more." This item captures elements of anxiety. Another (more severe) item asks whether the respondent or other adults in the household "cut the size of meals because there wasn't enough money for food." This item captures reductions in food intakes. The most severe item, which is only asked of households with children, asks whether "any of the children ever (did) not eat for a whole day because there wasn't enough money for food." This item describes a condition that would be associated with hunger for children. All except two of the questions refer to some limitation in terms of the quantity or adequacy of food. The complete set of items for the 12-month scale is listed in Appendix A.

The food insecurity scale is determined from the sum of the responses, with the thresholds for some categories of food insecurity depending on the presence of children. In 2003, households, regardless of the presence of children, that reported two or fewer problems were classified as "food secure." Households with children that reported three to seven problems were classified as "food insecure without hunger," while households without children that reported three to five problems were so classified. Households that reported more problems—eight or more problems for households with children and six or more for those without—were classified as "food insecure with hunger."[5] From the December 2003 survey, 88.5 percent of households were categorized as food secure; 7.7 percent were food insecure without hunger; 3.5 percent were food insecure with hunger; and 0.3 percent did not provide enough data to make a classification.[6]

Hamilton *et al.* (1997) report that the 18 items that comprise the food security scale were culled from the larger set of FSS items through a systematic set of tests that included exploratory linear and non-linear factor analyses, formal Item Response Theory modeling (Rasch modeling), and subsequent invariance, robustness, and reliability tests. These tests, which focused on the internal validity and reliability of the food security measure, indicated that the measure was unidimensional, that differing and stable levels of severity were evident in the component items, and that the resulting measure was consistent with "a managed process of efforts to cope with food insufficiency" (Hamilton *et al.*, 1997, p. 61). The scale progresses from conditions of anxiety to severe reductions in food intakes. Because of where the scale thresholds are set, anxiety alone does not result in a classification

[5]The USDA has now changed the definition of this condition to "very low food insecurity." We continue to use the nomenclature in place at the time of the survey.

[6]Several of the food insecurity questions are followed by additional queries regarding whether the household experienced the same problem or condition in the past 30 days. These can be used to calculate the "30-day food insecurity scale" (Nord, 2002). In principle, the shorter recall period for the 30-day scale should lead to more accurate responses. However, the use of the 12-month insecurity questions as screens means that false negatives from these items will be transmitted to the 30-day measure. We have examined these data and found that they have much weaker associations with our expenditure and needs measures than the 12-month measures.

of food insecurity—at least one problem involving food varieties or intakes must be reported. Thus, like the food insufficiency measure, the food insecurity scale relates to shortages of food.

There are some limitations of the scale. Hamilton *et al.* (1997) caution that although the food security scale incorporates more aspects of food problems than the food insufficiency measures, it does not include all of the components of the LSRO definition. In particular, the food security scale does not measure social acceptability in obtaining food, does not consider food safety and food variety, and only marginally considers nutritional quality. There is also a degree of arbitrariness in where the thresholds are set which may result in the scale underreporting problems.

There were also limitations of the validity analyses themselves. While substantial attention was given to issues of internal validity, external validity was given short shrift. A problem with analyses of external validity, of course, is that there is no objective "gold standard" measure of food insecurity. Researchers compared the scale to measures of income, weekly food expenditures, and food sufficiency and found that the scale was correlated with each of these measures in the anticipated directions. However, the associations were very modest. Hamilton *et al*. (1997) conclude from these analyses that they provide "reasonable assurance that the measure is functioning as intended." This study revisits the question of external validity by looking more extensively at the strength of the relationships between food hardships and other measures and by formalizing one test for "reasonability."

3. Conceptual Measurement Model

Although there are conceptual differences between the food insecurity and food insufficiency scales, both measures are alike in primarily describing the adequacy and availability of food. For instance, Nord *et al*. (2004 , p. 2) state that the food insecurity scale measures "difficulty meeting food needs" stemming from "a lack of money or other resources." Habicht *et al*. (2004, p. 12) similarly characterize food insecurity as "a concept that refers to a lack of food." We assume that this same general "quantity" interpretation guides how people answer questions regarding food hardships. Specifically and simply, we assume that a person answers these questions by comparing his or her household's level of food consumption, C, with assessments of the household's food needs, N, over the relevant time period. The person reports that a food hardship occurred if consumption falls below needs.

Although this model is very simple, it provides a useful framework for evaluating the food measures. It also helps to explain how people who are otherwise alike in terms of their consumption and other objectively observed circumstances might still give different answers to the questions. In particular, unmeasured differences in needs, including differences in food preferences, cultural ideas regarding diets, and subjective assessments of adequate food intakes, could influence people's responses.

Three primary implications emerge from this model of reporting behavior. The first is that reports of food hardships should be negatively associated with

food consumption. For our empirical analyses, we use weekly food expenditures as a measure of consumption. Expenditures are an imperfect measure because a household's consumption will also vary depending on how much time it spends preparing or growing food, how much money it allocates to wasteful or luxury purchases, and how much food it gives to or receives from others. Also, while some types of public food assistance, such as food stamps, are included in the expenditure measure, other types, such as school lunches and breakfasts, are not. In addition, expenditures may be reported with error. Despite the differences between expenditures and consumption, we would still expect that food expenditures would be strongly associated with food hardships. Food expenditures are also relevant for policy purposes because the major food assistance programs operate by increasing expenditures.

