Effects of COVID-19 Pandemic and Poverty on Food Insecurity: Yearly Spatial Analysis

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Abstract

Spatial regression analysis was applied separately to the annual US state-level food insecurity data from 2015 through 2018, and 2020 to examine the effects of race, region of residency, and poverty particularly due to the COVID-19 pandemic. The results of the analysis suggested that the US food insecurity level was trending downwards between 2015 and 2018 but increased by 33.5% in 2020, obviously due to the COVID-19 pandemic. Also, residents from the West experienced higher food insecurity levels relative to the Mid-West between 2015 and 2018. The analysis also revealed that race is not a determining factor of food insecurity as both White and Black are equally affected to a significant level. Rather, the most salient determinant of food insecurity is poverty. The effects of poverty were positive and strongly significant from 2015 through 2018. The effect was, however, mild in 2020 probably due to the stimulus and unemployment checks people received through the Care Act. This result underscored the importance of SNAP and other government intervention programs in addressing the country's food insecurity problems.

Keywords

Food Insecurity, Demographic, Spatial, COVID-19, Poverty

1. Introduction

The US Department of Agriculture (USDA) describes food insecurity as a lack of steady access to enough food for active and healthy living [1]. Level of food security is categorized into high food security, marginal food security, low food security, and very low food security. High food security is linked to households with no problems or anxiety about consistent access to adequate food; and for marginal food security, households had problems or anxiety at times about ac-

cessing adequate food, but the quality, variety, and quantity of their food were not substantially reduced. With regards to low food security, households reduced the quality, variety, and desirability of their diets, but the quantity of food intake and normal eating patterns were not substantially disrupted while very low food insecure households, their eating pattern of one or more members were disrupted and food intake reduced because the household lacked money or other resources of food at times during the year [2].

Food insecurity impacted over 37 million Americans including 11 million children in 2018, and African Americans and Latinos are among the most affected populations [3]. An estimated 11.8 percent of American households were food insecure at least sometime during the year in 2017, meaning they lacked access to enough food for an active, healthy life for all household members [4]. This was down from 12.3 percent in 2016. The prevalence of very low food security also declined to 4.5 percent from 4.9 percent in 2016. The increased rate of poverty, unemployment, and inconsistent access to enough healthy food in the US has made it challenging to completely eradicate the issue of food insecurity. Food insecurity is associated with a variety of problems including serious health complications such as anxiety, anemia, birth defects, and depression. Studies have shown that children in food-insecure households had 2.0 - 3.0 times higher odds of having anemia, 2.0 times higher odds of being in fair or poor health, and 1.4 - 2.6 times higher odds of having asthma [5] [6] [7].

There is also a growing concern about the ethnic and racial disparity of food insecurity among Americans. The national average of household food insecurity is 14% whereas Hispanic and African American households have an average of 22.4% and 26% respectively, compared to 11% for White non-Hispanics [2] [8]. Food insecurity is also associated with poverty for older adults, which was 18.4% for older African Americans, 17.5% for older Hispanics, and 8.8% for the US population in 2015 [9].

Regionally, the food insecurity rate was higher in the South, 11.2% than in the Northeast (9.6%), and West (10.2%). Food insecurity in the South was not substantially different from the food insecurity rate in the Midwest, 10.5% [10].

Several interventions to address food insecurity have been made to strengthen and make it easier for families to connect to the existing federal food and nutrition safety nets such as the Supplemental Nutrition Assistance Program (SNAP), and Women, Infants, and Children (WIC) assistance. SNAP has been the principal effort of the US government to eradicate food insecurity and nutrition-related issues due to poverty by supplementing the food budgets of low-income households. About 44.8% of SNAP recipients are a household with children, 20.3% are a household with disabled non-elderly individuals, and 17.4% are households with elderly [11]. SNAP participation reduced food insecurity in SNAP households by 6% - 17% and severe food insecurity was reduced by 12% - 19% [12]. Changes made in food assistance policy can have impacts on

economic activity and household income across the economy [13].

