



United States Department of Agriculture

Economic
Research
Service

Economic
Research
Report
Number 167

June 2014

Prevalence of U.S. Food Insecurity Is Related to Changes in Unemployment, Inflation, and the Price of Food

Mark Nord, Alisha Coleman-Jensen, and Christian Gregory





United States Department of Agriculture

Economic Research Service

www.ers.usda.gov

Access this report online:

www.ers.usda.gov/publications/err-economic-research-report/err167

Download the charts contained in this report:

- Go to the report's index page www.ers.usda.gov/publications/err-economic-research-report/err167
- Click on the bulleted item "Download err167.zip"
- Open the chart you want, then save it to your computer

Recommended citation format for this publication:

Nord, Mark, Alisha Coleman-Jensen and Christian Gregory. *Prevalence of U.S. Food Insecurity Is Related to Changes in Unemployment, Inflation, and the Price of Food*, ERR-167, U.S. Department of Agriculture, Economic Research Service, June 2014.

Cover image: Thinkstock.

Use of commercial and trade names does not imply approval or constitute endorsement by USDA.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and, where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.



**Economic
Research
Service**

Economic
Research
Report
Number 167
June 2014

Prevalence of U.S. Food Insecurity Is Related to Changes in Unemployment, Inflation, and the Price of Food

Mark Nord, Alisha Coleman-Jensen, and Christian Gregory

Abstract

This report examines the extent to which year-to-year changes in the prevalence of U.S. household food insecurity can be explained by changes in the national unemployment rate, inflation, and the price of food relative to other goods and services. Data are from the 2001-12 Current Population Survey Food Security Supplements and statistics on employment and prices from the U.S. Bureau of Labor Statistics. Understanding the strength and consistency of these associations can broaden understanding of how national and household economic conditions affect food insecurity. As an example, the report sheds light on why food security has remained essentially unchanged since the 2007-09 recession. Falling unemployment from early post-recession (2009-10) to 2012, absent any other changes, would suggest a modest decline in the prevalence of food insecurity. However, this report finds that potential improvement was almost exactly offset by the effects of higher inflation and the higher relative price of food in 2012.

Keywords: Food security, food insecurity, food prices, unemployment, food price inflation, SNAP, food assistance

About the Authors

Mark Nord (retired) was a sociologist in the USDA, Economic Research Service, when this research was conducted. Alisha Coleman-Jensen is a sociologist, and Christian Gregory is an economist, both in the USDA, Economic Research Service.

Acknowledgments

The authors thank Karen Cunyningham, Senior Analyst, Mathematica Policy Research; Judi Bartfield, Professor, University of Wisconsin; Kathryn Law and Sangeetha Malaiyandi, USDA, Food and Nutrition Service; and Shelly Ver Ploeg, David Smallwood, Jean Buzby, and Ephraim Leibtag, USDA, Economic Research Service, for their comments on the report. The authors also thank Dale Simms for editing and preparing the report for publication and Curtia Taylor for the design and layout of the report.

Contents

Introduction	1
Related Research	3
Data and Measures	5
Analytic Methods	9
Findings	11
National Economic Factors in Food Insecurity.....	11
Household Characteristics Associated With Food Insecurity.....	13
Robustness of Findings	20
Conclusion	21
References	23
Appendix A: Associations of National Economic Conditions With Very Low Food Security and Children’s Food Insecurity	24
Appendix B: Measures of Household Demographic, Economic, and Geographic Characteristics	27
Appendix C: Alternative Measures of National Economic Conditions	29



Find the full report at www.ers.usda.gov/publications/err-economic-research-report/err167

Prevalence of U.S. Food Insecurity Is Related to Changes in Unemployment, Inflation, and the Price of Food

Mark Nord, Alisha Coleman-Jensen, and Christian Gregory

What Is the Issue?

The U.S. Department of Agriculture (USDA) monitors the food security of the Nation's households—their consistent access to adequate food for active healthy lives—through an annual, nationally representative food security survey. Household-level determinants of food insecurity, like education levels and household income, are well documented in earlier research. But the effects of national-level economic factors such as inflation and food prices on food security—and the extent to which changes in both household and macroeconomic factors account for year-to-year changes in the national prevalence of food insecurity—are not known. The extent to which nationally aggregated economic measures such as the unemployment rate can proxy for household-level employment and labor force data in explaining year-to-year changes in the prevalence of food insecurity is also not known.

The association of food insecurity with household characteristics and national economic conditions over 2001-12 provides insight into why food insecurity remained at about the same level in 2012 as shortly after the recession (2009-10), despite an improvement in the national unemployment rate. Providing an explanation of these relationships can increase public understanding of food insecurity and its causes and may aid in the development of food and nutrition assistance policies and programs to support the food security of the Nation's households.

What Did the Study Find?

Three national-level economic measures taken together accounted for 92 percent of the year-to-year variation in the national prevalence of food insecurity from 2001 to 2012.

ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment, and rural America.

- An increase of 1 percentage point in the *unemployment rate* (measured as the highest monthly unemployment rate in the past calendar year) was associated with an increase of 0.5 percentage point in the prevalence of food insecurity.
- An increase of 1 percentage point in *annual inflation*, as measured by the Consumer Price Index (CPI-U), was associated with a 0.5-percentage-point increase in the prevalence of food insecurity.
- An increase of 1 percent in the annual *relative price of food* (i.e., the ratio of food price to the price of all goods and services) was associated with a 0.6-percentage-point increase in the prevalence of food insecurity.

These associations help explain why the prevalence of food insecurity in 2012 remained essentially unchanged from the early post-recession period (2009-10). Based on the associations estimated in the study:

- The observed decline of 1.65 percentage points in the highest monthly unemployment rate over that period, absent other changes, would have reduced the prevalence of food insecurity by 0.9 percentage point.
- However, this potential decline was almost exactly offset by effects of higher annual inflation and higher annual relative price of food in 2012.

Given the associations estimated in this study, the expected prevalence of food insecurity in 2012 was 14.7 percent, nearly the same as the observed prevalence of 14.5 percent.

This study has potential implications for SNAP (USDA's Supplemental Nutrition Assistance Program, formerly food stamps). The associations of food insecurity with inflation and the relative price of food suggest that timely and adequate adjustment of SNAP benefits for increases in food prices may be important for food security.

How Was the Study Conducted?

The study used data on household food security and other household characteristics from the Current Population Survey Food Security Supplement (CPS-FSS) and national statistics on unemployment and price inflation from the U.S. Bureau of Labor Statistics. The CPS-FSS is an annual, nationally representative survey of U.S. civilian households sponsored by USDA and administered by the U.S. Census Bureau. It is the source of data for USDA's series of annual reports on the food security of U.S. households.

Associations of the prevalence of food insecurity from 2001-12 with national-level economic measures were estimated using multivariate linear regression methods. Joint effects of national-level and household-level characteristics were estimated similarly. The extent to which changes in unemployment, inflation, and the relative price of food may have contributed to changes in the prevalence of food insecurity from pre-recession (2005-07) and early post-recession (2009-10) to 2012 was estimated based on results of the regression models.

Prevalence of U.S. Food Insecurity Is Related to Changes in Unemployment, Inflation, and the Price of Food

Mark Nord, Alisha Coleman-Jensen, and Christian Gregory

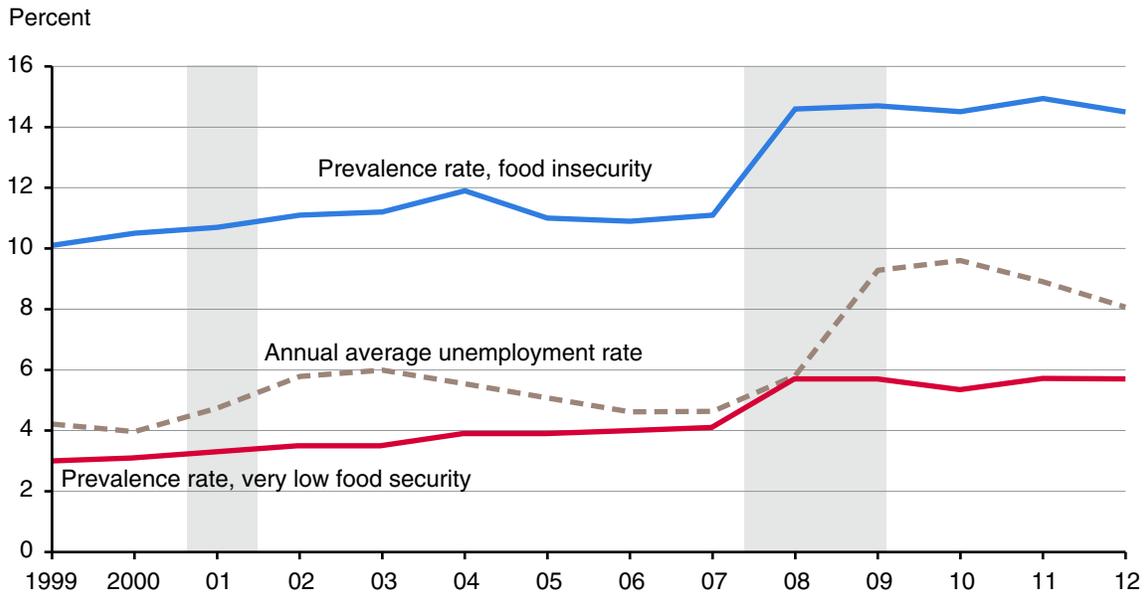
Introduction

A household's ability to consistently put adequate food on the table—its food security—is primarily a function of its available resources, competing demands for those resources, and the cost of acquiring food. Food insecurity, by definition, results from a household's lack of adequate resources for food, and in any given period the adequacy of those resources is affected by national economic conditions. It is likely, then, that year-to-year changes in the prevalence of food insecurity are associated with changes in both U.S. economic conditions and household circumstances. This report examines the strength of those associations at both national and household levels.

