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Identifying the Risk Factors for Food Insecurity in the United States

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ABSTRACT. Food insecurity is widespread in America and has both humanitarian and economic consequences. The purpose of this study is to identify the risk factors associated with food insecurity so that state officials can tailor assistance programs to benefit those most in need. A logistic regression model is employed using data from the 2016 Food Security Supplement to the Current Population Survey. The results provide evidence that food insecurity is negatively associated with income, education, home ownership, and age; it is positively associated with unemployment, disability, and a state's tax burden. Other influences include ethnicity, citizenship status, and participation in nutrition assistance programs.

I. Introduction

In 2016, 41.2 million Americans were food insecure, including 12.9 million children. In total, food insecure people represent 13% of the U.S. population (United States Department of Agriculture 2017a, 7). Food security is defined by the United States Department of Agriculture as "access by all people at all times to enough food for an active, healthy life." To evaluate its food security status, a household is asked a series of questions; three assess the entire household, seven assess the adults in the household, and eight assess the children if they are present. A list of these questions can be found in Appendix 1. Depending on the number of affirmative responses, the household is categorized as either food secure or food insecure. Food insecure families are further classified as having either low food security or very low food security (United States Department of Agriculture 2017a, 2). In general, households with low food security demonstrate a decline in quality and/or variety of meals, whereas families with very low food security also report a reduction in the quantity of meals.

The issue has humanitarian and economic consequences that warrant intervention. A growing body of literature has demonstrated various physical, mental, and social consequences of food insecurity including, but not limited to: lower bone mineral content (Eicher-Miller et al. 2011), impaired development of social skills and self-control (Howard 2011), higher rates of depression and suicidal symptoms (Alaimo et al. 2002),

more chronic diseases (Weinreb et al. 2002), and lower math and reading achievement scores (Winicki and Jemison 2003). These early-life conditions can have lasting effects on the development of human capital and the economic outcomes of the future workforce. It also costs the economy today. The health-related costs attributable to food insecurity have been estimated at about $160 billion in 2014 (Cook and Poblacion 2015, 248). Despite such unmistakable consequences, the body of literature devoted to food insecurity is relatively small.

II. Literature Review

Most of the existing research on food insecurity focuses on characteristics of the household or of the people in it. The fairly well-understood household-level determinants include: income, employment, disability status, educational attainment of one (both) parent(s), marital status, mother's age, ethnicity, number of children in the household, region, and urban/rural residency. Food insecure households are associated with low-paid, poorly educated, unemployed or disabled young single parents who live in urban areas, especially ethnic minorities with more children (Heflin, Arteaga, and Gable 2012, 31; Noonan, Corman, and Reichman 2015, 214; Anderson et al. 2016, 1089; Walsemann, Ro, and Gee 2017, 145). These studies fail to account for the differences in resources available to households in the state, such as average wages and tax burdens.

Bartfeld and Dunifon (2006) took a unique approach by combining the household-level and state-level factors in a hierarchical model. The study confirmed the effect of the household-level determinants discussed in previous literature, in addition to suggesting that renters and households with non-citizens are also prone to food insecurity. Additionally, households in states with low average wages, high rental costs, low participation in the National School Lunch Program and Food Stamps, high unemployment rates, residential instability, and high tax burdens were associated with a higher risk of food insecurity. For a complete listing of Bartfeld and Dunifon's regression results, consult Appendix 2. Their model captured 86% of the variance in food security between 1998 and 2001 but is now outdated. Since Bartfeld and Dunifon published their research, more variables have been shown to predict food insecurity strongly.

First, immigration status and ethnicity have been associated with food insecurity risk. Cook (2013, 41) discovered that having a foreign-born mother increases the odds of food insecurity by a multiple of 2.64. Furthermore, more recent immigrants are at a higher risk of being food insecure than immigrants who have been in the country longer (51). Walsemann, Ro, and Gee (2017, 143) took a different approach by investigating ethnicity/immigration covariates. Their method is more effective than Cook's because there are significant differences between ethnicities within a citizenship cohort (and vice versa), but still confirms Cook's findings. Immigrants, especially Latino immigrants, are particularly prone to food insecurity. Taken together, these sources suggest that immigration is a risk factor, and should be accounted for with a covariate approach.