The second implication of our model is that reports of food hardships should be positively associated with measures of food needs. For instance, we would expect that other things held constant, larger households would have greater needs and report more hardships than smaller households.

Previous validation studies involving objective measures have focused mainly on general associations between reported food hardships and either consumption or needs. The third implication of our model, however, departs from this previous work. If the minimum threshold for reporting a hardship is high enough so that it falls within the distribution of consumption levels, there will be a range of consumption levels in which everyone reports a hardship. Allowing for errors in the reports of food hardships and food expenditures and allowing for some food consumption from sources other than expenditures, there should still be a critical level of food expenditures below which most people report food hardships. This third implication motivates our analysis of reported hardships at the bottom of the expenditure distribution.

4. Empirical Analysis

Based on our model of reporting behavior developed above, we now consider whether the results from the FSS on the 2003 CPS are consistent with the implications of this model. We do so using a wide variety of methods followed by a consideration of several robustness checks.

4.1. *Analysis Sample and Measures*

For our empirical analyses of the food insecurity and insufficiency measures, we begin by selecting observations from the FSS where respondents would have been in the most reasonable position to report about household hardships and where respondents did not face unusual circumstances. In particular, we drop observations for people who were living in group quarters because of the difficulty of defining a household. We exclude households that contain sub-families and unrelated individuals because of the possibility that the person reporting on the household's food hardships might overlook them. We also exclude households from Alaska and Hawaii because of the unusually high costs of food and other

items in those states. For similar reasons, we omit households with more than eight members. For all of our analyses we use sampling weights that are supplied with the FSS.

In some of our analyses, we examine correlations between self-reported food hardships and other measures of expenditures and needs. For these analyses, we use the 4-category food insufficiency measure and the 3-category food insecurity measure that are included with the FSS.[7] In some other analyses, we examine the incidence of hardships. The variables that we construct from the food insufficiency measure include a binary indicator of whether the household reported sometimes or often not having enough to eat ("insufficient amounts of food") and an indicator of whether the household reported either lacking kinds or amounts of food. The first indicator describes a more severe condition associated with reduced food intakes, while the second indicator sets the threshold lower by considering reduced food intakes and reduced food quality. We also examine two binary indicators based on the food security measure. The first is an indicator of whether the household was food insecure with or without hunger (that is, responded affirmatively to three or more of the insecurity items). This measure is the standard definition of food insecurity. As mentioned, Hamilton *et al.* (1997) expressed concerns that the threshold for defining food insecurity may have been set arbitrarily high. This prompts us to consider an alternative indicator based on the less-severe threshold of answering *any* of the food insecurity questions affirmatively. This definition has also been called "marginal food insecurity" (see, e.g. Laraia *et al.*, 2006).

We use two measures of food expenditures from the FSS. Our first and primary measure is a report of the usual weekly expenditures by the household. The second measure is a report of the household's expenditures in the previous week. Both measures appear to have very high quality. The questions regarding expenditures are preceded by other questions that ask the respondent to recall specific types of food expenditures, and the interview includes consistency checks based on the responses. Oliveira and Rose (1996) have reported that the food expenditure amounts from the FSS correspond very closely with amounts from the Consumer Expenditure Survey. The overall quality of the measures notwithstanding, each one offers different advantages and disadvantages for the purposes of our analysis. On the one hand, usual expenditures should be more representative of the household's food experiences. On the other hand, expenditures from the previous week may be recalled more accurately.

Needs are much harder to measure than expenditures. Accordingly, we use several alternative indicators. Two readily observable measures, which are described and used by Nord *et al.* (2004), are (a) household sizes and (b) budget amounts from the USDA Thrifty Food Plan (TFP) that are specific to the size and age composition of the household. The TFP is the least expensive of several food plans that the USDA created with minimum amounts of foods that would make

[7]The FSS also supplies a 4-category food insecurity measure that distinguishes between being food insecure with moderate hunger or with severe hunger. We found that this measure had weaker associations with expenditures and needs than the 3-category measure.

up a nutritious diet; as such, it represents a very conservative estimate of food needs and is appropriate for identifying low levels of expenditures.[8]

In some analyses, we also construct model-based estimates of food needs. For these, we estimate ordered probit models of food insecurity with the natural log of food expenditures and a series of additional objective observable measures as explanatory variables. Thus, the latent indicator, y^*, in the ordered probit model can be written as

$$y^* = \alpha \ln(usual\ expenditures) + \mathrm{B}'X + \varepsilon$$

where X is a vector of observable variables (which includes non-parametric indicators for the number of adults in the household, non-parametric indicators for the number of children, linear controls for the ages of the youngest and oldest person, and dummy indicators for the state of residence), α and B are coefficients, and ε is a random error. If we assume that our measurement model applies, the term $\mathrm{B}'X$ provides an observed, objective indicator of needs. For our measure, we scale the predicted value of $\mathrm{B}'X$ in terms of the level of food expenditures, such that the estimated threshold value of needs equals $\exp(-\mathrm{B}'X/\alpha)$. Equivalently, we could use the predicted linear index (including expenditures) from the ordered probit specification as a scaled measure of expenditures. This model-based approach is straightforward, data driven, and flexible. For instance, it allows us to incorporate controls for state effects (e.g. cost of living, institutional, and market differences) that are not a part of the TFP. The chief disadvantage is that it incorporates the food insecurity scale itself as an input, which may result in a needs measure that is artificially *over-correlated* with hardships.