The U.S. Department of Agriculture (USDA) monitors the food security of the Nation's households through an annual, nationally representative food security survey conducted by the U.S. Census Bureau with support from USDA. USDA's Economic Research Service (ERS) analyzes the survey data; publishes an annual report on food security at the national level, for key subpopulations, and for each State; and conducts research on determinants of food insecurity. Previous research by ERS and others provides considerable insight into household-level factors that affect food insecurity. However, the effects of national economic factors such as inflation and food prices on the national prevalence of food insecurity are unknown. Also, the extent to which changes in household and macroeconomic factors account for year-to-year changes in the prevalence of food insecurity—and how well aggregate economic measures such as the unemployment rate proxy for household-level employment and labor force data—is not known.

This report is an attempt to fill those gaps. We first examine the extent to which year-to-year differences in the prevalence of food insecurity are associated with differences in national-level economic conditions. We then examine the joint effects of household-level and national economic conditions to ascertain the degree to which national economic conditions alone (as opposed to these conditions in combination with household-level factors) explain year-to-year changes in the prevalence of food insecurity. We investigate why the prevalence of food insecurity has remained at a higher level during the years immediately following the 2007-08 recession than during the years immediately preceding it. Following USDA's release of its annual report, *Household Food Security in the United States in 2012* (Coleman-Jensen et al., 2013), policy officials and media asked USDA why food security had not improved in 2012, considering that the unemployment rate had fallen since the end of the recession and that some other economic indicators had improved (fig. 1). Detailed understanding of national and household-level determinants of food insecurity may provide an answer to this question, increase public understanding of food insecurity and its causes, and inform policies and programs to support the food security of the Nation's households.

Figure 1
Prevalence of food insecurity, very low food security, and the national unemployment rate, 1999-2012



Note: Shaded areas indicate recessions.

Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and unemployment statistics from the Bureau of Labor Statistics.

Related Research

Selection of national economic indicators and household-level characteristics that may explain changes in U.S. food insecurity was based on previous studies of factors associated with food insecurity at the household level and the prevalence of food insecurity at the State level. Tapogna et al. (2004) found that the prevalence of food insecurity across States was positively associated with State measures of poverty, housing-cost burden, residential mobility, and the proportion of households with children. A multivariate model with these variables—plus State unemployment rate (highest monthly rate during the study period) and the share of the population that was non-Hispanic White—accounted for 70 percent of the cross-State variance in the prevalence of food insecurity and 59 percent of the variance in the prevalence of very low food security—the more severe range of food insecurity in which eating patterns of some household members were disrupted and their food intake reduced below levels they consider appropriate.

Bartfeld et al. (2006) estimated the joint effects of household and State-level factors on food insecurity. Household characteristics associated with higher probability of food insecurity included:

- Low income—income less than or up to 185 percent of the Federal poverty line
- Low education of adults—especially less than high-school education
- Minority status (Black, Hispanic, and Native American)
- Renting rather than owning the home
- Living in a central city of a metropolitan area
- Having three or more children
- Household headed by a single female
- No adult employed
- No elderly in the household
- Having a household member with a disability
- Having a noncitizen head of household.

Several State-level characteristics were also associated with higher probability of a resident household being food-insecure, even after adjusting for the household characteristics:

- Low average wages
- High cost of rental housing
- High unemployment rate
- High rate of residential instability
- Low participation in the Supplemental Nutrition Assistance Program (SNAP, formerly the Food Stamp Program)
- High tax burden on low-income households.

Taken together, these household and State characteristics accounted for 86 percent of the differences in the prevalence of food insecurity across States during 1998-2001 (Bartfeld et al., 2006).

Other studies have modeled household-level factors incidental to the main purpose of the studies (Nord and Coleman-Jensen, 2010; Nord and Prell, 2011; Nord 2013a). These studies confirm the consistent associations of food insecurity with low income, unemployment (including part-time employment by workers who want full-time work) and disability, and the inverse association of food insecurity with elderly household members. However, in some of these models, with income and employment more thoroughly specified, associations of food insecurity with low education, minority status, and residence in central cities became statistically insignificant or reversed.

Food prices have been found to be positively associated with food insecurity at the household level. The association appears to be strongest for SNAP recipients (Nord 2013a; Gregory and Coleman-Jensen, 2013; Nord and Prell, 2011), but it is likely that other low-income households are also affected (Zhang et al., 2013).

Data and Measures

Data on household food security are from the Current Population Survey Food Security Supplement (CPS-FSS) from 2001 to 2012. The CPS-FSS is an annual, nationally representative survey conducted for USDA by the U.S. Census Bureau. The CPS-FSS provides the data for USDA's annual reports on household food security in the United States (Coleman-Jensen et al., 2013). The survey included an average of 46,149 households each year during the study period.

One individual in each household responds to a series of 10 questions (plus an additional 8 if children are in the household) about behaviors and conditions that characterize households when they are having difficulty meeting their food needs (see box, "Questions Used To Assess Households' Food Security," on page 6). Each question asks about occurrences in the previous 12 months and specifies a lack of money as the reason for not having enough food so as not to count voluntary fasting or dieting as food insecurity.

Following standard procedures, households were classified as food insecure if they reported three or more behaviors or conditions indicating food insecurity (Bickel et al., 2000). Households were further classified as having very low food security if they reported six or more food-insecure behaviors or conditions (eight or more in households with children, counting responses to both adult and child items). Households with children were classified as having food insecurity among children if they reported two or more potentially food-insecure conditions in response to the eight child-referenced questions. The primary analyses were based on food insecurity at the household level and on the annual national prevalence rate of food insecurity based on that measure, i.e., the percentage of households that were classified as food-insecure. Key analyses (reported in Appendix A) were repeated for very low food security and for food insecurity among children.

U.S. monthly unemployment rates (seasonally adjusted) were accessed from the Bureau of Labor Statistics website. The national unemployment rate was hypothesized to be associated with food insecurity because it is aggregated from household-level employment status, which is known to be strongly associated with food security at the household level. The measure of unemployment expected to be most closely associated with the prevalence of food insecurity in a given year is the highest monthly unemployment rate during that calendar year (fig. 2); households' measured food insecurity generally reflects the most food-insecure conditions encountered during the year. Each question in the food security measure asks whether the condition or behavior ever occurred "in the past 12 months." Food insecurity tends to reflect the worst economic conditions over the year and these conditions are better captured by the highest monthly unemployment rate than by average annual unemployment.

Measures of inflation and prices were also accessed from the Bureau of Labor Statistics. Inflation was measured as the percentage change in the annual average Consumer Price Index (CPI-U) for all goods and services (fig. 3). With rapid price inflation, price increases may outpace increases in the incomes of some households. Inflation in food prices may pose particular challenges to food security, and food security may be affected by the current level of food prices compared with prices for other goods and services, as well as by any recent change in food prices (Nord and Prell, 2011; Nord, 2013a; Zhang et al., 2013; Gregory and Coleman-Jensen, 2013). The relative price of food was measured as the annual average CPI-U for food divided by the annual average CPI-U for all goods and services (fig. 4). Because food is relatively price inelastic, and because households on the

Questions Used To Assess the Food Security of Households in the CPS Food Security Survey

1. “We worried whether our food would run out before we got money to buy more.” Was that often, sometimes, or never true for you in the last 12 months?
2. “The food that we bought just didn’t last and we didn’t have money to get more.” Was that often, sometimes, or never true for you in the last 12 months?
3. “We couldn’t afford to eat balanced meals.” Was that often, sometimes, or never true for you in the last 12 months?
4. In the last 12 months, did you or other adults in the household ever cut the size of your meals or skip meals because there wasn’t enough money for food? (Yes/No)
5. (If yes to question 4) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
6. In the last 12 months, did you ever eat less than you felt you should because there wasn’t enough money for food? (Yes/No)
7. In the last 12 months, were you ever hungry, but didn’t eat, because there wasn’t enough money for food? (Yes/No)
8. In the last 12 months, did you lose weight because there wasn’t enough money for food? (Yes/No)
9. In the last 12 months did you or other adults in your household ever not eat for a whole day because there wasn’t enough money for food? (Yes/No)
10. (If yes to question 9) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