Other published research articles have also associated race, disability, unemployment, and poverty with food insecurity through multiple pathways [14] [15] [16] [17] [18]. The aforementioned articles have shown evidence that adults and children with any form of disability are more likely to be food insecure compared to healthy adults and children; non-Latino Blacks and Latinos experience higher rates than non-Latino whites. The decline in employment and high inflationary conditions also strongly impact the level of food security.

Finally, the COVID-19 pandemic has in the past year threatened the accessibility of food through the effects on food costs, and infrastructure, including changes in food assistance distribution, public transit access, and shortages of certain products, and widespread changes in food purchasing behaviors. The pandemic has induced a global economic crisis which happens to be the most serious crisis in the global economy since the end of the Second World War. The strategic response of the COVID-19, including lockdown and social-distancing, have negatively affected economic activity resulting in an increased unemployment rate and the number of households fallen below the poverty threshold [1]. According to the FAO, the consequences of COVID-19 will be largest for the unemployed, workers in the informal sector, and other vulnerable groups (e.g., women and children) [19].

Even though the food insecurity data is not released until September of the following year, Feeding America has employed the imputation method to make projections about the geography of food insecurity in 2020, and how food insecurity rates may have changed due to COVID-19 since 2018. The projection has accounted for the economic impacts of COVID-19 such as unemployment and its accompanied poverty [20]. Food insecurity is the direct result of poverty as McKenzie [21] concludes.

This study employs spatial regression techniques to separately examine the annual regional, demographic, and poverty effects on food insecurity in the U.S between 2015 and 2018; and 2020 particularly the effects of the Covid-19 pandemic. The paper is organized into six sections. Section 2 discusses the theoretical framework; the empirical application is presented in Section 3 while the data construction and sources, and estimation procedures are presented in Section 4; Section 5 presents the results and discussions; and Section 6, summary and conclusion.

2. Theoretical Model

The model is derived from the household's utility maximization and defined as:

$$u = f(x), \text{ subject to income } (I) \text{ constraint} \tag{1}$$

such that $I = p_x \cdot X$. Where, p_x is the price of the bundle of food consumed; and I, the income.

$$U(X) = f(x) = P_x X \tag{2}$$

For a unit cost,

$$P_x = 1 \tag{3}$$

Inserting (3) into (2) gives:

$$U(X) = X(I) \tag{4}$$

$$\frac{\mathrm{d}u}{\mathrm{d}x} = \frac{\mathrm{d}x}{\mathrm{d}x}(I) \tag{5}$$

$$x = f(I) \tag{6}$$

Since the primary goal of the study is to examine the effects of poverty on food security, we assume poverty (z) as a proxy of income. Dummy variables were included in the model such that, $r = 0$, represents the Mid-West; 1, Northeast; 2, South and 3, West. For race, the number of Black population was represented by b, and w, for the number of Whites.

Equations (5) can be implicitly written as

$$x = f(z, r, b, w) \tag{7}$$

3. Empirical Model

Equation (7), which is a yearly model is applied to a spatial regression technique to examine the regional, demographic, and poverty effects on food security in the US Equation (7) can be structurally written as below:

$$x_t = f(\beta_1 z_t + \beta_2 w_t + \beta_3 b_t + \beta_4 r + e_t) \tag{8}$$

where x_t = the level of food insecurity at time t; z_t = number of respondents that fall below the federal poverty level for the period t; w_t = number of Whites for the year under study; b_t = number of Blacks; r = region; e_t = an error term for the study period; and $\beta_1 \ldots \beta_4$ = coefficients of the variables.

## 4. Data Construction and Source, and Estimation Procedures

The state-level food insecurity data from 2015 to 2018 and projections for 2020 was obtained from Feeding America, Map the Meal Gap [22]. Even though data for 2019 is yet to be released, Feeding America made projection for 2020 to quickly isolate the impacts of the pandemic. It supplies information on the number of persons with some level of food insecurity and accounts for economic changes such as unemployment. Data on the number of Blacks, Whites living below the poverty line for each state was obtained from the World Population Review [23]. A dummy variable representing region was introduced with 0 representing the Mid-west, 1 for the Northeast, 2 for the South, and 3, representing the West. Equation (8) was applied to annual data and each estimated using the R software.