In addition to these objective and observable measures of needs, we also construct a subjective measure. After the question about usual food expenditures, the FSS asks whether the household would need to spend more than, less than, or the same as it usually does in order to just be able to meet the members' food needs. Respondents who indicate that the household would have to spend a different amount are asked how much more or how much less would be needed. We construct a subjective threshold for food needs by taking the household's usual food expenditures and adjusting it up or down by the amount people say they would need to just meet their food needs.[9] For people who indicate that they can meet their food needs by spending the same as they usually do, we use their usual food expenditures as the subjective standard. The subjective measure explicitly relates people's spending with their food needs. As such, it allows us to check whether expenditures are a consideration in reporting food problems. More formally, it allows us to examine the internal validity of the data—specifically, whether expenditure-based reports of hardships are consistent with other reports.

[8]The TFP is also used to develop the annual poverty thresholds in the U.S. Thus, the scaling is similar to that used in standard "income-to-needs" ratios in the U.S.

[9]For example, someone who reported that their household usually spent $100 per week on food and that would need to spend an additional $20 per week to meet their food needs would have a subjective needs level of $120.

4.2. *Correlation Between Reported Food Hardships and Food Expenditures*

We begin our empirical analysis by investigating the correlation between measures of food hardships and measures of expenditures and needs. We expect that hardships will be negatively associated with the former and positively associated with the latter. One complication that arises in our data is that the food insufficiency and food insecurity outcomes are categorical. Standard (Pearson) correlations involving categorical variables can be sensitive to the number of categories, making it difficult to compare results across variables. To address this problem, we estimate associations between continuous and categorical variables using Cox's (1974) method and associations between pairs of categorical variables using polychoric correlations. Both approaches assume that the categorical variables are manifestations of latent normally distributed variables. Cox's approach additionally assumes that the continuous variable is normally distributed. Each approach estimates correlations between the normally distributed variables.

Table 1 lists Cox and polychoric correlations between the two indicators for food hardships and alternative measures of food expenditures and needs.[10] The top half of Table 1 reports statistics for all households in the sample. The first column lists sample means for the expenditure and need measures. The next column lists correlations with the food insufficiency measure, and the final column lists correlations with the food insecurity measure. The bottom half of the table reports the same statistics calculated for households with incomes below approximately 185 percent of the poverty line. As we discussed, the December 2003 FSS only asked the food security questions of households that either (a) had incomes below 185 percent of the poverty line, (b) reported not having enough kinds or amounts of food in the food insufficiency question, or (c) reported resorting to some strategy to stretch their food budgets. These screens were imposed to reduce respondent burden, survey costs, and the number of erroneous reports. We examine outcomes among lower income households because, first and foremost, they are a policy-relevant and vulnerable group. In addition, the analysis of low-income households also serves a methodological purpose. Everyone in the low-income group was asked both the food insufficiency and food insecurity questions. Because of this, we can more readily compare the results for the two measures within this narrower sample.

The first row in each panel of Table 1 lists correlations of the food insufficiency and insecurity measures with the household's usual weekly food expenditures scaled by the number of people in the household. As expected, weekly per-person food expenditures are negatively correlated with both food insufficiency and food insecurity. Although these correlations are statistically different from zero, neither of them is especially strong. When the sample is restricted to households with incomes less than 185 percent of the poverty line, the same pattern of results appears, but the correlations with expenditures are even weaker. Correlations between household size and the food hardship measures also show the expected pattern, with modest positive correlations for both the general and low-income samples.

[10]Results based on Pearson (product-moment) correlations are similar, though the absolute values of the correlations are generally smaller.

TABLE 1

Correlations Between Food Hardship, Food Expenditure and Food Needs Measures

	(Mean)	Correlation[a] with Food Insufficiency Measure (4 categories)	Correlation[a] with Food Insecurity Measure (3 categories)
All households			
Alternative measures of food expenditures scaled by needs			
Usual weekly per-person food expenditures	(47.24)	–0.246	–0.266
Ratio of usual weekly food expenditures to TFP	(1.47)	–0.256	–0.264
Ratio of previous week's food expenditures to TFP	(1.63)	–0.264	–0.288
Ratio of usual weekly food expenditures to model-based objective threshold	(70.30)	–0.363	–0.541
Ratio of usual weekly food expenditures to subjective threshold	(1.17)	–0.282	–0.429
Alternative measures of food needs			
Household size	(2.42)	0.047	0.066
Thrifty Food Plan	(72.42)	0.043	0.055
Model-based objective threshold	(3.84)	0.163	0.186
Subjective threshold	(93.18)	0.034	0.079
Households with incomes less than 185 percent of the poverty line			
Alternative measures of food expenditures scaled by needs			
Usual weekly per-person food expenditures	(35.79)	–0.105	–0.090
Ratio of usual weekly food expenditures to TFP	(1.13)	–0.096	–0.078
Ratio of previous week's food expenditures to TFP	(1.22)	–0.082	–0.054
Ratio of usual weekly food expenditures to model-based objective threshold	(41.36)	–0.234	–0.331
Ratio of usual weekly food expenditures to subjective threshold	(1.02)	–0.241	–0.373
Alternative measures of food needs			
Household size	(2.48)	0.084	0.098
Thrifty Food Plan	(72.04)	0.075	0.084
Model-based objective threshold	(5.73)	0.124	0.150
Subjective threshold	(84.01)	0.172	0.187

Notes: Statistics calculated using weighted data from the December 2003 CPS-FSS.