Next, recent studies have shown that family structure plays a role in determining food security status. Balistreri (2012, 10-11) categorized families from the child's perspective as biological families, stepfamilies, families with unpartnered parents, and complex families. Biological families include two biological parents; stepfamilies include one biological parent and one step parent; families with unpartnered parents include a single parent in the home; complex families include all other family structures, e.g. group homes and families with more than two parents. Stepfamilies, families with unpartnered parents, and complex families are 2.22, 3.29, and 2.59 times more likely to suffer from food insecurity, as compared to completely biological families. Other studies have taken a more nuanced approach; Wallace and Cox (2012, 25-28) studied the effect of imprisonment on food security and found that the probability of food insecurity rises by 2-15% when a parent is imprisoned. Even absent fathers can influence their family's food security status. Nepomynaschy et al. (2014, 123) suggested that food security probabilities can be improved by 9-17% by paternal financial support. Therefore, food security is affected by marital status and family structure.

III. Method and Data

I replicate the model presented by Bartfeld and Dunifon (2006, 926) and offer two alterations: additional variables and a non-hierarchical approach. Bartfeld and Dunifon failed to include the household variables for unemployed members, age, and region, so I added these variables to my model. Additionally, I included variables for the total number of household

members and the household's participation in nutrition assistance programs. Because my data allowed me to match household observations to their state-level data, I have combined the two models presented by Bartfeld and Dunifon into a single model. Therefore, my final logistic model can be written as:

$$Ln\left(\frac{probability\ of\ food\ insecurity}{probability\ of\ food\ security}\right) = \alpha_0 + \beta_1 X_{HOUSEHOLD} + \beta_2 X_{STATE} + \varepsilon$$

where α_0 is a constant, $X_{HOUSEHOLD}$ represents a vector of household characteristics (rental status, income, number of children, etc.), X_{STATE} is a vector of state-level characteristics (unemployment rate, median rent, poverty rate, etc.), and ϵ is a random error term. A list of the variables in each vector and their descriptive statistics is presented in Table 1.

TABLE 1–Summary Statistics
N = 53, 013

Variable Name	Anticipated Sign	Min	Max	Mean	Standard Deviation
INSECURE	N/A	0	1	0.1207	0.3258
Household-Level Variables					
Household Nutrition Assistance Program Participation					
WICNUM	+	0	1	0.1207	0.3258
SNAP	+	0	3	0.0317	0.2346
FRCLUNCH	+	0	1	0.0884	0.2839
FRCBREAK	+	0	1	0.0725	0.2594
FRCDC	+	0	1	0.0694	0.2383
SOUPKITCH	+	0	1	0.0135	0.1153
FOODPANTRY	+	0	1	0.0033	0.0570
DELIV	+	0	1	0.0470	0.2116
COMMPROG	+	0	1	0.0039	0.0627
Education					
HSDROP	Omitted	0	1	0.0956	0.2941
HSGRAD	-	0	1	0.2688	0.4433
COLLEGE	-	0	1	0.1801	0.3842
DEGREE	-	0	1	0.4555	0.4980

TABLE 1 - Summary Statistics (continued)