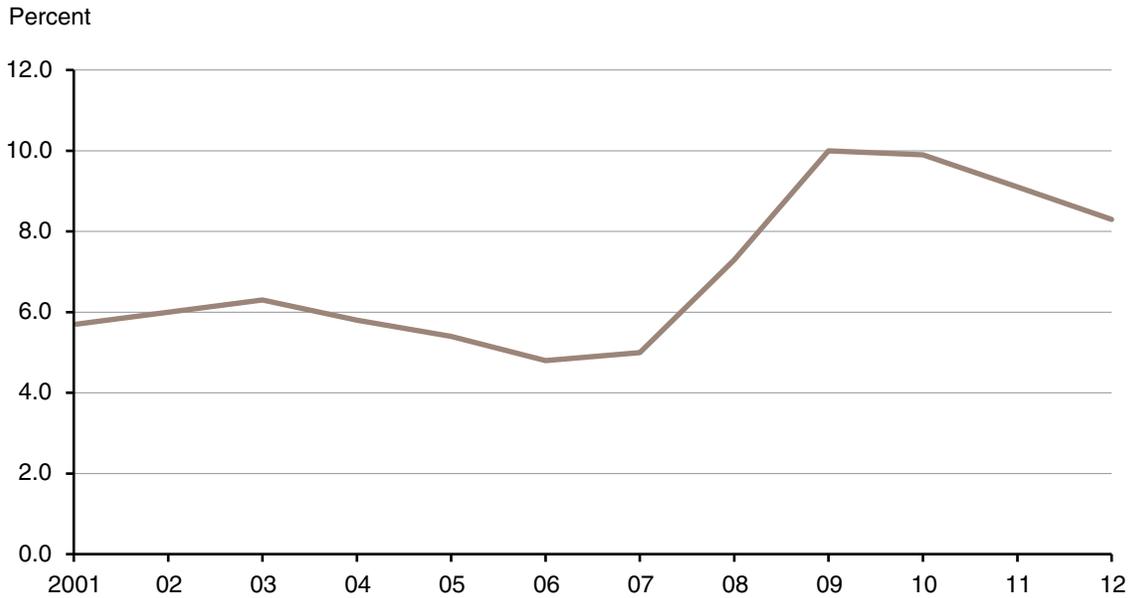
(Questions 11-18 were asked only if the household included children age 0-17)

11. “We relied on only a few kinds of low-cost food to feed our children because we were running out of money to buy food.” Was that often, sometimes, or never true for you in the last 12 months?
12. “We couldn’t feed our children a balanced meal because we couldn’t afford that.” Was that often, sometimes, or never true for you in the last 12 months?
13. “The children were not eating enough because we just couldn’t afford enough food.” Was that often, sometimes, or never true for you in the last 12 months?
14. In the last 12 months, did you ever cut the size of any of the children’s meals because there wasn’t enough money for food? (Yes/No)
15. In the last 12 months, were the children ever hungry but you just couldn’t afford more food? (Yes/No)
16. In the last 12 months, did any of the children ever skip a meal because there wasn’t enough money for food? (Yes/No)
17. (If yes to question 16) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
18. In the last 12 months did any of the children ever not eat for a whole day because there wasn’t enough money for food? (Yes/No)

Determination of Household Food Security Status

Households are classified as food insecure if they responding affirmatively to 3 or more questions. They are classified as having very low food security if they respond affirmatively to 6 or more questions (8 or more in households with children, including responses to the child-referenced items).

Figure 2
Highest monthly unemployment rate in the calendar year, 2001-12



Source: Calculated by USDA, Economic Research Service using monthly unemployment statistics from the Bureau of Labor Statistics.

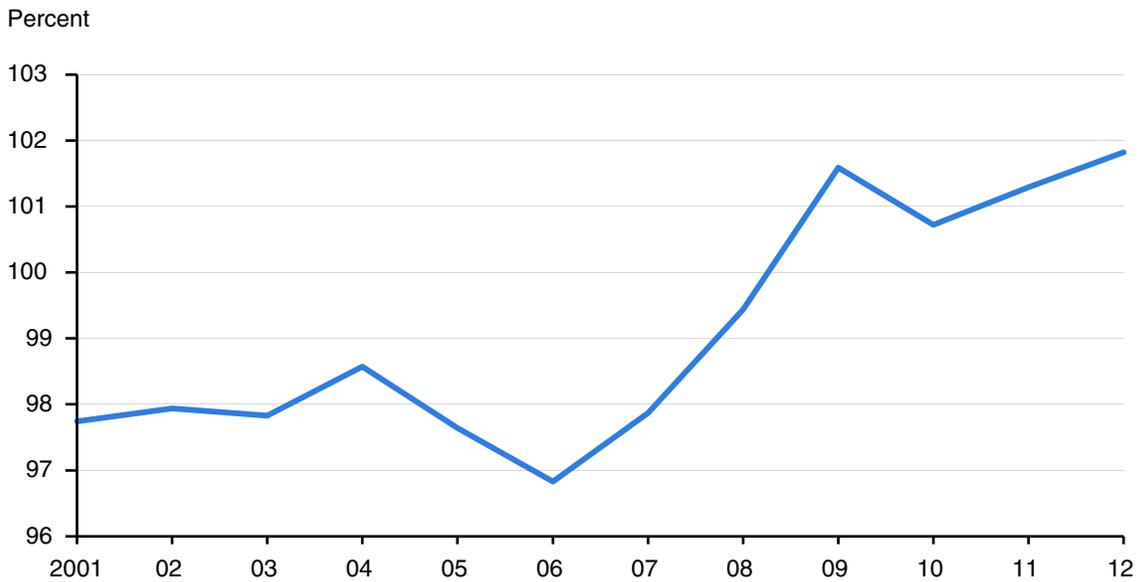
Figure 3
Annual inflation, Consumer Price Index for all goods and services (CPI-U), 2001-12



Source: United States Department of Commerce, Bureau of Labor Statistics.

Figure 4

Price of food relative to the price of all goods and services, 2001-12*



*The relative price of food was calculated for each year as the annual average Consumer Price Index (CPI-U) for food divided by the CPI-U for all goods and services, and expressed as a percentage. The base for both indices was the 1982-84 average, so the relative price of food for that period would have been 1.0.

Source: Calculated by USDA, Economic Research Service using Consumer Price Index statistics from the Bureau of Labor Statistics.

margins of food insecurity spend a higher share of their income on food, such households may be particularly sensitive to changes in the relative price of food.

Household-level characteristics likely to affect food security were identified from previous research, and variables representing those characteristics were calculated from CPS-FSS data. These included variables representing income, employment and labor-force status of adults in the household; household structure and composition; race and Hispanic ethnicity of the household reference person; education of the most highly educated adult in the household; recent household moves; and metropolitan residence (see Appendix B).

Analytic Methods

National-level associations of the annual prevalence of food insecurity with three annual economic variables were estimated using ordinary least-squares regression:

(National-level regression model)

$$FI_y = a + b_1 * Unemp_y + b_2 * Inflation_y + b_3 * Relative-price-of-food_y + e_y$$

All variables are annual statistics measured at the national level. FI_y is the percentage of households that were food insecure in year y . $Unemp_y$ is the highest monthly unemployment rate (seasonally adjusted) in calendar year y ; $Inflation_y$ is the annual average rate of CPI inflation for the year; and $Relative-price-of-food_y$ is the relative price of food for the year. Alternative specifications of the explanatory variables were explored, but none were found to perform better than the initial, theoretically based specifications (see appendix C).¹

The contributions of changes in the explanatory variables to changes in food insecurity from pre-recession (average 2005-07) and early post-recession (average 2009-10) to 2012 were calculated based on the regression coefficients estimated in the national model. Because the model was linear, the contribution of each explanatory variable was calculated as the coefficient multiplied by the change in the explanatory variable over the period of interest. The sum of these contributions equals the change in the dependent variable predicted by the model.

Household-level variables were then incorporated into the model by estimating a two-level random-intercept model in which the first level comprised households and the second level (for which separate intercepts were estimated) comprised survey years:

(Combined household-national-level regression model)

$$FI_{h,y} = a + \mathbf{B}_h \mathbf{X}_{h,y} + \mathbf{G}_y \mathbf{M}_y + e_h + f_y$$

In this model, the dependent variable, $FI_{h,y}$, is a binary variable with value 1 if the household is food insecure and 0 if the household is food secure. Household-level variables ($\mathbf{X}_{h,y}$) were assumed to have the same effect (estimated as \mathbf{B}_h) in all years. The intercept for each year was assumed to depend on the values of the national economic variables for that year (\mathbf{M}_y) with effects estimated as \mathbf{G}_y . Errors at each level were assumed to be distributed normally, with a mean of zero. The two-level random intercept model takes account of the limited degrees of freedom of the national-level variables (12 years versus more than half a million households), thus providing theoretically unbiased estimates of the variance of the coefficient estimates on which assessments of statistical significance are based.

The combined household/national model was estimated as a linear probability model. While a logistic or probit specification might be more precise and avoid certain biases, the linear probability model supports straightforward disaggregation of predicted change into components corresponding

¹The national poverty rate, as a measure of income, was also strongly correlated with the prevalence of food insecurity ($r = 0.91$), as expected, based on the associations reported in household-level analyses. However, including the poverty rate in the national-level regression model did not improve the model performance, and the coefficient was weak and not nearly statistically significant ($p = 0.76$).

to each explanatory variable. Given the range of observed rates of food insecurity (from 10.7 percent to 14.9 percent), the linear probability model was expected to introduce relatively little estimation bias.² Replication of the model using logistic regression confirmed this expectation.