[a]Cox's (1974) method is used to measure correlations between continuous and categorical variables, and polychoric correlations are used to measure the association between categorical measures. All of the correlations are statistically different from zero at the 5 or 1 percent level.

The second rows of the top and bottom panels list correlations involving usual weekly food expenditures scaled by the TFP, with results that are almost identical to those involving per-person food expenditures. Given that the TFP not only adjusts for household size but also for the age and gender composition of the members, we expected a stronger relationship with food hardships. However, three of the four estimated correlations are weaker when the TFP is used to scale expenditures.

The third rows of the top and bottom panels of Table 1 list correlations involving the household's food expenditures from the *previous week* scaled by the TFP. Because the usual and previous week's expenditures each have relative strengths, it is hard to say a priori whether the correlations involving one measure or the other should be stronger. The figures in the table indicate that the correlations

for the previous week's expenditures are slightly stronger than those for usual expenditures in the general sample but slightly weaker in the low-income sample. The similarities in the results increase our confidence that expenditures are being reported consistently. The results are certainly robust to the use of these alternative measures.

The next rows list results for usual weekly expenditures scaled by our model-based estimate of needs. The model-based estimate accounts for more conditions, including state-specific conditions, and is derived from the food insecurity measure, so it is not surprising that it leads to stronger correlations—both when used as a scaling term and when examined by itself—than the household size and TFP measures. Once again, we see the expected negative association between expenditures and hardships and the expected positive association between needs and hardships.

So far, we have examined food expenditures scaled by objective measures of needs. In the fifth row of each panel, we report statistics for food expenditures scaled by a subjective measure. For the full sample of households, the correlations between the food hardship measures and subjectively-scaled expenditures are negative and stronger than the correlations involving the per-person or TFP-scaled measures but weaker than the correlations involving the model-based needs measures. However, among the low-income households, the correlations involving the subjectively-scaled measures are stronger than those for all of the objectively-scaled measures. One possible explanation for the stronger performance in the low-income sample is that these households may have a better sense of what constitutes an actual hardship threshold. This would be consistent with the work on subjective poverty thresholds where more weight is placed on the responses of those lower in the income spectrum when constructing thresholds (see, e.g. Kapteyn *et al*., 1988).

4.3. *Food Hardship Rates Among Households with Low Food Expenditure Levels*

Our analysis of Table 1 is similar to previous analyses that have mainly examined raw or partial associations between hardships and other measures, including the analysis by Hamilton *et al*. (1997). In Table 2, we turn to the more novel implication from our measurement model—that most households with very low food expenditures should report food hardships. Table 2 lists the proportion of households with different characteristics that report experiencing particular forms of food hardships. Column (1) lists proportions of households that have insufficient amounts of food (i.e., they report that they sometimes or often do not get enough to eat), and Column (2) lists proportions of households that have insufficient amounts or kinds of food (i.e., they report that they sometimes or often do not get enough to eat or they have enough but not always the kinds of food they want to eat). Columns (3) and (4) are based on the food insecurity questions. In column (3), we use the definition from USDA of households being food insecure if they respond affirmatively to three or more questions on the 18-item food insecurity questionnaire. Column (4) includes households responding affirmatively to at least one question on the 18-item scale. As before, results are reported for the full sample of households in the top panel and for a subsample of households with income below 185 percent of the poverty line in the bottom panel.

TABLE 2

PROPORTIONS OF HOUSEHOLDS IN DIFFERENT CONDITIONS REPORTING FOOD INSUFFICIENCY AND INSECURITY

	Insufficient Amounts of Food (1)	Insufficient Amounts and Kinds of Food (2)	Food Insecure (3)	Report At Least One Food Insecurity Hardship (4)
All households				
All households	0.033	0.203	0.106	0.182
Usual weekly per-person food expenditures in lowest 5th percentile	0.092	0.319	0.225	0.331
Usual weekly food expenditures below $^1/_2$ TFP	0.090	0.323	0.222	0.324
Previous week's food expenditures below $^1/_2$ TFP	0.057	0.256	0.154	0.248
Usual expenditures low relative to model-based objective threshold (lowest 5th percentile)	0.107	0.463	0.334	0.489
Usual expenditures below subjective threshold	0.203	0.665	0.492	0.666
Households with incomes less than 185 percent of the poverty line				
All low-income households	0.083	0.393	0.260	0.424
Usual weekly per-person food expenditures in lowest 5th percentile	0.138	0.451	0.344	0.505
Usual weekly food expenditures below $^1/_2$ TFP	0.140	0.458	0.347	0.502
Previous week's food expenditures below $^1/_2$ TFP	0.112	0.449	0.315	0.489
Usual expenditures low relative to model-based objective threshold (lowest 5th percentile)	0.133	0.540	0.417	0.604
Usual expenditures below subjective threshold	0.254	0.758	0.603	0.789

Notes: Statistics calculated using weighted data from the December 2003 CPS-FSS. Food insecurity and core food insecurity hardships defined in Appendix A.