Variable Name	Anticipated Sign	Min	Max	Mean	Standard Deviation
LOWINC	+	0	1	0.1546	0.3615
MIDINC	+	0	1	0.2215	0.4153
HIGHINC	Omitted	0	1	0.4914	0.4999
Number of Members					
HHNUM	+	1	16	3.0100	1.5693
HHKIDS	+	1	8	0.5663	0.9916
Housing Tenure					
OWN	Omitted	0	1	0.6792	0.4668
RENT	+	0	1	0.3102	0.4626
NOPAY	-	0	1	0.0106	0.1025
Employment and Disability Status					
UNEMP	+	0	1	0.0405	0.1971
DISABLED	+	0	1	0.0832	0.2761
Region					
MIDWEST	Omitted	0	1	0.2098	0.4071
SOUTH	±	0	1	0.3578	0.4794
WEST	±	0	1	0.2688	0.4433
NORTHEAST	±	0	1	0.1637	0.3700
Urban/Rural Residency					
RURAL	Omitted	0	1	0.1890	0.3916
METRO	+	0	1	0.8005	0.3997
MISSMETRO	±	0	1	0.0105	0.1019
Age					
AGE	-	15	85	43.7521	14.7521
Ethnicity and Immigration Status					
NVWHITE	Omitted	0	1	0.7481	0.4341
NVAFRIC	+	0	1	0.0921	0.2891
NVASIA	-	0	1	0.0157	0.1244
NVNVA	+	0	1	0.0144	0.1190

TABLE 1 - Summary Statistics (continued)

Variable Name	Anticipated Sign	Min	Max	Mean	Standard Deviation
NTWHITE	+	0	1	0.0349	0.1836
NTAFRIC	+	0	1	0.0067	0.0817
NTASIA	-	0	1	0.0209	0.1431
NTNVA	+	0	1	0.0008	0.0278
NCWHITE	+	0	1	0.0460	0.2094
NCAFRIC	+	0	1	0.0044	0.0662
NCASIA	-	0	1	0.0142	0.1183
NCNVA	+	0	1	0.0019	0.0432
Family Structure					
BIO	Omitted	0	1	0.0616	0.2403
ADOPT	±	0	1	0.0026	0.0510
STEP	+	0	1	0.0105	0.1017
UNPARTNER	+	0	1	0.0583	0.2343
COMPLEX	+	0	1	0.8671	0.3395
State-Level Variables					
TAX	+	5.5000	16.8000	10.2885	2.0227
MEDRENT	+	682.0000	1483.0000	971.8093	217.8492
UNEMPRATE	+	2.8000	7.0000	4.6719	0.8986
POVRATE	+	6.4000	21.1000	12.8224	2.9217
BACHPCT	-	12.0608	23.9775	18.1008	2.6778
PCTNONMOVER	-	38.5000	63.6000	52.7817	4.8657
SNAPRATE	-	21.1581	70.3930	50.3213	10.0514
FRCBREAKRATE	-	25.2032	79.8131	47.3140	10.9967
FRCSUMMRATE	-	1.9797	52.8212	10.2791	9.0232

The data are derived from the December 2016 round of the Food Security Supplement to the Current Population Survey (United States Census Bureau n.d.), which includes 53,013 households. The supplement is conducted annually and takes advantage of the large sample size and experienced interviewers from the traditional Current Population Survey.

I then match the data to state-level data from various government agency sources using the state coding provided by the Current Population Survey.

Food security is measured in the Current Population Survey as high, marginal, low, or very low. For the purposes of this study, households with low and very low food security are considered food insecure, while households with high and marginal food security are considered food secure. Because the resulting dependent variable, INSECURE, is binary (food secure or food insecure), a logistic model is more appropriate than an ordinary least squares model. The coefficients of logistic regression models can also be interpreted as increasing or decreasing the probability of food insecurity, which helps to determine which characteristics are the most influential on food security status.

First, I consider participation in nutrition assistance programs. WICNUM is a count variable for the number of people in the household that received food through the Special Supplemental Nutrition Program for Women, Infants, and Children in the thirty days prior to their interview. In theory, the more participants in the home, the more influence the program has on their food security status. The number of participants is a proxy for the amount of benefit received. SNAP is a binary variable equal to one if anyone in the household received Food Stamps in the past 12 months, and zero otherwise. Similarly, FRCLUNCH, FRCBREAK, and FRCDC equals one if any child in the household received free or reduced-cost lunch, breakfast, or food at day care in the past thirty days, and zero otherwise. I also consider other community food programs. SOUPKITCH, FOODPANTRY, DELIV, and COMMPROG denote whether the family received food from a soup kitchen, food pantry, food delivery program (such as Meals on Wheels), or other community meal program in the past 30 days. By controlling for participation in each program, I can compare the likelihood of food insecurity among the participants in each nutrition assistance program. If the programs target food insecure participants, the variables will have positive coefficients.