In a preliminary estimation of the two-level model that included the same three national economic variables as in the national model, the coefficient on the unemployment variable was found to be weak and not statistically significant (analysis not shown). This was not unexpected, because the model included a rich set of variables representing employment, unemployment, and labor force status at the household level. In the final specification of the two-level model, therefore, the national-level unemployment variable was omitted.

The contributions of changes in explanatory variables to changes in food insecurity from pre-recession and early post-recession periods to 2012 were calculated as described for the national model, except that both household- and national-level variables were included. Contributions of household-level variables were then aggregated to groups of variables representing three general categories: income, employment/labor-force status, and “other.” The latter category includes a large number of household-level variables, but they are variables for which the means do not change greatly over periods of a few years, such as race/ethnicity and metropolitan/nonmetropolitan residence. As a result, those variables contribute little to the year-to-year changes in food insecurity.

The national-level model has few degrees of freedom and a limited number of independent variables. Future research using this model would benefit from additional years of data. A concern is that the three national-level variables may be proxying for other unmeasured factors not accounted for in the model. However, alternative variables and specifications were explored, along with robustness checks. Other key analyses were repeated with very low food security at the household level as the dependent variable and with children’s food insecurity as the dependent variable (see Appendix A).

Data manipulation and model estimations were carried out in SAS 9.2 (SAS Institute Inc., Cary, North Carolina). The national-level model was estimated using PROC REG. The two-level random-intercept model was estimated using PROC MIXED.³ Robustness of the results of the linear two-level model was assessed in a random-effects logistic regression model using the XTLOGIT procedure in STATA 11.2 (www.stata.com).

Supplement weights provided by the Census Bureau indicate how many households are represented by each interviewed household and were used for all calculations involving household-level data.⁴

²Predicted values from the regression model ranged from -.15 to .84, and about 18 percent of observations had values less than 0. However, these theoretically impossible probability values appear not to have biased the annual prevalence estimates substantially; the annual prevalence rates predicted by the linear and logistic models were essentially identical.

³The MIXED procedure model was specified as random intercept with survey year as the “subject.” The “degrees of freedom” was specified as “between-within.” Under this specification, SAS assigned degrees of freedom based on the number of years to variables that did not differ within the same year, thus to national economic variables.

⁴Food security weights multiplied by 0.75 were used rather than supplement weights for the 2007 CPS-FSS. This ensured that prevalence rates for that year were consistent with published rates, while taking into account the relatively small sample size in that year (USDA, Economic Research Service, 2008).

Findings

National Economic Factors in Food Insecurity

About 92 percent of the year-to-year variation in the national prevalence of household food insecurity from 2001 to 2012 was associated with changes in the national unemployment rate, inflation over the previous year, and the relative price of food (table 1). On average, the observed prevalence rate differed from the rate predicted by the model by about a third of a percentage point (mean absolute error 0.341). Holding other modeled conditions constant, a 1-percentage-point increase in the unemployment rate or in annual CPI inflation was associated with an increase of 0.523 percentage point in the prevalence of food insecurity. A 1-percentage-point increase in the price of food relative to the price of all goods and services was associated with an increase of 0.583 percentage point. The standardized regression coefficients, which take into consideration the extent to which each of the economic predictors vary from year to year, indicate that changes in the unemployment rate and relative price of food accounted for more of the year-to-year change in food insecurity than the change in CPI inflation. Given the relationships among the model variables over the entire period, the observed prevalence of food insecurity in 2012 was very near the predicted level (fig. 5).⁵

The regression results suggest why the prevalence of food insecurity remained above pre-recession levels in 2012 (table 2). The highest monthly unemployment rate was 3.23 percentage points higher in 2012 than in the period immediately before the recession (2005-07). The prevalence of food insecurity is estimated to have increased 1.69 percentage points as a result. The price of food relative to

Table 1
Linear regression of annual prevalence rate of food insecurity (percent of households) on national unemployment, inflation, and relative price of food, 2001-12

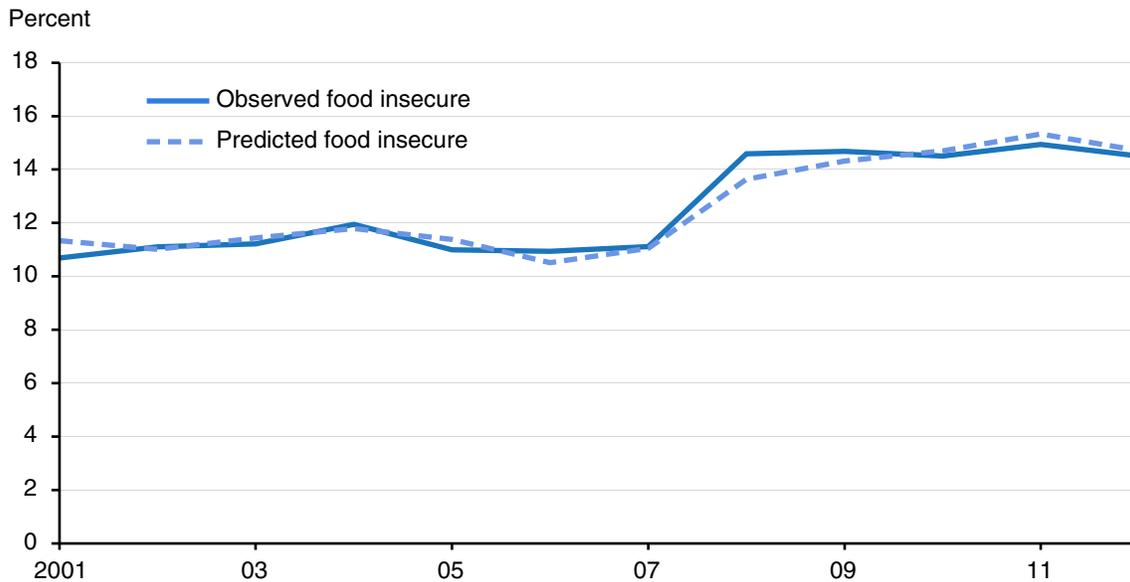
Variable	Coefficient (%-age points)	Std. coefficient	P
Constant	-50.010		
Highest monthly unemployment rate in year (percent)	.523	.542	.062
CPI inflation, annual average (percent)	.471	.288	.024
Relative price of food (CPI food as a percent of total CPI)	.583	.569	.041
Number of years	12		
Adjusted R2	.921		
Dependent mean (prevalence of food insecurity)	12.602		
Standard error of model-predicted prevalence	.513		
Mean absolute error of model-predicted prevalence	.341		

Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics.

⁵There was little evidence that regression results were distorted by effects of serial autocorrelation. The Durbin-Watson statistic for first-order autocorrelation was 1.60 (p = 0.16 for positive autocorrelation, and p = 0.84 for negative autocorrelation.)

Figure 5

Prevalence of food insecurity, 2001-12, and predicted prevalence based on highest monthly national unemployment rate, annual inflation, and relative price of food



Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics. Predicted prevalence rates are based on regression model in table 1.

Table 2

Sources of regression-predicted change in the national prevalence rate of food insecurity

	National economic determinants			Prevalence of food insecurity	
	Unemployment ¹	CPI inflation ²	Relative price of food ³	Predicted ⁴	Observed
Coefficient (from table 1)	0.523	0.471	0.583		
Level 2012	8.30	2.07	101.82	14.71	14.51
Level 2005-07 average	5.07	3.15	97.45	10.98	11.02
Change 2005-07 to 2012	3.23	-1.09	4.37	3.73	3.49
Coefficient x change 2005-07 to 2012	1.69	-.51	2.55	3.73	
Level 2009-10 average	9.95	.64	101.16	14.51	14.60
Change 2009-10 to 2012	-1.65	1.43	.66	.20	-.09
Coefficient x change 2009-10 to 2012	-.86	.67	.39	.20	

Notes:

¹Highest monthly unemployment rate during the year (percent)

²Percentage change in annual average Consumer Price Index (CPI-U)

³CPI for food as a percentage of CPI for all goods and services (CPI-U)

⁴Predicted prevalence based on regression model in table 1.

Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics.

the price of all goods and services was 4.37 percentage points higher in 2012 than in 2005-07, and this factor is estimated to have increased the prevalence of food insecurity by 2.55 percentage points. Changes in those two factors were partially offset by a lower rate of CPI inflation in 2012, which is estimated to have reduced the prevalence of food insecurity by 0.51 percentage point. Given the changes in these three factors, the prevalence of food insecurity was predicted to be 3.73 percentage points higher in 2012 than in 2005-07—slightly more than the observed increase of 3.49 percentage points.

Comparing 2012 with the early post-recession period (2009-10) provides additional insight into why food insecurity rates have changed so little since the recession. The highest monthly unemployment rate fell from 2009-10 to 2012 and, absent any other changes, it is estimated that food insecurity would have fallen by 0.86 percentage point as a result (table 2). However, that potential decline was offset by the effects of higher overall inflation and higher relative price of food in 2012 compared with the early post-recession period. The net result was a predicted increase in food insecurity of 0.20 percentage point from 2009-10 to 2012, compared with an observed decline of 0.09 percentage point.