The first rows in the top and bottom panels list the total proportions of each sample reporting different hardships. The statistics confirm previous findings that low-income households are several times more likely to report food hardships than other households. This is not surprising insofar as we would expect a higher incidence of food hardships among poor and near-poor households due to their having fewer resources available for food purchases. Among low-income households in our analysis sample, 8.3 percent report not being able to obtain the amounts of food they wanted (being food insufficient), and 39.3 percent report not being able to obtain the amounts or kinds of food that they wanted. Also among the low-income households, 26.0 percent report being food insecure during the previous year, and 42.4 percent report experiencing at least one food insecurity hardship.

The next five rows in each panel list the incidence of food hardships among households whose food expenditures fall below certain thresholds. As our first indicator, we consider households whose usual weekly per-person food expenditures are in the bottom 5th percentile—less than $12.50 per person. Given such a low level of expenditures, we would expect to see many reports of hardships among households in this portion of the distribution. The estimates from Table 2 reveal, however, that this is not the case. To be sure, the proportions of households with hardships are higher in the second row of each panel than the first; however, none of these proportions—not even for low-income households—reaches much above

50 percent. If we look at the food insecurity estimates, less than a quarter of households in the bottom 5th percentile of the per-person food expenditure distribution are categorized as food insecure, and if we restrict our attention to low-income households with low expenditures, the estimated incidence of food insecurity only rises to about one-third. Even if we consider the broader category of reporting any food hardships, only about half of low-income households with very low food expenditures show evidence of hardships. Put another way, roughly half the households with incomes below 185 percent of the poverty line and with food expenditures in the bottom 5 percent of the expenditure distribution report no food hardships whatsoever. Given the very low levels of resources and expenditures, the estimated incidence of food problems seems implausible if the questions are working as intended.

We see very similar results when we define the cut-off in usual food expenditures at one-half of the value of the TFP (about $36 for the household) and when we consider the previous week's expenditures. Recall that the TFP itself represents a low-end estimate of the minimum amount needed to purchase a nutritious diet; thus, one-half of this amount is a very miserly level. Nevertheless, the incidence of food hardships in each of our samples remains low.

In the fourth row of each panel, we calculate the incidence of food hardships among households whose usual food expenditures scaled by our model-based estimate of needs are in the bottom 5th percentile of the distribution. The model-based estimate appears to be a better indicator of needs. When this scaling is used as opposed to other objective scalings, we observe a higher incidence of reported food problems among households in the bottom part of the expenditure distribution. For instance, using the model-based scaling, 33.4 percent of the low-expenditure households in the general sample and 41.7 percent of the low-expenditure households in the low-income sample report being food insecure. While the reported incidence of food hardships is higher with this definition of needs with the other objective definitions, the level of hardships remains lower than expected.

In the last rows of each panel, we adopt a subjective rather than an objective threshold. When we do this, the proportion of low-expenditure households classified with food hardships increases dramatically. For example, about two-thirds of households with subjectively low usual expenditures report having insufficient amounts or kinds of food, and about half of the households report being food insecure over the past year. Among the sample with incomes below 185 percent of the poverty line, the incidence of hardships is even higher: 75.8 percent report having insufficient amounts and kinds of food, while 60.3 percent report being food insecure over the past year. These results indicate that people's reports of food hardships are consistent with their responses regarding expenditure thresholds.

4.4. *Non-Parametric Regressions*

Our model of reporting behavior implies that food hardships should be reported when food expenditures fall below some threshold, but it does not specify where the threshold should be. Although the expenditure thresholds in Table 2 are

all very stringent, there are many other points that could be considered. One way to show the robustness of our results to different thresholds is to calculate the incidence of food hardships at every point along the expenditure distribution. We do this by estimating non-parametric (kernel-smoothed) regressions of the food hardship measures on the expenditure measures. Along with allowing us to examine the robustness of our results to alternative thresholds, these non-parametric regressions will allow us to consider the relationship between food expenditures and food insufficiency and food insecurity at other points along the expenditure distribution.

The first row of Figure 1 displays results from non-parametric regressions that graph each of the binary indicators from Table 2—insufficient amounts and kinds of food, insufficient amounts of food, food insecurity, and reporting any of the food insecurity hardships—against usual weekly per-person expenditures. Each graph displays results for the entire sample of households (dark lines) and for the restricted sample of low-income households (light lines). All of the regressions exclude a small number of observations that reported having no usual food expenditures.[11] For the low-income sample, they also omit a few observations with weekly per-person expenditures in excess of $200.

The figure provides a more complete picture of the relationships between reported food hardships and expenditures than Table 2. Several features are consistent with our earlier descriptive results. Low-income households are more likely to be classified as having a food hardship than other households at all levels of food expenditures. For both the low-income and general samples, food hardships generally decline with expenditures, except at the very lowest levels of expenditures. In line with the findings from Table 2, we never observe near-universal reporting of food hardships at any point along the expenditure distribution when household size is used as a scaling variable. With this scaling, the highest incidence of food hardships occurs around $10–12 per person, where roughly half of the low-income households report having insufficient amounts and kinds of food and about 40 percent report being food insecure.

The second row of graphs presents results from non-parametric regressions with the same dependent variables but using usual weekly expenditures scaled by the TFP as the explanatory variable. The results are very similar to the previous regressions. In particular, the highest incidence of having insufficient amounts or kinds of food among low-income households is 50 percent, while the highest incidence of food insecurity among low-income households is 40 percent.