The model takes the educational level of the household head into account. Many studies, including the one by Bartfeld and Dunifon (2006), have shown that as education rises, so does the likelihood of food security. The variables are denoted as HSGRAD, COLLEGE, and DEGREE. They equal one if the household head's highest educational attainment was a high school diploma, some college without a degree, or a college degree, and zero otherwise. High school dropouts serve as the omitted category.

Following the results of previous work, I expect each of these variables to have positive associations with food security.

I also control for income. Each household is placed into one of three categories: low, middle, or high income. LOWINC equals one if the household earns below $25,000 annually, whereas MIDINC equals one if the household earns between $25,000 and $50,000 annually, and zero otherwise. High-income households, who earn above $50,000 annually, are omitted for comparison. Past research has shown that lower-income households are more likely to have food insecurity, so I expect both of these variables to have positive coefficients.

Food security depends on the number of household members, especially the number of children. HHNUM is a numerical value for the total number of household members. The coefficient for the variable is expected to be positive because given an income level, feeding more people is more difficult than feeding a few. For example, a $30,000 salary may be sufficient for a family of two, but not a family of eight. HHKIDS captures the number of children in the home. Because children are inherently dependent upon the adults' income, having more children to feed partitions the available food supply into smaller shares for each person. Therefore, the more children there are, the more likely food insecurity exists.

RENT is a binary variable equal to one if the household rents its home for cash, and zero otherwise. If no cash rent is paid, NOPAY is set to one, and zero otherwise. Owning a home or making payments towards owning a home is the excluded category for comparison. Bartfeld and Dunifon (2006) found renters significantly more likely to be food insecure. Therefore, I anticipate the RENT coefficient to be positive. Because the residents who do not pay rent have more of their income to devote to food, I expect the coefficient of NOPAY to be negative.

Employment plays a significant role in food security status. If the household includes an unemployed or disabled member, UNEMP or DISABLED is equal to one, and zero otherwise. These households are at a particular disadvantage because unemployed or disabled people may earn less income and have increased expenses, such as travel expenses for job searches or medical expenses for additional health equipment and services. Therefore, I anticipate both coefficients to be positive.

Following Heflin, Arteaga, and Gable (2012), I also control for regional differences. The Current Population Survey categorizes the states into four regions: the Midwest, the South, the West, and the Northeast. For

this study, each region is a binary variable, taking the value of one if the household resides in that region and zero otherwise. I exclude households from the Midwest to compare regional effects. Although I do not anticipate their coefficients to have any particular sign, accounting for regional differences will identify which regions, if any, are significantly more at risk and in need of more support.

Food insecurity in urban areas is well known (Heflin, Arteaga, and Gable 2012, 35; Anderson et al. 2016, 1089; Noonan, Corman, and Reichman 2016, 208; Arteaga, Heflin, and Gable 2016, 88; Bullinger and Gurley-Calvez 2016, 168). These studies showed that living in an urban or metropolitan area correlates with food insecurity. In this study, rural areas serve as the omitted category. METRO is a binary variable equal to one if the household is located in a metropolitan area, and zero otherwise. Because urban areas are more prone to food insecurity than rural areas, I expect that metropolitan residents are more at risk for food insecurity. MISSMETRO equals one if metropolitan information is unavailable, and zero otherwise. Because inferences cannot be made about the composition of households in the MISSMETRO category, I expect the coefficient of MISSMETRO to be insignificantly different from zero.