5. Results and Discussions

Figure 1 presents the trend of persons in the US with some level of food inse-

curity from 2015 to 2018, and 2020. It reveals that the average number of food-insecure persons has fallen from 44.58 million in 2015 to 39.92 million in 2018, representing a reduction of about 10%. This reduction may be due to the intervention of government food and nutrition assistance programs including SNAP and WIC [12]. However, in 2020 as expected, the average number of food insecurity increased from 39.92 million to 53.29 million, about 33%. This uptake may be due to the COVID-19 pandemic [21].

The average number of persons with some level of food insecurity per state between 2015 and 2018 is presented in **Figure 2**. From the map, the states with lighter colors represent low number of food insecurity and darker, a high number. The top five states and districts with the lowest number of food insecurity are North Dakota, Washington DC, Wyoming, South Dakota, and Alaska, all
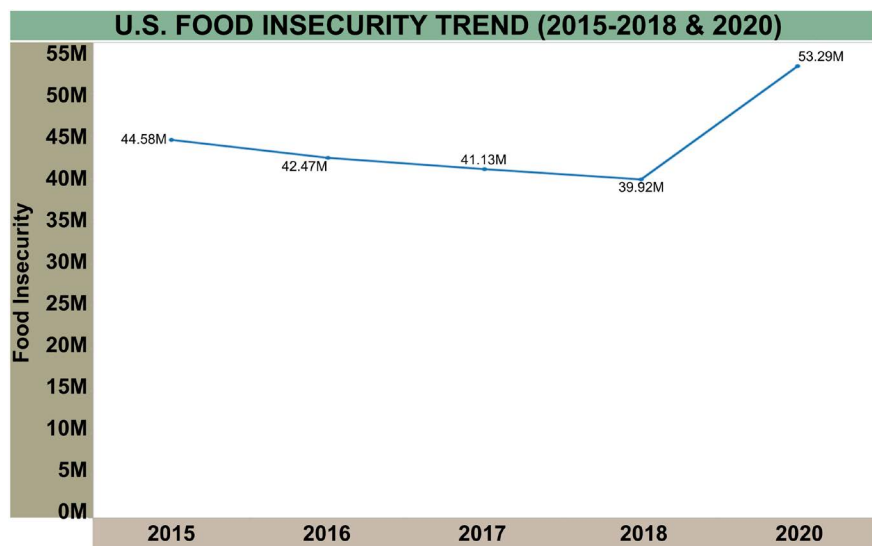
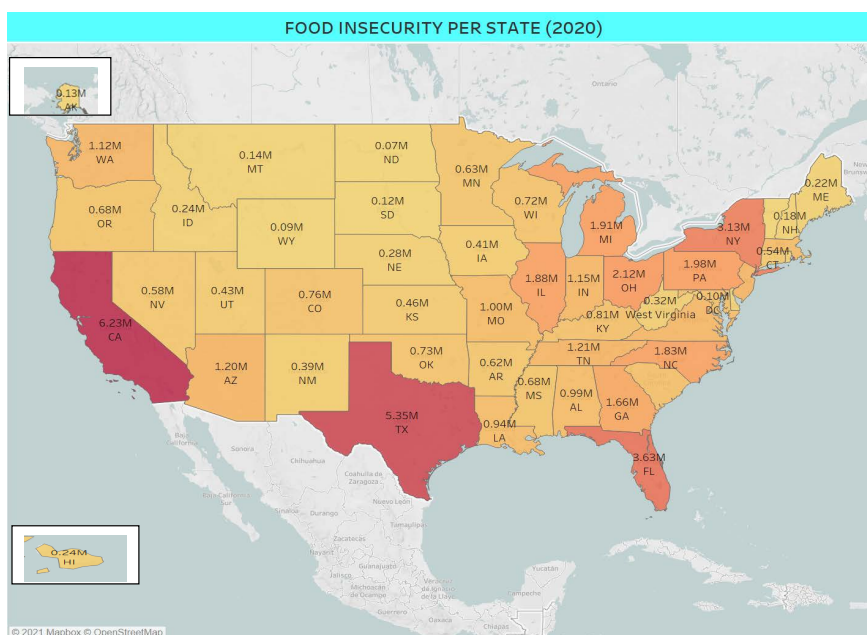**Figure 1.** US food insecurity trend. Source: Author's computation based on the data.
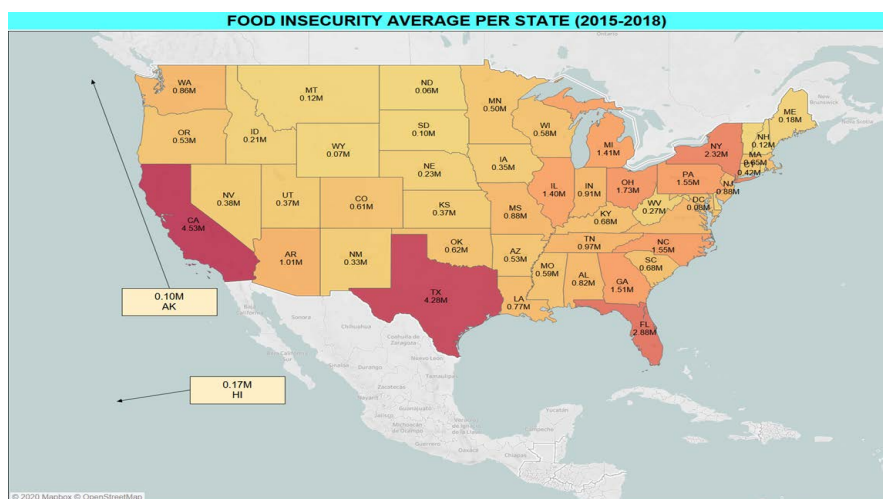
Figure 2. US food insecurity state average (2015-2018). Source: Author's computation based on the data.