The third row of graphs in Figure 1 displays results of non-parametric regressions that use the previous week's expenditures scaled by the TFP as an explanatory variable. The results are also similar to the results from the previous rows with two exceptions: the incidence of food hardships declines more uniformly across the lower range of expenditures in the new graphs, and the maximum incidence of food hardships is slightly higher in the estimates based on the previous week's expenditures, reaching approximately 60 percent for the indications of insufficient

[11]The households reporting no usual expenditures were dropped because of the obvious inconsistency with food consumption. The incidence of hardships among these households was slightly lower than the incidence among households with small positive expenditures.

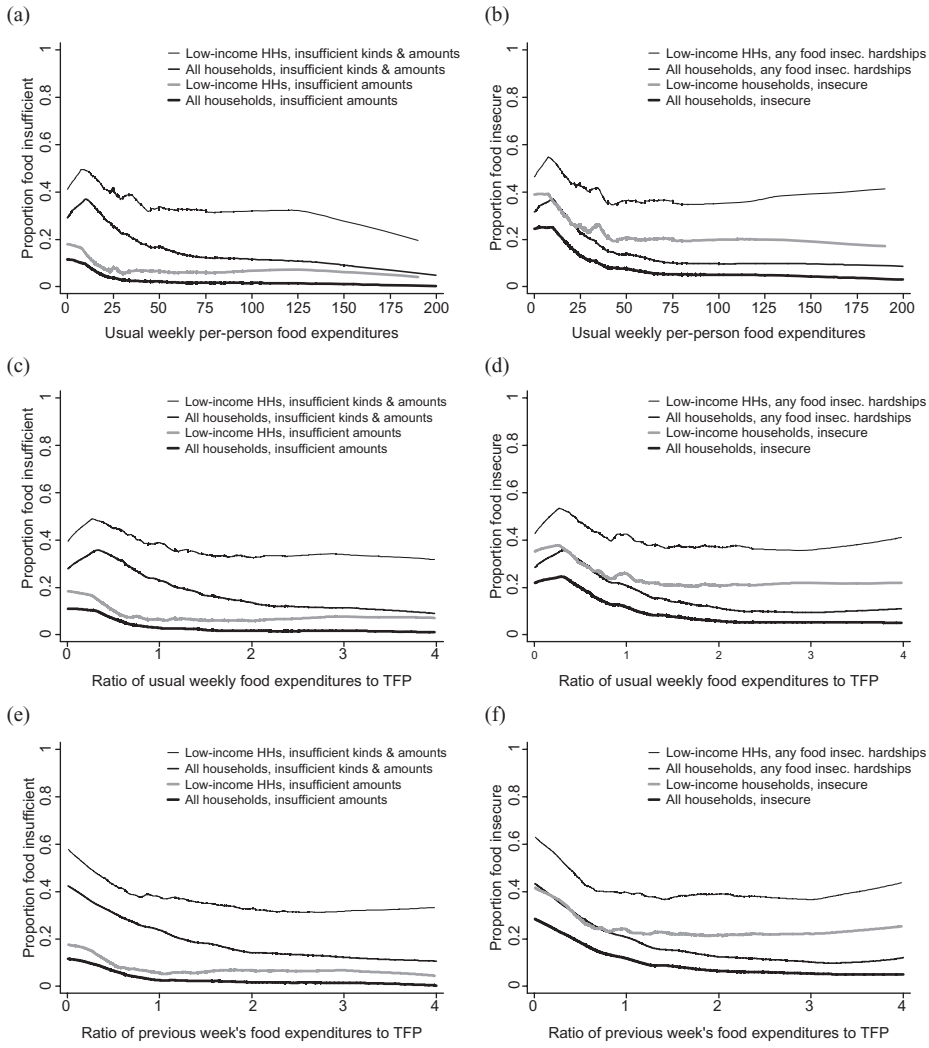

Figure 1. Non-Parametric Regression Estimates of the Relationship Between Food Hardships and Weekly Food Expenditures

Notes: Non-parametric regressions estimated using weighted data from the December 2003 CPS-FSS. The estimates omit households with no reported expenditures and households with very high expenditures (usually above the 95th percentile).

amounts and kinds of foods in the low-income sample and a similar level for indications of any hardships in that same sample.

In the fourth row, we examine the relationship between food hardships and the distribution of usual food expenditures scaled by our model-based estimate of needs. The estimates from these non-parametric regression models show a stronger relationship than the estimates from our previous models. The reported incidence of food hardships falls with expenditures across the entire distribution. At the