AGE is the age of the survey respondent. Several studies found maternal age to be significant in determining food security (Heflin, Arteaga, and Gable 2012, 35; Cook 2013, 43). Because the survey respondent, who is oftentimes the head of the household, may or may not be the mother, my study is somewhat unique. If the head of the household is the mother, my variable for AGE is the same as in previous studies. If the head of the household is her spouse, then my AGE is approximately the same as in previous studies, assuming that the two spouses are of comparable age. Although AGE is a proxy for maternal age, I still anticipate its coefficient to be negative, even if it is not as significant as in past studies. That is, younger household heads are expected to be more likely to be food insecure.

I also analyze the covariates of ethnicity and immigration status as Walsemann, Ro, and Gee did in 2017. In the Current Population Survey, household members were classified as Native, Foreign-Born with U.S. citizenship by naturalization, or Foreign-Born without U.S. citizenship. Survey participants also identified their own ethnicity as either white, black, Asian, or Hawaiian/Native American/Alaskan Native. I ignore all household members who identified as more than one ethnicity because significant differences between each combination are bound to occur.

Using both of their responses, I categorize all of the households by ethnicity and immigration status covariate cohorts, e.g. native whites and naturalized African-Americans. In general, I expect African-American and Native-American non-citizens to be relatively food insecure, compared to white and Asian citizens.

Family structure also contributes to food security status. Balistreri (2012, 7-8) categorized families as biological, step, unpartnered parent, or complex. The Current Population Survey does not use these categories, but instead asks whether each parent is biological, step, adoptive, or not present. Therefore, I define biological families as having both a biological mother and father present, and omit it for comparison purposes. Stepfamilies are defined as having one biological parent and one step parent. If either of the parents is not present, the family is considered to have an unpartnered parent. I also create a category for adoptive families, where either one or both of the parents are adoptive. The remaining families are categorized as complex. As with Balistreri, I expect biological families to be relatively food secure and families with unpartnered parents to be relatively food insecure. I also anticipate adoptive families to perform like biological families.

State-level variables are then introduced. The first set considers budgetary variables. To hold the average household income constant, I include AVGWAGE, a measure of the average wages per job in a given state in 2016, as given by the Bureau of Labor Statistics (United States Department of Labor 2018b). As the average wage falls, less income is available for food expenditures, so I expect the coefficient for AVGWAGE to be negative. TAX is the tax burden, as a percentage of income, of the lowest quintile of the state income distribution, which is available through the Institute on Taxation and Economic Policy (2015). Because a higher tax burden would reduce a household's food budget, I expect TAX to be negatively associated with food security. In the same way, high rent payments reduce available funds for food purchases. I measure the median rent payment, MEDRENT, using the 2016 American Community Survey (United States Census Bureau 2016b). Although state-level budgetary controls are necessary, they are not sufficient to determine the nutritional environment in the state.

To get a better idea of the living conditions of the average state resident, I employ additional variables. UNEMPRATE records the 2016 unemployment rate in each state, as given by the Bureau of Labor Statistics (United States Department of Labor 2018a) and multiplied by

100. The higher the unemployment rate, the higher food insecurity rates I expect. To determine how prevalent poverty is within the state, I use POVRATE to record the poverty rate, multiplied by 100. Although the Census Bureau recorded poverty rates for 2016, I retrieved them from Statista (2018). Still, I expect states with more poverty to have more food insecurity. Because higher education has been associated with food security, I expect that having more people with Bachelor's degrees or higher will decrease the prevalence of food insecurity. BACHPCT measures the graduation rate, as given by the 2016 American Community Survey (United States Census Bureau 2016c), multiplied by 100. PCTNONMOVER denotes the percentage of the population that has not moved since 2010, as of the 2016 American Community Survey (United States Census Bureau 2016a), multiplied by 100. Because people are more inclined to move away from the state in search of better opportunities if they are food insecure, I expect PCTNONMOVER to be negatively associated with food insecurity. Overall, the more of the population who meet the household-level determinants, the less prevalent food insecurity should be.