Household Characteristics Associated With Food Insecurity

Associations of food insecurity with household characteristics were consistent with those found in previous studies. The coefficients in table 3 represent the difference in probability of food insecurity that is associated with a one-unit difference in the covariate. With the exception of income and numbers of children in two age ranges, the covariates are all binary (zero/one) variables, so the difference represented by the coefficient is the difference in probability of food security between households with and without the characteristic that is identified by the variable. Or, for a variable that is one of a set of several binary variables representing a multiple-category classification (such as household composition) the coefficient represents the difference in probability of food insecurity between households with the identified characteristic and households in the reference category for that set of variables. Multiplying a coefficient by 100 expresses these differences in percentage points. The average prevalence of food insecurity over the 12-year period was 12.6 percent, which provides a context for interpreting these percentage-point differences.

Food insecurity was strongly associated with household income and employment. For example, households with incomes 1.5 times the poverty line were about 6 percentage points less likely to be food insecure than households with incomes at half the poverty line.⁶ Food insecurity was also associated strongly with household employment and labor force status. Holding income and all other covariates constant, compared with households where all adults were out of the labor force for reasons other than retirement and disability, the following associations were estimated (principal labor force status):

- Households with an adult employed full-time were 4.13 percentage points less likely to be food insecure.
- Households with no adult employed full-time, but with one or more adults retired, were 6.44 percentage points less likely to be food insecure.

⁶The complex specification of income in this model complicates interpretation. In the example described, the difference in food insecurity associated with a difference of 1 “poverty level” unit—from 0.5 to 1.5—takes into account both the coefficient on income and the coefficient on income-squared.

Table 3

Coefficients from the combined household-national-level regression model of food insecurity and means of the model variables for three periods

	Coefficient ¹	p	Mean 2005-07	Mean 2009-10	Mean 2012
Intercept	-0.4794	<.001			
Income (ratio to poverty line)	-.0675	<.001	3.8145	3.6647	3.6215
Income (ratio to poverty line) squared	.0041	<.001	21.1760	19.5522	18.9516
Income less than 50% poverty line	.0382	<.001	.0392	.0445	.0474
Income in lowest reported category	-.0500	<.001	.0245	.0270	.0267
Income not reported	.0013	.260	.2000	.2155	.2140
Labor force status, principal (reference: out of labor force, not retired or disabled)					
Employed full time	-.0413	<.001	.6942	.6478	.6538
Out of labor force—retired	-.0644	<.001	.1790	.1874	.1920
Part-time for non-economic reasons	-.0285	<.001	.0422	.0451	.0438
Part-time for economic reasons	.1196	<.001	.0085	.0221	.0177
Unemployed	.1306	<.001	.0186	.0367	.0278
Out of labor force—disabled	.1486	<.001	.0365	.0386	.0421
Labor force status of other adults (omitted: out of labor force, not retired or disabled, or no other adult)					
Employed full time	-.0139	<.001	.2770	.2393	.2477
Out of labor force—retired	-.0031	.071	.1165	.1199	.1298
Part-time for non-economic reasons	-.0140	<.001	.1255	.1129	.1095
Part-time for economic reasons	.0694	<.001	.0150	.0352	.0341
Unemployed	.0775	<.001	.0369	.0757	.0634
Out of labor force—disabled	.0780	<.001	.0518	.0581	.0583
Household composition (reference: married couple with child/children)					
Single male with child/children	.0318	<.001	.0224	.0247	.0247
Single female with child/children	.0960	<.001	.0828	.0835	.0853
Other household with child/children	.0248	<.001	.0055	.0052	.0048
Two or more adults, no child	.0011	.457	.3870	.3958	.4079
Male living alone	-.0021	.290	.1191	.1219	.1223
Female living alone	.0066	<.001	.1523	.1490	.1473
Number of children ages 5-9 years	.0112	<.001	.1784	.1771	.1713
Number of children ages 10-17 years	.0125	<.001	.2901	.2799	.2713
One or more elderly in the household	-.0490	<.001	.2330	.2463	.2627
Race and Hispanic ethnicity (reference: White non-Hispanic)					
Black non-Hispanic	.0443	<.001	.1209	.1229	.1232

—continued

Table 3

Coefficients from the combined household-national-level regression model of food insecurity and means of the model variables for three periods—continued

	Coefficient ¹	p	Mean 2005-07	Mean 2009-10	Mean 2012
Hispanic	.0354	<.001	.1092	.1146	.1257
American Indian or Alaska Native	.0430	<.001	.0073	.0084	.0094
Educational attainment of most highly educated adult (reference: high school or GED)					
Less than high school	.0374	<.001	.0857	.0777	.0695
Some college, no four-year degree	-.0026	.020	.2965	.3006	.3024
Bachelor degree	-.0346	<.001	.2220	.2265	.2322
Professional or advance degree	-.0361	<.001	.1401	.1513	.1607
Household moved recently	.0216	<.001	.0495	.0448	.0459
Metropolitan/nonmetropolitan residence (reference: metropolitan, not in principal city)					
Metropolitan, principal city	.0061	<.001	.2781	.2761	.2794
Metropolitan, not specifically identified	-.0021	.098	.1428	.1430	.1412
Not in metropolitan area	-.0155	<.001	.1685	.1686	.1651
National-level economic measures					
Inflation in CPI-U since previous year	.0037	.044	3.1799	.6444	2.0690
Price of food relative to all goods and services	.0079	<.001	97.4090	101.1539	101.8200
Number of cases	541,687		127,786	89,955	43,792

¹Coefficients represent probabilities; multiply by 100 to represent associations in percentage points.

Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics.

- Households with an adult employed part-time for economic reasons (i.e., underemployed), those with an adult unemployed (looking for work), and those with an adult out of the labor force because of disability were 12 to 15 percentage points more likely to be food insecure (households in these categories had no adult employed full-time or retired or employed part-time for non-economic reasons (i.e., voluntarily part-time)).

Employment and labor-force status of other adults in the household was also associated with food insecurity. The associations were in the same direction as those for principal labor force status, but the coefficients were smaller. For example, households with another adult employed full-time were 1.39 percentage points less likely to be food insecure than households with no other adults or with other adults out of the labor force for reasons other than retirement and disability.

Even after taking into account income and employment, several other household characteristics were associated with food insecurity.

- Single parents with children were more likely to be food insecure than other households (3.18 percentage points for single men with children and 9.60 percentage points for single women with children).
- Households with elderly were less likely (4.90 percentage points) to be food insecure than households with no elderly.
- Households with Black, Hispanic, American Indian, or Alaska Native reference persons were more likely to be food insecure.
- Households in which no adult graduated high school or completed a GED were more likely to be food insecure than those with a high school graduate. Households with an adult who completed a 4-year college degree or higher were less likely to be food insecure than those in which the most highly educated adult held only a high school diploma or GED.
- Households in the “principal cities” of metropolitan areas (i.e., within the incorporated area of the largest city or cities comprising the area) were 0.61 percentage point more likely to be food insecure than those in suburban and exurban areas around metropolitan areas.
- Households outside of metropolitan areas were 1.55 percentage points less likely to be food insecure than those in suburban and exurban areas around metropolitan areas. Apparently, the nonmetro disadvantage in food insecurity reported for most years in USDA’s annual food security reports (Coleman-Jensen et al., 2013) is accounted for entirely by lower household income and differences in other household characteristics included in this regression model.

The coefficients on the two national-level economic variables in the two-level model remained statistically significant with the richer set of controls for household-level income, employment, and other characteristics. The coefficient on CPI-U inflation was smaller in the two-level model (0.37 percentage point) than in the national model (0.471 percentage point), while the coefficient on the relative price of food was larger in the two-level model (0.79 percentage point) than in the national model (0.583 percentage point). Considering the estimation errors in both models, however, the differences between these coefficients in the two models were not statistically significant.

The size of the coefficient on the relative price of food in both models, but especially in the two-level model, is larger than expected given other evidence for the association of food insecurity with food spending (Nord and Prell, 2011). Examination of the relative price of food over the study period reveals that the variable changed relatively little prior to the recession, increased during the recession, and remained relatively unchanged subsequently (fig. 4). Thus, in the regression analyses, the coefficient could be representing effects not only of the relative price of food, but also of any other variables not controlled in the model that changed coincident with the recession. With a dummy variable added to the model to identify recession and post-recession years, the coefficient on relative price of food was about one-fourth as large as that in table 3 (0.18 compared with 0.79, analysis not shown). Nonetheless, the findings on the importance of food prices to food insecurity are consistent with previous research on food security and food prices/spending (Gregory and Coleman-Jensen, 2013; Zhang et al., 2013; Nord and Prell, 2011; Nord, 2013).

The predicted changes in food insecurity from pre-recession (2005-07) to 2012 based on the two-level model were similar to those based on the national model, although the relative size of the factors’ contribution differed. The two-level model suggests that from 2005-07 to 2012, lower income and less favorable employment accounted for an increase in food insecurity of 1.24 percentage points (table 4), compared with 1.69 percentage points for the unemployment rate in the national-level model (table 2). The two-level model assigned a larger increase in food insecurity

Table 4

Sources of regression-predicted change in the national prevalence rate of food insecurity based on the combined household-national-level model

Statistic	2005-07 to 2012	2009-10 to 2012
	<i>Percent</i>	
Prevalence of food insecurity		
Base period (2005-07 average or 2009-10 average)	11.01	14.60
2012	14.51	14.51
Change from base period to 2012	3.50	-.09
Accounted for by changes in explanatory variables in the model*		
Income	.40	.05
Employment and labor force status	.84	-.28
Other household characteristics	-.25	-.11
CPI-U inflation, all goods and services	-.41	.52
Price of food relative to price of all goods and services	3.50	.53
Total accounted for by model	4.08	.71
Not explained by model*	-.58	-.80

*Based on coefficients and means in table 3.

Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics.

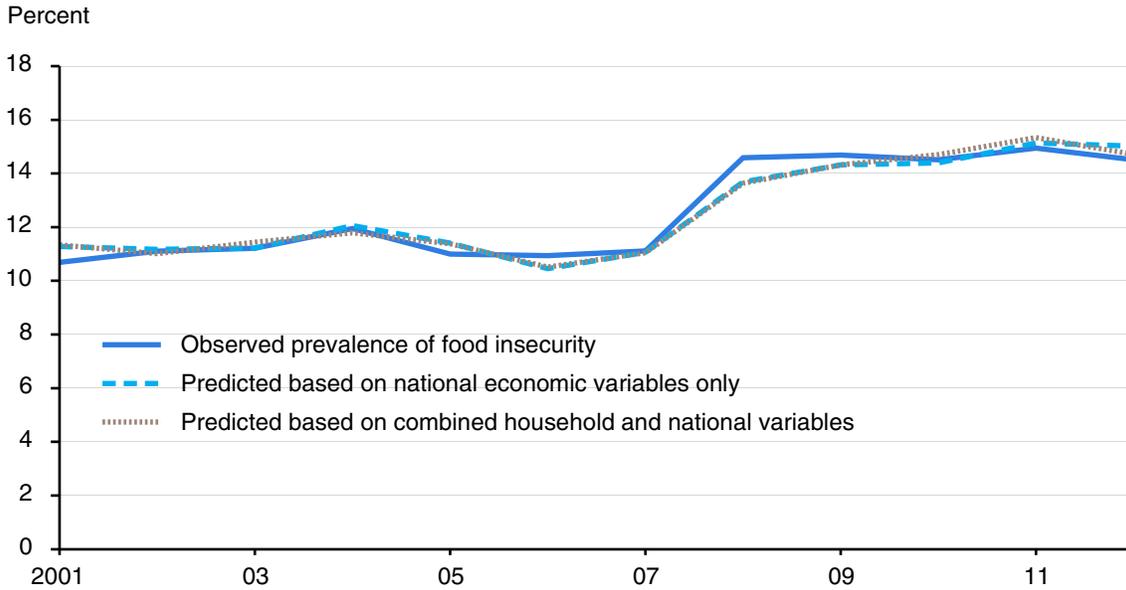
urity to the higher relative price of food (3.50 percentage points) than did the national-level model (2.55 percentage points). In both models, the effects of lower inflation in 2012 partially offset these increases (-0.41 percentage point in the two-level model and -0.51 percentage point in the national model). The reduction in food insecurity of 0.25 percentage point accounted for by “other household characteristics” in the two-level model reflects primarily an increase in the number of households with elderly members and improvements in educational attainment from 2005 to 2012.

The two-level analysis comparing the early post-recession (2009-10) to 2012 was also similar to the national model. The two-level model assigned a smaller positive role to income and employment (a decline in food insecurity of 0.23 percentage point, compared with 0.86 percentage point in the national model). In both models, this improvement was more than offset by an increase in the prevalence of food insecurity associated with higher inflation and the higher relative price of food in 2012. The increase in food insecurity associated with higher overall inflation was estimated at 0.52 percentage point by the two-level model and 0.67 percentage point by the national model. The increases associated with the higher relative price of food were 0.53 percentage point in the two-level model and 0.39 percentage point in the national model.

Predicted annual rates of food insecurity based on the two models were similar (fig. 6). Both indicate that the observed prevalence of food insecurity in 2012 was near or slightly below the predicted

Figure 6

Prevalence of food insecurity, 2001-12, and predicted prevalence based on two regression models



Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics.

Table 5

Comparisons of model fit and accuracy of annual estimated prevalence rates of food insecurity by the national-level regression model and the combined household-national-level regression model

Statistic	National-level model	Combined household-national-level model ¹
R-squared	.943	.945
Adjusted R-squared ¹	.921	.940
Standard error (percentage points)	.513	.450
Mean absolute error (percentage points)	.341	.318
Largest overestimate (percentage points)	.653	.596
Largest underestimate (percentage points)	.953	.900
N	12	12

¹Statistics for the combined household-national-level model were calculated from a second regression in which survey year was the unit of analysis, the observed prevalence of food insecurity was the dependent variable, and the predicted prevalence based on the combined household-national-level model was the single independent variable. The adjusted R-squared for this model is overstated because it does not take account of the degrees of freedom lost due to the two national-level variables in the combined model.

Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics.

level given household and national conditions in that year and the associations observed over the 12-year period.

Estimates from the two-level (household and national) model were, on average, nearer the observed values than the estimates from the national-level model, but the differences were not large (table 5). Total R-squared was nearly the same for the two models.⁷ Mean absolute error was smaller for the two-level model (0.318 percentage point) than for the national model (0.341), as were the largest positive and negative errors.

⁷Adjusted R-squared was larger for the two-level model (0.940) than for the national-level model (0.921), but the unadjusted R-squared, which was essentially the same for the two models, may provide a more appropriate comparison for assessing future performance. Although the secondary regression (of observed prevalence by year on predicted prevalence from the two-level model) included only that single independent variable, this understates the loss of degrees of freedom due to the model because two national-level variables were included in the two-level model on which the single independent variable in the secondary regression was based.

Robustness of Findings

The combined household/national model was replicated using logistic regression (results not shown). Given the binary character of the dependent variable (food insecurity), logistic regression should provide more accurate coefficient estimates. The linear model was preferred for the purpose of this study because it is more understandable to a broad audience and it more readily supports decomposition of year-to-year changes into changes due to each of the explanatory variables. But use of the linear model is appropriate only if it does not substantially distort coefficients. The logistic regression analysis assessed the extent of those distortions and verified that they were not substantial. Coefficients from the logistic regression (converted to marginal effects) were essentially identical to the coefficients from the linear model, and the two national-level variables in the two-level model (inflation and relative price of food) remained statistically significant in the logistic model.

Variance estimates in the two-level regression analysis could be understated because most households are in the CPS-FSS twice. Households in the monthly CPS are interviewed in each of 4 successive months, then again in the same 4 months a year later; the possible lack of independence between these two observations was not accounted for in the model. To assess possible bias on variance estimates of regression coefficients that could result from this survey schedule, the analysis was repeated twice, first with the subsample of households that were in 1 of their first 4 months in the CPS sample, then with households that were in 1 of their final 4 months (analysis not shown). In each of these subsamples, no household was included more than once. In the subsample analyses, the size of the coefficients on the two national-level variables—those of primary interest for the analysis—differed by less than 5 percent from the main-model estimates. The coefficients on relative cost of food remained highly statistically significant in both subsamples ($p < 0.0001$). The coefficients on annual inflation remained statistically significant with single-tailed $p < 0.05$ in both subsamples.

Conclusion

The association of food insecurity with household characteristics and national economic conditions over 2001-12 provides insight into why food insecurity remained at about the same level in 2012 as shortly after the recession. Although employment and income had improved somewhat by 2012, the predicted reduction in food insecurity associated with those improvements was only in the range of 0.23 to 0.86 percentage point. However, that potential improvement was offset by the effects of higher inflation and higher prices of food relative to other goods and services in 2012.

The relationships estimated in this study may inform future queries about why food security improves, worsens, or remains unchanged from prior years. Effects of the relative price of food may be overestimated in this report because of the co-occurrence of the recession and the increase in that measure. (Other factors not accounted for in the models may have changed at the time of the recession and remained unchanged since.) Monitoring this association in the next few years might better capture the effect of the relative price of food on food insecurity. The effect of food prices estimated in this study were in the same direction but larger than in related studies.

Differences in the accuracy of food insecurity estimates between the national model (with 3 independent variables) and the household/national model (with 37 household-level variables and 2 national-level variables) were relatively small. Contributions of the major determinants to year-to-year changes in food insecurity were also similar between the two models. The two-level model will likely provide more accurate estimates of food insecurity prevalence in future years and a more detailed and nuanced assessment of the factors underlying changes in rates. On the other hand, the national-level model is simpler, relies on familiar national-level statistics, and is likely easier to explain to policy officials, media, and the general public. Further, the national unemployment rate appears to serve as a proxy for more difficult to obtain household economic characteristics. Thus, both models may contribute to increasing public understanding of important determinants of U.S. national food security.

The national model is only based on 12 years of data with 9 degrees of freedom. It will be necessary to monitor results of this model in coming years with more data. While the model appears to explain food insecurity rates very well, the limitation of the model is that it may be prone to outliers and idiosyncratic conditions.

Previous research has established that employment and other factors affecting household resources are important determinants of food security. The findings of this study reinforce those findings and suggest, additionally, that food security is affected by recent inflation and the price of food relative to other goods and services. Over the period studied, differences in the national annual prevalence of food insecurity were associated as strongly with inflation and food prices, taken together, as with the unemployment rate.