recording under 0.2 million each while California, Texas, Florida, New York, and Ohio ranked at the bottom with food-insecure persons, all over 1.7 million. California ranked highest with 4.54 million with New York in a close second (4.28 million), and Ohio, having the least (1.73 million).

Figure 3 presents the food insecurity level by the state in 2020. The result showed that Ohio had 2.12 million food-insecure persons. This was up from the average of 1.73 million in 2015-2018, representing an increase of 23%. The situation was even worse for California, Texas, Florida, and New York. California and Texas recorded 6.23 million and 5.35 million, respectively. Florida and New York did not fare better either, 3.63 million and 3.13 million, respectively. All these states recorded at least 20% more, food-insecure persons in 2020 than the 2015-2018 average. The top five most food-secure states and districts in 2020 were North Dakota, Wyoming, Washington DC, South Dakota, and Alaska. North Dakota and Wyoming recorded the least, 0.07 million and 0.09 million, respectively while Washington DC, South Dakota, and Alaska had 0.10 million, 0.12 million, and 0.13 million food insecure persons. But all these states and districts have seen an increase of at least 17% above to 2015-2018 averages. As expected, almost every state saw an increased number of persons with some level of food insecurity in 2020. This result was consistent with the findings of [21].

Table 1 presents the yearly regression analyses of the regional distribution of food insecurity persons as affected by poverty and race in the US, race from 2015 to 2018, and 2020. The result showed that Black was significant ($p < 0.01$) and positive in all the years, 2015 through 2018 with an average coefficient of 0.094. Black was significant ($p < 0.05$) again in 2020 but negative with a coefficient

Figure 3. US food insecurity state average (2020). Source: Author's computation based on the data.