Finally, I include variables for other nutrition assistance program participation rates. The U.S. Department of Agriculture (2018) holds 2016 data for each program. Following Bartfeld and Dunifon, I calculated SNAPRATE as the number of Food Stamp recipients per 100 households below 185% of the Federal Poverty Line. The 2016 American Community Survey (United States Census Bureau 2017) collected the number of impoverished people. Furthermore, the number of low-income school breakfast participants per 100 low-income school lunch participants is labeled FRCBREAKRATE, while FRCSUMMRATE calculates the ratio of low-income summer food service participants to low-income school lunch participants, multiplied by 100. Participation alleviates food insecurity, so I anticipate each of the variables to have negative coefficients.

IV. Results

AVGWAGE was removed from the model because it was multicollinear with the National School Lunch Program participation variables. If an area has very low wages, more families will be eligible for and participate in the program. Therefore, low participation indicates high wages, and vice versa. Table 3 displays the logistic regression results after AVGWAGE

was removed. Column 2 provides the coefficients; however, for a logistic regression model, it is more appropriate to examine the odds ratios of the variables, as provided in Column 4. The odds ratio can be interpreted by comparing it to the omitted category, whose odds ratio is always equal to 1. The max-scaled R^2 is 0.3501 and is a goodness-of-fit measure for the model.

TABLE 2–Regression Results

N=53,013 max-scaled R^2=0.3501

Variable	**Coefficient**	**Significance Level**	**Odds Ratio**
Intercept	-2.3528	***	N/A
Household-Level Variables			
Household Nutrition Assistance Program Participation			
WICNUM	0.1132	***	1.12
SNAP	0.8473	**	2.33
FRCLUNCH	0.8400	***	2.32
FRCBREAK	-0.0483	***	0.95
FRCDC	0.1535		1.17
SOUPKITCH	1.1357	***	3.11
FOODPANTRY	1.8815	***	6.56
DELIV	0.1307		1.14
COMMPROG	0.3657	**	1.44
Education			
HSDROP		Omitted	
HSGRAD	-0.0972		0.91
COLLEGE	-0.0902	**	0.91
DEGREE	-0.5235		0.59
Income			
LOWINC	1.1374	***	3.12
MIDINC	0.09835		2.67
HIGHINC		Omitted	

TABLE 2–Regression Results (continued)

Number of Members			
HHNUM	0.0207		1.02
HHKIDS	-0.0172		0.98
Housing Tenure			
OWN		Omitted	
RENT	0.5505	***	1.73
NOPAY	-0.0484		0.95
Employment and Disability Status			
UNEMP	0.6161	***	1.85
DISABLED	0.5596	***	1.75
Region			
MIDWEST		Omitted	
SOUTH	0.1275	**	1.14
WEST	0.0917		1.10
NORTHEAST	0.0906		1.10
Urban/Rural Residency			
RURAL		Omitted	
METRO	0.0171		1.02
MISSMETRO	0.2575	*	1.29
Age			
AGE	-0.0058	***	0.99
Ethnicity and Immigration Status			
NVWHITE		Omitted	
NVAFRIC	0.1024	**	1.11
NVASIA	-0.3003	*	0.74
NVNVA	0.2947	***	1.34
NTWHITE	-0.1405		0.87
NTAFRIC	0.2585		1.30
NTASIA	-0.5994	***	0.55
NTNVA	0.4763		1.61

TABLE 2–Regression Results (continued)