The associations of food insecurity with inflation and relative food prices warrant further research because of their potential policy implications for SNAP. If the associations reflect causal relationships, and if the effects are as strong as suggested by the results, then they point to the importance of timely and adequate adjustment of SNAP benefits for changes in food prices. Currently, SNAP benefits are adjusted for inflation in October of each year, based on food-price data from June of that year. Thus, by the end of the fiscal year in the following September, any further inflation that may have occurred over a period of 15 months is not reflected in the SNAP benefit amount. If the effects

of food-price inflation on food insecurity are as strong as suggested by results of this study, then this lag in adjustment could weaken the food security of SNAP recipients, especially when inflation is high. For every 1 percentage point of food-price inflation not accounted for in SNAP benefits, food insecurity may be expected to increase by nearly a half percentage point.

References

- Bartfeld, Judi, Rachel Dunifon, Mark Nord, and Steven Carlson. 2006. *What Factors Account for State-to-State Differences in Food Security?* Economic Information Bulletin No. 20. U.S. Department of Agriculture, Economic Research Service.
- Bickel, Gary, Mark Nord, Christofer Price, William L. Hamilton, and John T. Cook. 2000. *Guide to Measuring Household Food Security, Revised 2000*. USDA, Food and Nutrition Service. <http://www.fns.usda.gov/fsec/files/fsguide.pdf/>
- Coleman-Jensen, Alisha, Mark Nord, and Anita Singh. 2013. *Household Food Security in the United States in 2011*, Economic Research Report No. 155. U.S. Department of Agriculture, Economic Research Service.
- Edin, Kathryn, Melody Boyd, James Mabli, Jim Ohls, Julie Worthington, Sara Greene, Nicholas Redel, and Swetha Sridharan. 2013. "SNAP Food Security In-Depth Interview Study: Final Report" Family Programs Report. U.S. Department of Agriculture, Food and Nutrition Service.
- Gregory, Christian A., and Alisha Coleman-Jensen. 2013. "Do High Food Prices Increase Food Insecurity in the United States?" *Applied Economic Perspectives and Policy*, Oct., doi: 10.1093/aapp/ppt024.
- Nord, Mark. 2013a. *Effects of the Decline in the Real Value of SNAP Benefits from 2009 to 2011*. Economic Research Report No. 151. U.S. Department of Agriculture, Economic Research Service.
- Nord, Mark. 2013b. "Youth Are Less Likely To Be Food Insecure Than Adults in the Same Household," *Journal of Hunger and Environmental Nutrition* 8(2):146-163.
- Nord, Mark, and Alisha Coleman-Jensen. 2010. "Food Insecurity after Leaving SNAP," *Journal of Hunger and Environmental Nutrition* 5(4): 434-453.
- Nord, Mark, and Mark Prell. 2011. *Food Security Improved Following the 2009 ARRA Increase in SNAP Benefits*. Economic Research Report No. 116. U.S. Department of Agriculture, Economic Research Service.
- U.S. Department of Agriculture, Economic Research Service. 2008. *December 2007 Microdata File: Technical Documentation*. http://www.ers.usda.gov/datafiles/Food_Security_in_the_United_States/Current_Population_Survey/2007/notes1207.pdf.
- Tapogna, John, Allison Suter, Mark Nord, and Michael Leachman. 2004. "Explaining Variations in State Hunger Rates," *Family Economics and Nutrition Review* 16(2): 12-22. www.cnpp.usda.gov/Publications/FENR/V16N2/fenrv16n2.pdf
- Zhang, Qi, Sonya Jones, Christopher J. Ruhm, and Margaret Andrews. 2013. "Higher Food Prices May Threaten Food Security Status Among American Low-Income Households with Children," *Journal of Nutrition* 143(10): 1659-1665.

Appendix A: Associations of National Economic Conditions With Very Low Food Security and Children’s Food Insecurity

The national-level model (table 1) was repeated with very low food security as the dependent variable (table A-1). The annual prevalence of very low food security from 2001 to 2012 was less strongly associated with unemployment, inflation, and the relative price of food than was overall food insecurity. About 81 percent of the year-to-year variation in the national prevalence of very low food security was accounted for by the model, compared with 92 percent for overall food insecurity. On average, the observed very low food security rate differed from the rate predicted by the model by 0.307 percentage point, smaller than for overall food insecurity (0.341 percentage point). But the *mean* prevalence of very low food security (5.5 percent) was less than half that of overall food insecurity (12.6 percent), so the proportional error was greater for very low food security.

The association of the highest monthly unemployment rate was weaker with very low food security than with food insecurity overall, and the coefficient was not statistically significant ($p=.492$). However, the associations of very low food security with annual CPI inflation and the relative price of food were statistically significant. Tabled values indicate significance with 90-percent confidence, but those values are based on two-tailed tests. If statistical significance is assessed based on single-tailed tests—which is appropriate considering that the hypothesized associations are directional—the associations were significant with 95-percent confidence. Holding other modeled conditions constant, an increase in annual CPI of 1 percentage point was associated with an increase of 0.28 percentage point in the prevalence of very low food security. A 1-percentage-point increase in the price of food relative to the price of all goods and services was associated with an increase of 0.445 percentage point in very low food security. The standardized regression coefficients, which take into consideration the extent to which each of the economic predictors vary from year to year, indicate

Table A-1

Linear regression of annual prevalence rate of very low food security (percent of households) on national unemployment, inflation, and relative price of food, 2001-12

Variable	Coefficient	Std. coefficient	P
Constant	-41.278		
Highest monthly unemployment rate in year (percent)	.150	.279	.492
CPI inflation, annual average (percent)	.280	.308	.093
Relative price of food (CPI food as a percent of total CPI)	.445	.780	.064
Number of years	12		
Adjusted R ²	.811		
Dependent mean (prevalence of very low food security)	4.528		
Standard error of model-predicted prevalence	.443		
Mean absolute error of model-predicted prevalence	.307		

Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics.

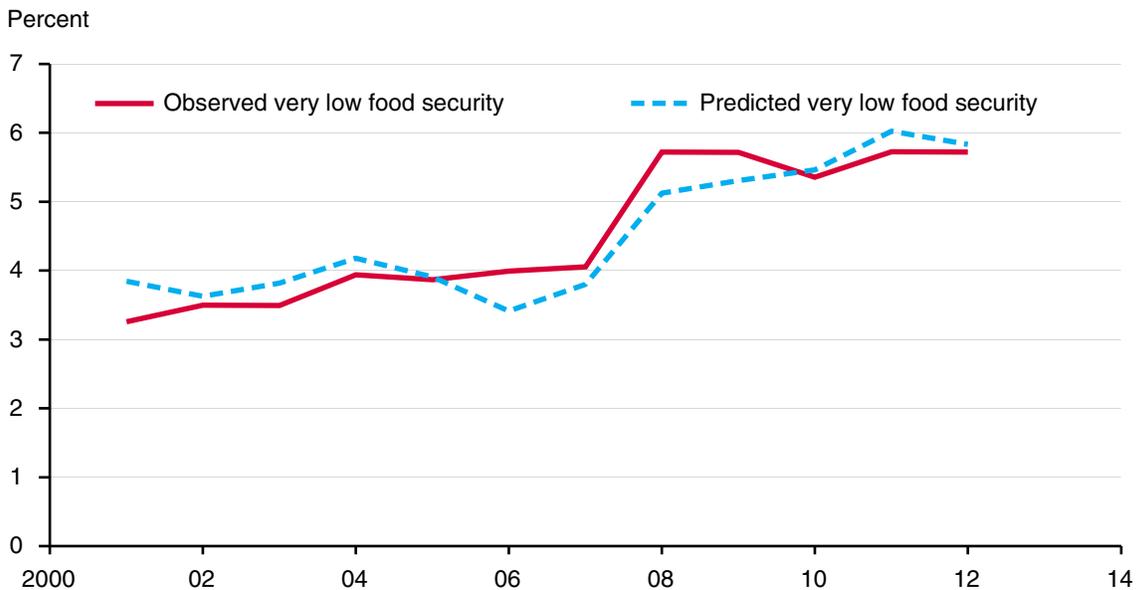
that the relative price of food was more strongly associated with the prevalence of very low food security than was annual CPI inflation. Given the relationships among the model variables over the entire period, the prevalence of very low food security in 2012 was very near the expected level (fig. A-1).

The decomposition of sources of change in very low food security from pre-recession and early post-recession to 2012 are similar to those for food insecurity (table A-2). From pre-recession (2005-07 average) to 2012, the higher relative price of food was associated with an increase in very low food security of 1.95 percentage points. Higher unemployment was associated with an additional increase of 0.49 percentage point. (This is the in-sample association, but because it is not statistically significant, there is some uncertainty about the causal relationship and about the likelihood of a similar relationship in future years.) These effects were partially offset by lower overall inflation (in 2012), which is estimated to have reduced the prevalence of very low food security by 0.30 percentage point. Thus, the observed increase of 1.75 percentage points in the prevalence of very low food security from 2005-07 to 2012 was slightly less than expected based on the regression model (2.13 percentage points).

Comparing 2012 with the early post-recession period (2009-10) may help explain the lack of improvement in very low food security since the recession. Unemployment fell from 2009-10 to 2012, and absent any other changes, it is estimated that very low food security might have fallen by 0.25 percentage point as a result. However, that potential decline was offset by the effects of higher overall inflation and the higher relative price of food in 2012 compared with 2009-10. The net result was a predicted increase in the prevalence of very low food security of 0.45 percentage point from 2009-10 to 2012, compared with an observed increase of 0.19 percentage point.