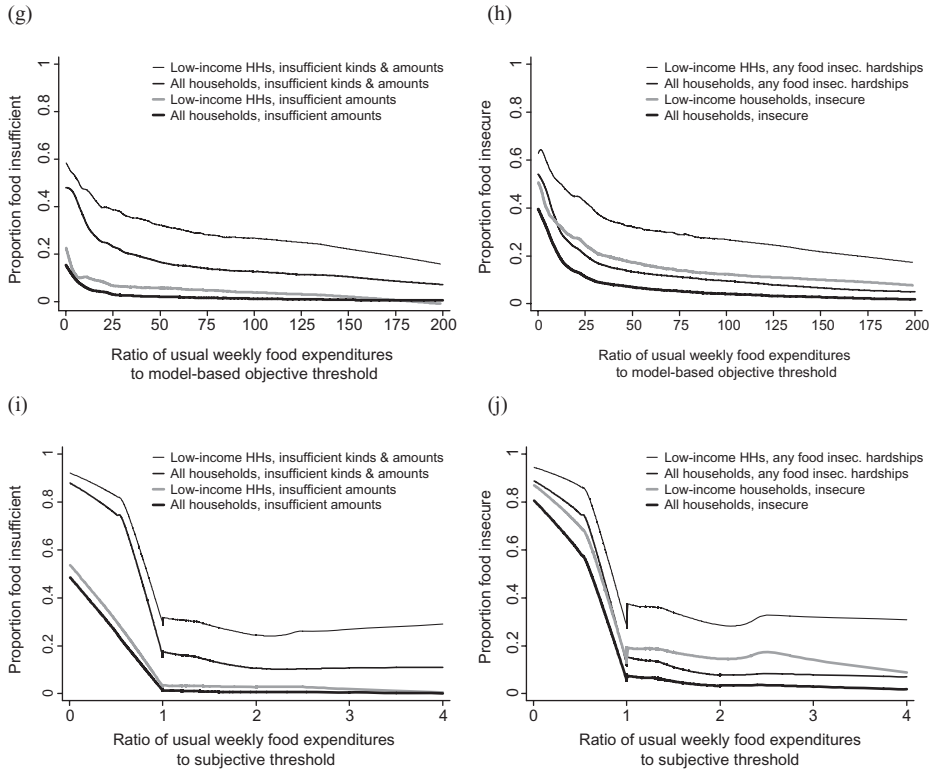

Figure 1. Continued

bottom of the expenditure distribution, 60 percent of low-income households report having insufficient amounts or kinds of food and just over 50 percent report being food insecure.

The graphs in the final row show the results of non-parametric regressions run using usual weekly expenditures scaled by the subjective threshold as the explanatory variable. The estimates fit the pattern predicted by our theoretical model—there is near-universal reporting of food hardships at the lowest levels of expenditures, and hardships subsequently decline with expenditures. Another interesting feature of the graphs is that the reporting behavior of low-income households is almost identical to that of the general set of households when expenditures are below the subjective threshold.

4.5. *Alternative Explanations and Sensitivity Analyses*

Our analyses reveal both that when simple objective scalings are used, food expenditures are only modestly associated with reported food hardships and that when any type of objective scaling is used, households with low food expenditures report surprisingly few hardships. In contrast, a much higher percentage of households with low food expenditures below a self-identified subjective threshold report food hardships. As we consider this evidence, we need to evaluate possible

reasons for the weak relationship between objectively-scaled expenditures and self-reported food hardships.

First, an immediate concern is that the food expenditure measures may be noisy indicators of food consumption, which could reduce the association with hardships. Indeed, some patterns in the results, such as the households that report zero usual food expenditures and the initially rising incidence of food hardships at very low levels of usual expenditures, suggest that there may be reporting deficiencies. To see whether these deficiencies may affect our results, we repeated our analyses several different ways. First, we restricted the sample to only include households with annualized food expenditure-to-income ratios between 5 and 50 percent. In the full sample, only about one-sixth of households had food expenditures that were outside of these ranges. When we eliminate these households, there was little change in the results.

Second, we re-examined the results looking at households at successively lower points in the income distribution. The idea behind this exercise is that households with very low incomes and very low expenditure levels should be especially likely to experience low levels of food consumption. We replicated the results of Table 2, restricting the sample to households with incomes below 50 percent of the poverty line (a common definition of extreme poverty).[12] As expected, the incidence of food hardships is higher among these groups than among the general sample of households but only slightly higher than the low-income (185 percent threshold) sample.

Third, we looked at households which may be at greater risk of food hardships for reasons associated with their demographic characteristics. In particular we looked at households headed by someone without a high school degree, renters, and households headed by a single parent. The results are presented in Appendix B. As seen, the general results of Table 2 remain the same.

Fourth, we were concerned that expenditures would be an inaccurate measure of consumption if the household had access to food assistance programs through any one of the following food assistance programs: the Food Stamp Program (now known as the Supplemental Nutrition Assistance Program (SNAP)), the National School Lunch Program, the National School Breakfast Program, the Special Supplemental Nutrition Program for Women, Infants, or Children (WIC), a food pantry, or a soup kitchen. Receipt of food from these sources could lead to expenditures understating consumption and thus explain lower reported levels of food hardships. We re-analyzed the data using a sample that omitted households that reported receiving meals from "free" sources—a little over 5 percent of the general sample reported getting some sort of food assistance. Results from this restricted sample, however, were not different from the general sample. We also re-examined the incidence of food hardships among households that appeared to be eligible for food stamps on the basis of income.[13] We found that households

[12]In the CPS, income is reported in 14 intervals rather than continuously. To establish income, we assign the midpoint of the relevant interval to each household.

[13]To receive food stamps, households must meet three financial criteria: a gross income test, a net income test, and an asset test. Because of limited information in the CPS, we could only apply the gross income test, restricting the sample to households with gross monthly pre-tax incomes approximately below 130 percent of the poverty line.

with food stamps reported more food hardships than eligible households without food stamps, suggesting that food stamps were not contributing to under-reporting of problems.

Fifth, the availability of multiple reports of food expenditures provides another way to account for possible mismeasurement in any one report. Specifically, we used factor analysis to extract the common factor (presumably an alternative measure of usual expenditures) from each of our expenditure measures scaled by the TFP. The factor analyses indicated that the two expenditure measures were closely related. Non-parametric regression estimates based on predictions of usual weekly expenditures based on the resulting factors (shown in Appendix C) are very similar to estimates based on the individual expenditure measures. As a further test, we conducted a second factor analysis and extracted a common factor from the two expenditure measures along with the income-to-needs ratio. We found that a single factor could adequately account for the correlation among these variables. Non-parametric regression results for this factor were also similar to our other results.