Table 1. Regression analyses of food insecurity by year.

	Dependent variable: Food Insecurity				
	2015	2016	2017	2018	2020
	(1)	(2)	(3)	(4)	(5)
log (Black)	0.158***	0.073***	0.054*	0.092***	−0.502**
	(0.029)	(0.027)	(0.029)	(0.032)	(0.213)
log (White)	0.590***	0.330***	0.355***	0.410***	−0.132
	(0.064)	(0.067)	(0.067)	(0.075)	(0.489)
log (Poverty)	0.212***	0.581***	0.579***	0.467***	1.204*
	(0.062)	(0.081)	(0.084)	(0.086)	(0.608)
Region: Northeast	−0.030	0.048	0.001	0.025	−0.410
	(0.076)	(0.058)	(0.059)	(0.060)	(0.425)
Region: South	0.065	0.060	0.112*	0.100	−0.002
	(0.080)	(0.059)	(0.059)	(0.063)	(0.428)
Region: West	0.278***	0.194***	0.153**	0.148**	−0.762*
	(0.078)	(0.061)	(0.064)	(0.064)	(0.433)
Constant	−0.426	−0.355	−0.487	−0.365	6.071***
	(0.413)	(0.318)	(0.322)	(0.345)	(2.210)
Observations	51	51	51	51	51
R2	0.979	0.987	0.987	0.986	0.314
Adjusted R2	0.976	0.985	0.985	0.984	0.220
Residual Std. Error (df = 44)	0.171	0.131	0.133	0.135	0.957
F Statistic (df = 6; 44)	335.852***	561.839***	544.553***	528.710***	3.357***

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

of −0.502.[1] This implies that a 1% increase in the Black population on average increased the number of persons with some level of food insecurity by 0.1% between 2015 and 2018. But in 2020 the same percentage increase in the Black population rather reduced the number of food insecure inividuals by 0.5%. This result might be attributed to the impacts of the stimulus and the weekly unemployment checks that tax payers received from the Care Act passed in spring 2020. The results of the White population were not different from the Black. The entries for the White population also showed the same positive and significance ($p < 0.01$) for the period 2015 through 2018; and again, significant ($p < 0.05$) but negative in 2020[1]. The effects of poverty on food insecurity from 2015 through 2018; and 2020, suggest that poverty played a significant role in individual Americans' food security statuses during those periods. Thus, food insecurity may not be a racially dependent phenomenon, but rather poverty. The spatial

[1]A separate analysis was conducted to investigate the reasons for the negative sign for black and white in 2020. The results showed that stimulus checks and economic support during COVID-19 may have influenced the negative sign.

examination also revealed that the South had the highest food-insecure persons, almost 0.1% higher relative to the Mid-West. The number of food-insecure persons in the West was significantly higher between 2015 and 2018 compared to the Mid-West. The entries for 2020 indicated the West was significant (p < 0.1) but negative relative to the Mid-West. The coefficient of −0.762 implies that the number of food-insecure persons in the West in 2020 was about 0.8% lower than those in the Mid-West.

6. Summary and Conclusion

The goal of this paper was to examine the yearly effects of the region of residency, demographic, and poverty on food insecurity in the US, especially during the COVID-19 pandemic. Spatial regression analysis was applied separately to the annual data from 2015 to 2018 and 2020. The results of the analysis suggested that the US food insecurity level was trending downwards between 2015 and 2018 but increased by 33.5% in 2020, obviously due to the COVID-19 pandemic. Also, residents from the West experienced higher food insecurity levels relative to the Mid-West between 2015 and 2018. The analysis also revealed that race was not a determining factor of food insecurity as both White and Black were equally affected to a significant level. Rather, the salient determinant of food insecurity is poverty. The effects of poverty were positive and strongly significant from 2015 through 2018. The effect was, however, mild in 2020 probably due to the stimulus and unemployment checks people received through the Care Act. This result underscored the importance of SNAP and other government intervention programs in addressing the country's food insecurity problems.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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