Figure A-1

Prevalence of very low food security, 2001-12, and predicted prevalence based on highest monthly national unemployment rate, annual inflation, and relative price of food



Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics. Predicted prevalence rates are based on regression model in table A-1.

Table A-2

Sources of regression-predicted change in the national prevalence rate of very low food security

	National economic determinants			Prevalence of food insecurity	
	Unemployment ¹	CPI inflation ²	Relative price of food ³	Predicted ⁴	Observed
Coefficient (from table A-1)	0.150	0.280	0.445		
Level in 2012	8.30	2.07	101.82	5.83	5.72
Level 2005-07 average	5.07	3.15	97.45	3.71	3.97
Change 2005-07 to 2012	3.23	-1.09	4.37	2.13	1.75
Coefficient x change 2005-07 to 2012	.49	-.30	1.95	2.13	
Level 2009-10 average	9.95	.64	101.16	3.38	5.53
Change 2009-10 to 2012	-1.65	1.43	.66	.45	.19
Coefficient x change 2009-10 to 2012	-.25	.40	.30	.45	

Notes:

¹Highest monthly unemployment rate during the year (percent)²Percentage change in annual average Consumer Price Index (CPI-U)³CPI for food as a percentage of CPI for all goods and services (CPI-U)⁴Predicted prevalence based on regression model in table A-1.

Source: Calculated by USDA, Economic Research Service using food security data from the Current Population Survey Food Security Supplement and statistics on unemployment and inflation from the Bureau of Labor Statistics.

A two-level (household/national) model was also estimated for very low food security following the procedures described for overall food insecurity (results not shown). As was the case in the food security model, the national unemployment variable was not significant and was omitted from the final model. Coefficients for both the annual inflation and relative price of food variables were statistically significant with values that differed little from those in table A-1. Predicted prevalence rates for each year were essentially identical to those from the national-level model shown in figure A-1. Given the similarities of the coefficients and predicted prevalence rates, a decomposition of sources of change was not conducted for the prevalence of very low food security based on the two-level model.

The national-level model was repeated once more with food insecurity among children as the dependent variable (results not shown). Model fit was weaker than for the household-level measures. Adjusted R-squared was 0.53 with all three national economic variables in the model, and none of the coefficients was statistically significant. Bivariate associations with the prevalence of children's food insecurity were statistically significant and of nearly the same strength for both the highest monthly unemployment rate (coefficient=0.39, adjusted R-squared=.57, p=.003) and the relative price of food (coefficient=.42, adjusted R-squared=.60, p=.002). With both variables in the model, however, neither was statistically significant (p=.59 for unemployment and p=.37 for relative price of food). There remains, therefore, considerable uncertainty about the causal relationships of the two variables with children's food insecurity.

Appendix B: Measures of Household Demographic, Economic, and Geographic Characteristics

This appendix provides descriptions of each of the household-level variables in the two-level model in table 3. These were calculated from variables in the labor force core section of the Current Population Survey.

Income (ratio to poverty line)—Annual household income is reported in ranges in the core labor force portion of the CPS. Income for each household was approximated as the center of the reported range. The poverty line for each household was assigned from the Census Bureau’s table of poverty thresholds for the year of the survey, based on the number of adults and the number of children in the household and whether the household reference person was younger or older than 65. Income was specified as quadratic (i.e., including ***Income Squared***) because the association of income with food insecurity is substantially nonlinear. A binary variable indicating ***Income Less Than 50 Percent of the Poverty Line*** was also included to account for further nonlinearity in the lowest income range.

Income in lowest reported category—A binary variable indicates whether the household reported annual income in the lowest income (less than \$5,000) category. This category may include a mixture of households that have very low income and low resources and other households that have temporarily low income but have other resources to draw on. There is evidence of this in the present study in that the coefficient on this variable is negative and statistically significant, indicating that households with incomes reported in the lowest category have better food security than expected given their reported income and other characteristics.

Income not reported—A binary variable indicating that the household did not report annual income. (About 20 percent of households did not report annual income in the CPS.)

Labor force status, principal—The labor force status of each adult (age 18 or older) was assigned in one of six categories, based on the variables *monthly labor force recode* (PEMLR) and *full/part-time work status* (PRWKSTAT) in the core labor force portion of the CPS. The six categories are:

1. Employed full time
2. Out of the labor force—retired
3. Employed part time for noneconomic reasons (the individual was not seeking full-time work)
4. Employed part time for economic reasons (the individual wanted to work more hours but could not find a full-time job)
5. Unemployed (looking for work)
6. Out of the labor force—disabled
7. Out of the labor force—not retired or disabled.

Principal labor force status for the household was assigned as the lowest-numbered category of any adult in the household. Thus, a household in category 5 would have had no adult employed or out of the labor force due to retirement and at least one adult unemployed and looking for work. The set of categories was represented in the multivariate model as a set of six dummy variables, with category 7 (out of the labor force—not retired or disabled) as the reference category.

Labor force status of other adults—The labor force status of any additional adults in the household was represented by a series of six binary variables representing the categories described above. More than one of these variables could have value 1 if there were more than two adults in the household. All six variables were zero if there was only one adult present or if any other adults were in the omitted category (out of the labor force—not retired or disabled).

Household composition was represented by a set of six dummy variables. The reference category was *married couple with child/children*.

Number of children ages 5-9 and 11-17 adjusts both for the difference in expenses for older versus younger children, and also for the greater extent to which adults shield younger children from food insecurity even if the adults are food insecure (Edin et al., 2013; Nord, 2013b). The presence of children younger than age 5 only is accounted for by the household composition variables together with values of zero for these two variables.

One or more elderly in the household is a binary variable indicating the presence of at least one household member age 65 or older.

Race and Hispanic ethnicity of the household reference person is represented by a set of three dummy variables for Black non-Hispanic, Hispanic, and American Indian or Alaska Native. The reference category is White non-Hispanic and Asian non-Hispanic. Those who reported their race as American Indian or Alaska Native and also reported Hispanic ethnicity were classified as American Indian or Alaska Native.

Educational attainment of most highly educated adult is represented by a set of three dummy variables with *just high school or GED* as the reference category.

Household moved recently is a binary variable indicating that the household has moved into the sampled address since that address was first in the survey sample—a period that could have been from 1 to 15 months.

Metropolitan/nonmetropolitan residence is represented by a set of three dummy variables with *metropolitan, not in principal city* as the reference category. These would generally be households in the suburban and exurban areas outside the incorporated city or cities at the heart of the metropolitan area.

Appendix C: Alternative Measures of National Economic Conditions

The following alternative and additional specifications of national-level income, employment, and labor force conditions were explored.

- The annual poverty rate was examined as a representation of income and income distribution. In the national-level model, the coefficient was weakly negative (i.e., opposite in sign to the expected direction of association) and not nearly significant ($p = 0.76$).
- The annual average unemployment rate was examined as an alternative to the highest monthly unemployment rate. As expected, it was not as strongly associated with food insecurity as the highest monthly unemployment rate. Food-insecure conditions tend to be based on the worst economic conditions during the year, which is better captured by the highest monthly unemployment rate.
- The highest monthly unemployment rate for workers with less than a high school education might better represent labor market conditions faced by less educated and less skilled workers, who are more likely to be vulnerable to food insecurity. In fact, the association of this measure with the prevalence of food insecurity was essentially identical to that of the highest monthly unemployment rate for all workers, and the two unemployment measures were highly correlated over the 12-year period (Pearson correlation = 0.997). We elected to use the more comprehensive measure.
- The annual average labor force participation rate for persons age 16 and older was included in an exploratory model to account for the fact that the unemployment rate does not directly represent discouraged workers who drop out of the labor force. The coefficient for the labor-force participation variable was weak and not nearly significant, so the variable was not included in the final models.
- Two measures of long-term unemployment were assessed. The number of workers unemployed for more than 26 weeks was entered as a percent of total labor force and (in a separate analysis) as a percent of unemployed. Neither measure contributed to overall model fit, and neither coefficient approached statistical significance.

Households with discouraged workers who drop out of the labor force and workers who are unemployed for long periods probably are more likely to be food insecure than otherwise similar household without such members. However, at the national level, those conditions are, apparently, so strongly associated with the unemployment rate that the model accounts adequately for the effects of those associated conditions on food insecurity.

Two alternative specifications of inflation and prices were also explored.

- The price of food *at home* relative to the prices of other goods and services was considered as an alternative to the corresponding measure based on the price of all food. This measure did not perform as well as the broader measure, possibly because even low-income households rely in part on food away from home.
- A similar measure of the relative price of foods in the Thrifty Food Plan was calculated as the cost of the Thrifty Food Plan in December of the survey year divided by the CPI-U for all goods and services in the same month. Inflation in the cost of the Thrifty Food Plan is based

on changes in prices of more basic, less processed foods, which may more closely represent the foods typically purchased by lower income households. Although this measure performed somewhat better than the relative price of all food, we retained the more general measure out of concern that discontinuities could occur in the Thrifty Food Plan-based measure periodically when the methodology for calculating the cost of the Thrifty Food Plan is revised.