Sixth, in addition to problems in using expenditures as a measure of consumption, we also considered potential reporting and recall problems in the food hardship indicators themselves. Random variation would weaken the correlations between these and other measures. It does not seem, however, as though measurement error is a major culprit in the pattern of results. For one thing, the incidence of hardships is fairly low. Because of the boundary condition, response errors would tend to inflate the measured incidence of hardships rather than diminish it, at least along some parts of the distribution. Also, the answers to the food insecurity items mostly follow expected severity patterns and are correlated with other subjective measures. Similar patterns in the food insecurity results appear for households with and without children, despite the differences in the numbers of questions asked of each type of household. The available evidence indicates that the hardship measures are internally valid.

Seventh, the respondents to the questions regarding food insecurity may be unaware of the food expenditure patterns of other household members. As an example, someone may not be aware of a spouse's food expenditures. As another example, someone may not be aware of children's food expenditures while in school. To address both these possibilities, we estimated our models with samples of, respectively, one-person households[14] and households without children. For both these samples, reports of food insufficiency and food insecurity at low levels of food expenditures were even lower than for our primary sample when we used measures of food expenditures normalized by objective thresholds. (In contrast, the relationships were relatively similar when the subjective threshold was used.) Thus, misinformation about the food expenditures of other household members does not seem to be relevant.

[14]This restriction also allows us to address a point made by Wunderlich and Norwood (2006); namely that food insecurity does not necessarily affect all household members the same. By looking at one-person households we do not face this issue.

5. Conclusion

Our empirical analysis carefully examines the relationship between self-reported food insecurity and insufficiency measures and several measures of expenditures and needs. Unlike previous validation studies, our analysis is framed in terms of a model of how people answer the hardship questions. The model generates the standard predictions that self-reports of food hardships should be negatively associated with food consumption and positively associated with food needs. However, it also predicts that reported food hardships should be nearly universal once food consumption falls below a threshold level. The model motivates an analysis of the incidence of food hardships at different food expenditure levels but especially at the low end of the distribution. It also indicates ways in which people might combine objective and subjective elements in answering questions about food hardships.

Consistent with previous research finding evidence that food hardships have some basis in objective, material circumstances, we find that food insecurity and insufficiency are associated with incomes, expenditures, and needs in the expected directions. However, we also find that the association between self-reported food hardships and objectively-scaled food expenditures is weak and that the prevalence of hardships among households with low levels of income and objectively-scaled expenditures is low. The highest incidence of food insecurity when the full sample of households is arrayed along an objectively-scaled measure of food expenditures is 40 percent. The incidence rises among households with lower incomes but is never much above 50 percent.

When we use a subjective normalization, we find a much higher incidence of food hardships among households with low food expenditures. This leads us to conclude that reports of food hardships are internally consistent. Nevertheless, the low level of reporting among households at the bottom of the expenditure distribution indicates the skepticism expressed by some social scientists regarding the accuracy of food hardship measures may be well-placed. The most reasonable explanation for these reporting patterns is social-desirability bias, which occurs when survey subjects are uncomfortable reporting potentially embarrassing information. Unfortunately, the data in the CPS-FSS do not allow us to pursue this explanation further.

Reporting problems notwithstanding, food insecurity and food insufficiency appear to be real phenomena with serious consequences. Our analysis shows that they are associated, albeit modestly, with incomes, expenditures, and needs. Other research has related these measures to negative health outcomes (see Gundersen and Kreider, 2009, for a review).

Our findings that food hardships are under-reported at the low end of the expenditure distribution should be disquieting to researchers and policymakers. The data may be masking genuine distress among the disadvantaged households, and the modest relationship with food expenditures may mean that the food insecurity and insufficiency measures will have difficulty registering increases in well-being from policy innovations and economic improvements.

We conclude with three suggestions for future research which may provide a better connection between subjective and objective measures of well-being.

First, researchers may wish to examine whether some of the questions within the FSS are better correlated with food expenditures. Consistent with past work, we have defined whether someone is food insecure based on responses to the set of 18 questions in the FSS but, in so doing, a possible closer connection between food hardships and food expenditures may be obscured. Second, administrators of surveys with the FSS may wish to have brief follow-up checks on those who report low levels of food expenditures and food security and those who report high levels of food expenditures and food insecurity. These checks could inquire about the accuracy of food expenditure reports, food insecurity reports, or both. Third, researchers may wish to consider the relationship between other direct indicators of well-being and income and consumption-based measures of well-being. As noted in the introductory remarks, there has been an extensive literature looking at a wide array of direct indictors; analyses akin to those in this article could be applied to those direct indicators. In particular, we believe examinations of whether low-levels of income and/or expenditures are associated with low-levels of direct indicators of well-being are warranted.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix A: Food Insecurity Questions in the Core Food Security Module.

Appendix B: Proportions of Households in Different Demographic Categories Reporting Food Insufficiency and Insecurity.

Appendix C: Non-parametric Regression Estimates of the Relationship Between Food Hardships and Weekly Food Expenditures Adjusted for Measurement Error.

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