Ethnicity and Immigration Status (continued)			
NCWHITE	-0.0832		0.92
NCAFRIC	0.3504	*	1.42
NCASIA	-0.6112	***	0.54
NCNVA	0.3342		1.40
Family Structure			
BIO		Omitted	
ADOPT	0.1271		1.14
STEP	-0.0949		0.91
UNPARTNER	0.1324		1.14
COMPLEX	0.1917	**	1.21
State-Level Variables			
TAX	0.0257	***	1.03
MEDRENT	-0.0003	*	1.00
UNEMPRATE	0.0983	***	1.10
POVRATE	-0.0458	***	0.96
BACHPCT	-0.0419	***	0.96
PCTNONMOVER	0.0055		1.01
SNAPRATE	-0.0057	**	0.99
FRCBREAKRATE	0.0002		1.00
FRCSUMMRATE	-0.0004		1.00
*Significant at 10% level | **Significant at 5% level | *** Significant at 1% level			

Consistent with other studies on the household-level determinants of food insecurity, I found a statistically significant relationship between food insecurity status and income, education, employment and disability status, age, region, and ethnicity. On average, low-income households are 3.12 times more likely to be food insecure than high income households. Household heads with college degrees are 41% less likely to be food insecure than high school dropouts. On average, having an unemployed or disabled member in the household increases food security risk by 75% and 85%. For each additional year the household head ages, the risk of being

food insecure falls by about 1%. Households in the South are 10% more likely to be food insecure than households in the Midwest, on average. Compared to white people, African-Americans and Native Americans are as much as 42% and 61% more likely to be food insecure, whereas Asians are as much as 26% less likely to be food insecure, depending on immigration status.

In regards to the household's nutrition assistance program participation, I found statistically significant relationships between each of the variables and food insecurity, except participation in free and reduced-cost meals at daycare and food delivery services. In the remaining programs, participants are more likely to be food insecure than nonparticipants, with the exception of free and reduced-cost breakfast participants. Most notably, food pantry participants are 6.56 times more likely to be food insecure than nonparticipants. In the case of the Special Supplemental Nutrition Program for Women, Infants, and Children, the risk of food insecurity rises by 12% for each additional household member enrolled.

In addition, I was able to confirm many of Bartfeld and Dunifon's results from their seminal 2006 study. Of the variables not included in other household-level studies, I was able to confirm their results for rental status of the household, and the tax burden and unemployment rate in the state. Renters are 73% more likely to be food insecure than owners, on average. For each percentage increase in the state tax burden on the lowest quintile of income earners, the risk of food insecurity for the state's residents rises by 3%. If the state unemployment rate rises by 1%, the state's residents are 10% more likely to be food insecure.

Though Bartfeld and Dunifon (2006) did not take a covariate approach while analyzing immigration status, they found that noncitizens were prone to food insecurity. Among African-Americans, this appears to be true; non-citizen African-Americans are 42% more likely to be food insecure than white citizens, while native African-Americans are just 11% more likely to be food insecure than white citizens. Among Native Americans, those who are naturalized are the most at risk for food insecurity. For whites and Asians, those born in the U.S. are the most likely to be food insecure. These results suggest that a covariate approach is more appropriate, since the effect of citizenship on food security status is dependent on ethnicity.

This study did not find a statistically significant relationship between being a single parent and food insecurity, unlike Bartfeld and Dunifon

(2006). Because I considered family structure from the child's perspective rather than the marital status of her parents, the results of the two studies are difficult to compare. For Bartfeld and Dunifon, single parents were compared to couples, regardless of their relationship to the child; for this study, single parents were compared to biological families in particular. The only statistically significant relationship found was for complex families, who are 21% more likely to be food insecure than biological families.

Unlike Bartfeld and Dunifon (2006), I found that residents of states with high proportions of people with Bachelor's degrees are less likely to be food insecure. For each additional percentage increase in the population with Bachelor's degrees or more, the likelihood of the state's residents being food insecure falls by 4%. Bartfeld and Dunifon expected this result, suggesting that my study captures a more realistic relationship between food insecurity and the state population's educational attainment.

Though the state's median rent is statistically significant at the 10% level, it is practically insignificant. In other words, the coefficient for MEDRENT is so small that even large changes in the state's median rent will have little effect on the food security status of the state's residents. Bartfeld and Dunifon (2006) found a stronger relationship and suggested that high median rent signifies high risk of food insecurity. More research is needed in this area to determine how much MEDRENT influences food security.

I was unable to find a significant relationship between food security status and urban residency or the number of children in the household. Among the state's characteristics, I was also unable to find the variables for the National School Lunch Program participation and percentage of non-movers statistically significant. With the exception of the number of children, each of the coefficients had predictable signs. Perhaps the discrepancy between my results and previous ones is due to differences in the variables used. In other words, perhaps the previously significant variables served as proxies for variables I have included in this study.

V. Conclusion

While many studies have investigated the relationships between food insecurity and household characteristics, only one previous study investigated how state characteristics influence food insecurity. After collecting data from the 2016 Food Security Supplement to the Current

Population Survey, I used a logistic regression and found that the availability and accessibility of affordable food in the state affects the prevalence of food insecurity. These results have significant implications for policy. Because soup kitchens and food pantries attract the most food insecure people, perhaps states should partner with local communities to enroll participants in other nutrition assistance programs and services. Also, because non-citizens, especially of African background, tend to be more food insecure, visa travelers should be informed about the nutrition assistance programs offered. Perhaps food insecurity could be prevented by spreading awareness about the resources available to them before they reach the country. States should also consider decreasing their taxes on the lowest quintile of income earners, making Food Stamps and other assistance programs more accessible, and encouraging economic growth to boost employment. Because this study used national data, it may generalize the conditions associated with food insecurity risk. By studying smaller areas such as a particular city, the state's resources can be targeted to the populations deemed most at risk. After all, identifying the food insecure is the first step in overcoming the food insecurity epidemic in America.

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Appendix 1: Questions to determine food security status

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)

Source: United States Department of Agriculture 2018b.

Appendix 2: Regression results from Bartfeld and Dunifon (2006)

Variable	Coefficient	Significance Level
Intercept	-2.33	***
Household-Level Variables		
Income		
Income/Poverty Ratio	-0.48	***
Ratio Squared	-0.05	***
Missing Income	-0.01	
Education		
Less than High School	Omitted	
High School	-0.12	***
Some College	-0.18	***
College Degree or More	-0.71	***
Race		
White non-Hispanic	Omitted	
Black	0.18	***
Hispanic	0.13	***
American Indian	0.32	***
Asian	-0.05	
Housing Tenure		
Own	Omitted	
Rent	0.42	***
Live without Paying	0.02	
Location		
Central City	0.10	***
Other Metropolitan	Omitted	
Nonmetropolitan	-0.09	***
Missing	-0.26	
Number of Children		
1	Omitted	
2	0.03	
3	0.18	***
4 or more	0.26	***

Appendix 2 (continued)

Variable	Coefficient	Significance Level
Family Type		
Couple with Children	Omitted	
Single Mother	0.51	***
Single Father	0.05	***
Other household with children	0.10	**
Household Characteristics		
Any employed in household	-0.18	***
Any elderly in household	-0.31	***
Any disabled in household	0.69	***
Any noncitizens in household	0.10	**
State-Level Variables		
Federal Food Programs		
Food Stamp Recipients per 100 Poor Persons	-0.002	
Low-Income School Breakfast Participants per 100 Low-Income School Lunch Participants	-0.001	
Low-Income Summer Food Service Program Participants per 100 Low-Income School Lunch Participants	-0.004	**
Low-Income Summer School Lunch Participants per 100 Low-Income School Lunch Participants	-0.009	***
Economic Policies		
Low-Income Tax Burden	0.016	**
Overall Tax Burden	0.015	
Economic Attributes		
Unemployment Rate	0.063	**
Poverty Rate	0.004	
Percent with Bachelor's Degree	0.011	**
Average Wages per Job ($1,000s)	-0.035	***
Median Rent ($100s)	0.161	***
Social Attributes		
Percentage Nonmovers	-0.011	***

*Significant at 10% level | **Significant at 5% level | ***Significant at 1% level